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OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1860.

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

MECHANICS, USEFUL ARTS, NATURAL PHILOSOPHY, CHEMISTRY, ASTRONOMY, GEOLOGY, ZOOLOGY, BOTANY, MINERALOGY, METEOROLOGY, GEOGRAPHY, ANTIQUITIES, ETC.

TOGETHER WITH

NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1859; A LIST OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF EMINENT SCIENTIFIC MEN, ETC.

EDITED BY

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NOTES BY THE EDITOR

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1859.

The thirteenth meeting of the American Association for the Advancement of Science was held at Springfield, Mass., August 3—9, 1859 — Prof. Stephen Alexander, of Princeton, N. J., in the chair. The attendance of members was large, and the meetings harmonious and interesting. The whole number of papers registered for presentation was 108.

The following gentlemen were elected officers for the ensuing year: President, Isaac Lea, of Philadelphia; Vice President, Dr. B. A. Gould, jr., of Cambridge; Secretary, Prof. Joseph LeConte, of South Carolina; Treasurer, Dr. A. L. Elwyn, of Philadelphia.

The Standing Committee recommended that a Winter Session be held in some Southern city in the winter of 1860-1.

A new expedition, by Lieut. Gillies, to South America, for the more accurate determination of the Solar Parallax, was recommended, and a committee of seven appointed to confer with him, and further the enterprise.

The Association adjourned to meet in Newport, R. I., August 1st, 1860.

The twenty-ninth annual meeting of the British Association for the Promotion of Science, was held at Aberdeen, Scotland, September 1859 — Prince Albert in the chair. The attendance on the part of the members and the public was unusually large, and the communications numerous and important.

The meeting for 1860 was appointed to be held in Oxford, Lord Worthlesley being the President elect.

From the report of the Council, we learn that the difficulties which have hitherto presented themselves in the way of a daily photographic record of the sun's disk, have been almost entirely surmounted.

"It has been found, after repeated trials, that the best photographic definition is obtained when the sensitized plate is situated from 1-10th to 1-8th of an inch beyond the visual focus in the case of a 4-inch picture; and that when the adjustment is made, beautiful pictures are obtained of the sun four inches in diameter, which still bear magnifying with a lens of low power, and show considerable detail on the sun's surfaces besides the spots, which are well defined. Mr. De la Rue, by combining two pictures obtained by the Photoheliograph at an interval of three days, has produced a stereoscopic image of our luminary, which presents to the mind an idea of sphericity. Under Mr. De la Rue's direction, Mr. Beckley is making special experiments, having for their object the determination of the kind of sensitive surface best suited for obtaining perfect pictures; for it has been found that the plates are more liable to stains of the various kinds, known to photographers, under the circumstance of exposure to intense sun-light, than they could be if employed in taking ordinary pictures in the camera. Now that the photographic apparatus has been brought to a workable state, Mr. De la Rue and Mr. Carrington, joint Secretaries of the Astronomical Society, propose to devote their attention to the best means of registering and reducing the results obtained by the instrument."

The customary review of the recent progress of science having been omitted from the annual address by the president, the deficiency was supplied, in part, by addresses from the presiding officers of the sections, on assuming their respective chairs.

Prof. Owen, in assuming the chair of the section on Zoölogy, etc., noticed the progress of Natural Science in Australia and the United States, as follows:

" But it is in the younger countries where we see an advance more evident. Australia and Van Diemen's Land, now that wealth permits time and luxury, have attended to science, and in most of the journals of those countries we have original observers, and by-and-by we shall have the results of the study of the remarkable productions of these lands made where they live and grow. New Zealand also has its scientific journal. It is, however, in the New World where the greatest activity at present prevails. She has already, with credit to herself, sent out scientific expeditions of a general character, and those of Wilkes and Rae and Kane are well known, and huge works have sprung from each. But the boundings of territory now claimed by the American people have given rise to surveys and exploratory expeditions at home, and these are proceeding in all directions to fix the boundary lines, and the best railway routes to the Pacific. Naturalists and draftsmen accompany each expedition, the results of which are published in reports to Congress, in which they are assisted by the Smithsonian Institution of Washington. But the work of the greatest magnitude and importance to America is, 'Contributions to the Natural History of the United States,' by Agassiz, advertised to be completed in ten large volumes. Two volumes for the first year, on the Testudinata or Tortoises, have been published, illustrated by thirty-four plates. An important part of these volumes is an introductory essay, which has been re-published separately in an 8vo volume. Louis Agassiz's 'Essay on Classification,' embraces the whole range of the subject, which he treats in a wider and more comprehensible and less mechanical manner than has hitherto been done. But while I thus praise the work, and the manner in which it is treated, and agree with a great many of the positions he has taken up, I must warn its readers that some subjects are treated in a way Prof. Agassiz will not be able to maintain; and that, to those who are unable or unwilling to think for themselves, the author's reputation will prove a guarantee not altogether to be trusted. It must be studied with great care and great caution. Nevertheless, I look upon it as the remarkable book of the year. There is another work, upon a similar subject, advertised, from which we may expect some curious reasonings, 'On the Origin of Species and Varieties,' by Charles Darwin."

At the opening of the Geological section, Sir Charles Lyell reviewed the subject of the "Geological Age of Man," with special reference to the researches which have been recently brought before the public.

"No subject," he said, "has lately excited more curiosity and general interest among geologists and the public than the question of the antiquity of the human race, — whether or no we have sufficient evidence to prove the former coëxistence of Man with certain ex- inct
te~~rna~~l mammalia, in caves, or in the superficial deposits commonly called 'drift,' or 'deluvium.' For the last quarter of a century, the occasional occurrence, in various parts of Europe, of the bones of man, or the works of his hands, in cave-breccias and stalactites, associated with the remains of the extinct hyæna, bear, elephant, or rhinoceros, have given rise to a suspicion that the date of man must be carried further back than we have heretofore imagined. On the other hand, extreme reluctance was naturally felt, on the part of scientific reasoners, to admit the validity of such evidence, seeing that so many caves have been inhabited by a succession of tenants, and have been selected by man as a place not only of domicile but of sepulture, while some caves have also served as the channels through which the waters of flooded rivers have flowed, so that the remains of living beings which have peopled the district at more than one era may have subsequently been mingled in such caverns, and confounded together in one and the same deposit. The facts, however, recently brought to light during the systematic investigation, as reported on by Falconer, of the Brixham Cave, must, I think, have prepared you to admit that skepticism in regard to the cave-evidence in favor of the antiquity of man, had previously been pushed to an extreme. To escape from what I now consider was a legitimate deduction from

the facts already accumulated, we were obliged to resort to hypotheses requiring great changes in the relative levels and drainage of valleys, and, in short, the whole physical geography of the respective regions where the caves are situated — changes that would alone imply a remote antiquity for the human fossil remains, and make it probable that man was old enough to have coëxisted, at least, with the Siberian mammoth. But, in the course of the last fifteen years, another class of proofs have been advanced, in France, in confirmation of man's antiquity, into two of which I have personally examined in the course of the present summer, and to which I shall now briefly advert. First, so long ago as the year 1844, M. Aymard, an eminent palæontologist and antiquary, published an account of the discovery, in the volcanic district of Central France, of portions of two human skeletons — the skulls, teeth, and bones — imbedded in a volcanic breccia, found in the mountain of Denise, in the environs of Le Puy en Velay, — a breccia anterior in date to one, at least, of the latest eruptions of that volcanic mountain. On the opposite side of the same hill, the remains of a large number of mammalia, most of them of extinct species, have been detected in tufaceous strata, believed, and I think correctly, to be of the same age. The authenticity of the human fossils was from the first disputed by several geologists, but admitted by the majority of those who visited Le Puy, and saw with their own eyes the original specimen now in the museum of that town. Among others, M. Pictet, so well known to you by his excellent work on Palæontology, declared, after his visit to the spot, his adhesion to the opinions previously expressed by Aymard. My friend Mr. Scrope, in the second edition of his 'Volcanoes of Central France,' lately published, also adopted the same conclusion, although after accompanying me this year to Le Puy, he has seen reason to modify his views. The result of our joint examination — a result which, I believe, essentially coincides with that arrived at by MM. Hebert and Lartet, names well known to science, who have also this year gone into this inquiry on the spot — may thus be stated. We are by no means prepared to maintain that the specimen in the museum at Le Puy — which, unfortunately, was never seen *in situ* by any scientific observer — is a fabrication. On the contrary, we incline to believe that the human fossils in this, and some other specimens from the same hill, were really imbedded by natural causes in their present matrix. But the rock in which they are entombed consists of two parts, one of which is a compact, and, for the most part, thinly laminated stone, into which none of the human bones penetrate; the other, containing the bones, is a lighter and much more porous stone, without lamination, to which we could find nothing similar in the mountain of Denise, although both M. Hebert and I made several excavations on the alleged site of the fossils. M. Hebert, therefore, suggested to me that this more porous stone, which resembles in color and mineral composition, though not in structure, parts of the genuine old breccia of Denise, may be made up of the older rock, broken up, and afterwards re-deposited, — or, as the French say, *remané*, — and therefore of much newer date; an hypothesis which well deserves consideration; but I feel that we are, at present, so ignorant of the precise circumstances and position under which these celebrated human fossils were found, that I ought not to waste time in speculating on their probable mode of interment, but simply state that, in my opinion, they afford no demonstration of Man having witnessed the last volcanic eruptions of Central France. The skulls, according to the judgment of most competent osteologists who have yet seen them, do not seem to depart in a marked manner from the modern European, or Caucasian, type, and the human bones are in a fresher state than those of the *Elephas meridionalis* and other quadrupeds found in any breccia of Denise which can be referred to the period even of the latest volcanic eruptions. But, while I have thus failed to obtain satisfactory evidence in favor of the remote origin assigned to the human fossils of Le Puy, I am fully prepared to corroborate the conclusions which have been recently laid before the Royal Society by Mr. Prestwich, in regard to the age of the flint implements associated in undisturbed gravel, in the North of France, with the bones of elephants at Abbeville and Amiens. These were first noticed at Abbeville, and their true geological position assigned to them by M. Boucher de Perthes, in 1849, in his 'Antiquités Celtiques,' while those of Amiens were afterwards described in 1855, by the late Dr. Rigollot. For a clear statement of the facts, I may refer you to the abstract of Mr. Prestwich's Memoir, in the Proceedings of the Royal Society for 1859, and have only to add that I have myself obtained abundance of Flint Implements (some of which are laid upon the table) during a short visit to Amiens and Abbeville. Two of the worked flints of Amiens were discovered in the gravel-pits of St. Acheul — one at the depth of ten, and the other of seventeen feet below the surface, at the time of my visit; and M. Georges Pouchet, of Rouen, author of a work on the Races of Man, who has since visited the spot, has extracted with his own hands one of these implements, as Messrs. Prestwich and Flower had done before him. The stratified gravel resting immediately on the chalk in which these rudely fashioned instruments are buried, belongs to the post-pliocene period, all the freshwater and land shells which accompany them being of existing species. The great number of the fossil instruments, which have been likened to hatchets, spear-heads, and wedges, is truly wonderful. More than a thousand of them have already been met with, in the last ten years, in the valley of the Somme, in an area fifteen miles in length. I infer that a tribe of savages, to whom the use of iron was unknown, made a long sojourn in this region; and I am reminded of a large Indian mound, which I saw in St. Simond's Island, in

Georgia — a mound ten acres in area, and having an average height of five feet, chiefly composed of cast-away oyster shells, throughout which arrow-heads, stone axes, and Indian pottery are dispersed. If the neighboring river, the Alatamaha, or the sea which is at hand, should invade, sweep away, and stratify the contents of this mound, it might produce a very analogous accumulation of human implements, unmixed perhaps with human bones. Although the accompanying shells are of living species, I believe the antiquity of the Abbeville and Amiens flint instruments to be great indeed if compared to the times of history or tradition. I consider the gravel to be of fluviatile origin, but I could detect nothing in the structure of its several parts indicating cataclysmal action — nothing that might not be due to such river-floods as we have witnessed in Scotland during the last half-century. It must have required a long period for the wearing down of the chalk which supplied the broken flints for the formation of so much gravel at various heights, sometimes one hundred feet above the level of the Somme, for the deposition of fine sediment including entire shells, both terrestrial and aquatic, and also for the denudation which the entire mass of stratified drift has undergone, portions having been swept away, so that what remains of it often terminates abruptly in old river-cliffs, besides being covered by a newer unstratified drift. To explain these changes I should infer considerable oscillations in the level of the land in that part of France, — slow movements of upheaval and subsidence, deranging but not wholly displacing the course of the ancient rivers. Lastly, the disappearance of the Elephant, Rhinoceros, and other genera of quadrupeds now foreign to Europe, implies, in like manner, a vast lapse of ages, separating the era in which the fossil implements were framed and that of the invasion of Gaul by the Romans. Among the problems of high theoretical interest which the recent progress of Geology and Natural History has brought into notice, no one is more prominent, and, at the same time, more obscure, than that relating to the origin of species. On this difficult and mysterious subject a work will very shortly appear, by Mr. Charles Darwin, the result of twenty years of observation and experiments in Zoölogy, Botany, and Geology, by which he has been led to the conclusion, that those powers of nature which give rise to races and permanent varieties in animals and plants, are the same as those which, in much longer periods, produce species, and, in a still longer series of ages, give rise to differences of generic rank. He appears to me to have succeeded, by his investigations and reasonings, to have thrown a flood of light on many classes of phenomena connected with the affinities, geographical distribution, and geological succession of organic beings, for which no other hypothesis has been able, or has even attempted, to account. Among the communications sent in to this Section, I have received from Dr. Dawson, of Montreal, one confirming the discovery which he and I formerly announced, of a land shell, or pupa, in the coal formation of Nova Scotia. When we contemplate the vast series of formations intervening between the tertiary and carboniferous strata, all destitute of air-breathing Mollusca, at least of the terrestrial class, such a discovery affords an important illustration of the extreme defectiveness of our geological records. It has always appeared to me that the advocates of progressive development have too much overlooked the imperfection of these records, and that, consequently, a large part of the generalizations in which they have indulged in regard to the first appearance of the different classes of animals, especially of air-breathers, will have to be modified or abandoned. Nevertheless, that the doctrine of progressive development may contain in it the germs of a true theory, I am far from denying."

One of the most interesting of recent contributions to Chemical Science, is a Memoir by the well-known Swiss Chemist, Schonbein, "On the result of twenty years study of oxygen." The principal points which he desires to establish are as follows: He recognizes the existence of oxygen in three conditions. One, ordinary oxygen, that which we respire from the atmosphere; the two other kinds are two forms of ozone, which bear the same relation to each other that the two forms of electricity possess. In fact, says Schonbein, we form ordinary oxygen when we bring these two kinds of ozone together; and, on the other hand, ordinary oxygen is destroyed when, by any given chemical action, one of these two allotropic modifications that compose it is removed.

The tendency, on the part of the two modifications, to be produced from ordinary oxygen, explains certain effects heretofore called *catalytic*, which have been unaccountable. Thus, peroxide of barium and oxygenated water, being acidified by nitric acid, are reciprocally decomposed, giving rise to the formation of water, protoxide of barium, and ordinary oxygen; under similar circumstances, permanganate of potassa is reduced to manganic oxide, and chromic acid becomes oxide of chrome; that is to say, these compounds are deoxidized in the presence of an abundant source of oxygen, and precisely from the contact of that particular form of oxygen, or ozone, whose oxidizing properties are effective in the direct oxidation of the least oxidizable bodies, such as nitrogen, which is, as we know, directly transformed, under the influence of ozone, into nitric acid. These effects, so contradictory, are thus explained by Schonbein: A combination strongly oxygenous can be decomposed in the presence of a compound, rich in oxygen, whenever one of the compounds contains oxygen in the condition that may be called *positive*, and the other in that which may be called *negative*. The result of this decomposition is ordinary, or *neutral* oxygen. It is this, moreover, which is obtained, when we experiment with ozone obtained with phosphorus by the action of oxygenized water — the product being pure water and ordinary oxygen. Therefore, in order that ozone or nascent oxygen, obtained by phosphorus, should act as an energetic oxidizer, it is necessary that it should not be in presence of nascent oxygen produced from oxygenized water. Thus, an acid loses its acid properties in presence of a base, and reciprocally; and ozone, affected with a sign + loses its oxidizing properties in the presence of ozone of the sign —.

The new classification of Reptiles, as proposed by Prof. Owen, in a paper laid before the British Association at its last meeting, must be regarded as one of the most important of recent contributions to Natural History. The sub-class of Reptiles, which was formerly divided into four orders, the Professor now proposes to divide into thirteen. This revision has resulted from the study of the fossil forms which have been found in such abundance in the secondary strata of the earth's surface. At the head of the Reptile Orders he places an extinct form, — Archegosaurus, — and in the lowest Order the Batrachian Reptiles (the toads and frogs). He still retains these amongst the reptiles, on account of the difficulty of distinguishing between them and the Chelonia, or tortoises and turtles. At the same time, the Professor acknowledges his inability to distinguish between the Batrachia and the next group of animals, the Fishes.

The investigations of Prof. Faraday on Electricity, recently communicated to the public through the Royal Institution, seem to almost conclusively settle the question as regards the nature of this subtle agent, and must be considered as one of the memorable scientific incidents of the year.

During the past year the Exploring Expedition, despatched in the spring of 1853, by Lady Franklin, under Capt. McClintock, R. N., has returned, bringing relics, and definite information respecting the lost navigators. The details of the expedition are briefly as follows: — "After visiting Beachy Island where it was known Sir John Franklin passed his first winter, Capt. McClintock continued his course down Peel's Sound, in the direction of the magnetic pole, and established his winter position at the entrance to Bellot Strait, in a snug harbor, which he called Port Kennedy. To Lieut. Hobson he allotted the search of the western shore of Boothnia to the magnetic pole, while he himself went southward, toward the same point, in the hope of communicating with the Esquimaux, and obtaining such information as might lead us at once to the object of our search. His success was quite complete, and entirely justified his foresight. He started on the 17th of February, and in eleven days he fell in with a party of the natives, from whom he learnt that, several years ago, a ship was crushed by the ice off the north shore of King William's Island, but that all her people landed safely, and went away to the Great Fish River, where they died. From this band of Esquimaux he obtained many relics. On a second journey, a month later, he met with other natives, and from them received information of another ship having been seen off King William's Island, which drifted ashore in the autumn of the same year — 1848; and that many of the white men dropped by the way, as they went toward the Great River. Continuing his search, he found, on the 24th of May, about ten miles eastward of Cape Herschel, on King William's Island, a bleached skeleton, around which lay some fragments of European clothing. 'Judging from his dress,' adds Capt. McClintock, 'this unfortunate young man was a steward or officer's servant, and his position exactly verified the Esquimaux's assertion, that they dropped as they walked along.' Lieutenant Hobson was even more fortunate than his commander. After parting from him, he made for Cape Felix, the northern extremity of King William's Island, where he found a cairn, about which were relics of a shooting or magnetic station, and among them a boat's ensign. A few miles to the southward, upon Point Victory, he came upon another cairn, where a vast quantity of clothing and stores lay strewed about, as if here every article was thrown away which could possibly be dispensed with; pickaxes, shovels, boats, cooking utensils, ironwork, rope, blocks, canvas, a dip circle, a sextant, engraved 'Frederic Hornby, R. N.,' a small medicine-chest, oars, etc. But among them, and more interesting and precious than all, was a record, dated April 25th, 1848, from which, and from a duplicate found soon after, they learned that the *Erebus* and *Terror* passed their first winter at Beachy Island, after having ascended the Wellington Channel to lat. 77 deg. N., and returned by the west side of Cornwallis Island. When the spring opened, the hardy mariners struggled southward, making for King William's Island, hoping to reach beyond it the continent of America, and thus open the long-sought-for North-West Passage. Their efforts were, however, in vain. The ice-fields which flow down between Melville Island and Bank's Island, and block up the narrows about King William's Island, caught them on the 12th of September, 1846, in lat. 70° 5′ N., and long. 98° 23′ W. From this position the ships never escaped, except to drift a few miles further southwards. Here, also, on the 11th of June, 1847, Sir John Franklin died — not, we may hope, of starvation, or with any fearful foresight of the fate that was to befall his companions, but quietly and peacefully — worn out with arduous labor, yet full of hope that his task was about to be accomplished, and with the cherished and consoling conviction that they who bore his last words to those he loved at home, would carry, also, the news of that success to the very brink of which he had led them. On the 22d of April, 1848, after another season of dreary waiting and suffering, which will never be told, the remainder of the officers and crew, one hundred and five in number, under the command of Capt. Crozier, abandoned their ships, five leagues N. N. West of Point Victory, on King William's Island, and started for the Great Fish River. The total loss by deaths in the expedition, up to this date, was nine officers and fifteen men. In attempting to reach the Great Fish River, the whole party probably perished, as the natives said, 'dropping down by the way, one by one.' In their further journeys, Lieut. Hobson and Capt. McClintock fell in with a boat, which the sufferers had abandoned, with its bow turned toward the ship, and in it were two human skeletons, one in each end. Two guns stood against her side, loaded, and a barrel cocked in each. There was fuel in abundance about her, but no food, and no remains of any, except some tea and chocolate. They found in her, also, several watches, and some silver spoons and forks, and plenty of ammunition. But guns and powder were as useless as fuel and forks, where there was nothing to kill. And here their sad story ends. That wilderness is marked, perhaps, for many a mile with other bleaching bones, and tattered relics, as the wanderers fell, one after the other, in their horrible and hopeless march; but no pious hand will ever gather them together, and give them Christian burial — no friendly and pitying eyes ever drop a tear upon them."

Some years since, the Duke of Luynes, a distinguished French photographic amateur, instituted a prize, under the auspices of the French Academy, for the discovery of a method of producing photographs by the use of carbon alone (neglecting salts of gold, silver, and other metals), this being the only material which, submitted to the test of time, has transmitted to us, without change, records almost 3000 years old. The Commission of the Photographic Society, Paris, to whom the applications for the prize were referred, have recently reported that they are unable to announce a full success, and, therefore, adjourn the decision for three years. The desideratum is to obtain a coating of carbon in a manner analogous to that from silver or gold — namely, by reduction. But chemistry, as yet, has failed to discover a process for the reduction of carbon compounds, and photographers have resorted to animal-black, which they have applied, in any convenient manner, to plates previously exposed to the sun. From the many contestants of the prize, the Commission esteemed two memoirs presented as worthy of reward; and the following *résumé* of these is given by M. Nickles, in his correspondence with *Silliman's Journal*:

Messrs. Garnier and Salmon, the authors of one of these memoirs, cover the face of paper with a film obtained from an intimate mixture of bichromate of ammonia and albumen. This coating is dried by heat, and exposed to the sun in a frame covered by a glass positive. The picture appears in a yellow-brown tint, which becomes more intense by a gentle warmth. The sheet thus prepared is fixed on a planchette, and covered with finely powdered ivory-black, the coating being made even by a stump of cotton. It is next detached and plunged in common water, the image uppermost, and there gently moved at intervals for a quarter of an hour. The water is then drawn off, and the picture served in a bath composed of five parts of concentrated sulphurous acid diluted in 100 parts of water, moving it about, as before, at intervals. After this double process, the carbon almost entirely disappears from the lights and clear spaces, while it remains in quantities proportional to the greater or less intensity of action of the light upon the other portions, and thus the proof finally reproduces the positive, but not perfectly, since the lights and half tints are not pure, and the blacks lack somewhat of brilliancy and perfectness. But the process is simple and good; it remains only to perfect it.

M. Pouncy, another competitor, operates a little differently, but obtains results equally satisfactory. His process differs in applying the carbon before exposure of the proof to light — the sensitive coating being formed at once, of bichromate of potassa, gum arabic, and finely divided carbon, exposed not under a positive, but under a negative plate. On removal, the plate is placed in a bath of pure water; after five or six hours' immersion, he washes under a stream of common water, and the carbon positive is obtained. In this process the manipulation is a little easier and more simple. The use of a negative authorized the expectation of a better result; but the exposure is longer than in the mode of Garnier and Salmon, whose use of a positive avoids the chances of accident which attend the negative plates in the hands of the operator. Messrs. Pouncy, Garnier, and Salmon, share the prize with Mr. Poitevin, who has the merit of anticipating these photographers, whose methods are only an advance on the process which Mr. Poitevin published in 1856.

In order to enable the public to derive full advantage from the photographic negatives made officially for the British Government, from rare and valuable objects in public and other collections, British and foreign, the Committee of Council on Education, for Great Britain, has caused an office for the sale of photographic impressions from such negatives, to be established in London. Photographic negatives made by order of the Trustees of the British Museum, and for the War and other Government offices, will also be sold. The tariff for unmounted impressions will be as follows: A single impression, the dimensions of which contain less than 40 square inches, — *e.g.*, 5 × 7 inches, or 4 × 8 inches, — 5d. Above 40 square inches, 2½d. should be added to every 20 square inches or under. A detailed list of the objects photographed is printed, price 2d. The department does not charge itself with the mounting of impressions, as the public is able to do this for itself.

Much importance has of late years been attached by astronomers to the formation of catalogues and charts of stars in the vicinity of the ecliptic, the region of the planetary bodies. The fixed points whose positions are thus determined and mapped, not only serve as points of reference for the places of the moving bodies of our system, but they also afford most important facilities for the discovery of new planets. They enable us to determine the variation and the position of a moving body by a simple micrometrical measurement, or even by ocular triangulation, and so render much more easy the detection of those regular variations of place which enable us to pronounce the moving body to be a planet. Induced by these considerations, and stimulated by zeal for the advancement of his favorite science, Mr. Cooper, of England, some eight years ago, undertook the formidable task of determining the position of all the stars in the neighborhood of the ecliptic to the twelfth magnitude inclusive. Mr. Cooper's catalogue now extends to five volumes, and is the result of upwards of 72,000 observations carried on uninterruptedly during eight years, or at the rate of 9000 observations per annum. A singular circumstance attended the progress of this great undertaking, namely, the disappearance of about seventy-seven stars which had been previously observed, and whose positions had been noted. Of these, fifty had been catalogued by Mr. Cooper in the earlier part of his labors, but when afterwards sought for, were not to be seen; the others had been noted in the catalogues of foreign astronomers. This remarkable fact of the disappearance of stars, recently observed, has been confirmed by M. Chacornac, of France, who has published eighteen charts of the positions of ecliptic stars. It is of course possible that some cases of supposed disappearance may only be apparent, and arise from the errors of former observers, and perhaps, also, by the discovery of the small planets situated between Mars and Jupiter, which, at the time of observation, were mistaken for stars. But the greater number are, undoubtedly, real disappearances, which can only be accounted for by an actual variability in the stellar systems, whether periodical or otherwise. The number of known *variable* stars — those, namely, whose brightness alternately increases and diminishes at regular intervals — has been greatly augmented since the attention of astronomers has been directed to stars of inferior magnitude; and it is not improbable that the stars which have disappeared belong to this class, and that they will, consequently, be found to reäppear at some future time. But it is highly improbable that all are of this class, and, therefore, destined to become once more visible. If, on the contrary, it be found that there are no permanent changes in the stellar system, which are not compensated by opposite fluctuations, these observations of Mr. Cooper, and others of a similar kind, made by other astronomers, acquire an importance far beyond that belonging to their immediate object, — opening up, in fact, a new field of astronomical inquiry, and new motives to diligence and accuracy in the arduous duty of mapping the stars.

At the meeting of the American Association, Springfield, 1859, Prof. Henry stated, that at the present time most of the telegraphic companies south of New England and east of the Mississippi send to the Smithsonian Institution weather reports every day. When these are received, a man indicates the weather upon a large map of the United States, hung in the public hall, by means of a system of small cards and pins. For example, a green card was hung over a point where it was snowing; black, where it was raining; brown, where it was cloudy; and white where it was clear; and by this means an observer was able to see at a glance the exact state of the weather over nearly the whole of the United States, at the same hour. As the storms of the United States generally travel east, they were enabled, from the meteorological reports at 9 A.M., in Cincinnati and upon the Mississippi, to predict the state of the weather in Washington twelve hours in advance, and could thus announce or postpone their evening lectures, in conformity with the weather.

Under the auspices of the Smithsonian Institution, Mr. Meech has been for some time engaged in investigating the subject of the partial absorption or extinction which the rays of solar heat experience in passing through the atmosphere to the surface of the earth. The phenomenon is one of special interest, and various instruments have been devised for its measurement; among which the pyrheliometer of Pouillet, and the actinometer of Herschel, may be mentioned. The observations with these instruments, says Mr. Meech, are certainly valuable and instructive, but, with one very doubtful exception, they fail to exhibit any distinct law. The law of absorption not being obvious directly from observation, the simple hypothesis has generally been adopted that equal thickness or strata of the medium absorb equal proportions of the light or heat incident upon each stratum. Lambert, Laplace, Pouillet, and others, have expressed this assumption in an analytic form, which applies very correctly at higher altitudes and near the zenith. For low altitudes, Laplace combined the same assumption with his theory of refraction, and derived an approximate expression for the relative amounts.

But the inquiry arises, how far the fundamental assumption is sustained by experiments. During the trigonometric survey of India, the astronomer, Jacob, observed the extinction of light reflected through an extent of sixty miles of horizontal atmosphere. His results were found to correspond very nearly with the law that "as the first differences of distance increases in arithmetical progression, the intensity of light diminishes in geometrical progression." The experiments of Delaroche and Melloni also indicate that the hypothesis of equal thicknesses, absorbing equal portions of the incident heat, is only an approximation, which, in extended media, will differ widely from the truth; indeed, their experiments show an increasing facility of transmission through equal strata in the direction in which the rays proceed.

The necessity of a change, therefore, in the theory of atmospheric absorption, to render it conformable to such experiments, being obvious, the greater part of Mr. Meech's time, available during the past year, has been devoted to this object. The remaining discussions, relative to the theory of climatic heat, of which this forms a part, are yet in progress. It may here be stated, however, that, on computing by this method the observations given in the translation of Kaemtz's Meteorology, p. 150, Mr. Meech shows that out of one hundred rays descending vertically from the zenith, twenty-two rays are lost or absorbed in the atmosphere, and seventy-eight are transmitted to the earth's surface. The same process applied to the mean of observations made with Herschel's actinometer, on the Faulhorn and at Brientz, in Switzerland, leads to precisely the same result when reduced to the sea level.

The Scottish Meteorological Society offer a reward of twenty pounds ($100) for the best essay on the following questions:

1. Whether the amount of Rainfall in the western parts of Europe, and particularly in Scotland, is less now than it formerly was.

2. Assuming this fact to be established, what are the most probable causes of it?

With reference to the first of these questions, the Secretary of the Society, A. Keith Johnson, says:

"Notice may be taken of the popular belief that springs of water have been gradually diminishing, or altogether drying up, especially in arable districts; and of the following statement in the Report of the Registrar-General for England, for the quarter ending June, 1859:—'The deficiency in the fall of rain from the beginning of the year is 1¾ inch. The deficiency in the years 1854, 1855, 1856, 1857, 1858, amounting to the average fall of one year, viz., 25 inches. From a careful examination of the fall of rain (year by year) from the year 1815, it would seem that the annual fall is becoming smaller, and that there is but little probability that the large deficiency will be made up by excess in future years.'

"With reference to the second question, notice may be taken of the supposed effects of deep drainage and deep culture of the soil, in raising the temperature both of the soil and atmosphere, in lessening evaporation, and in diminishing the condensation of vapor."

During the past year, Dr. W. Odling, Secretary to the London Chemical Society, has prepared an elementary text-book on chemistry for the use of those lecturers and students who employ, or wish to employ, the unitary system of chemistry, according to which the molecule of water is represented by the formula H_2O. Water thus becomes a unit of comparison, to which the majority of oxides, hydrates, acids, salts, alcohols, ethers, etc., can be referred. Moreover, the anomaly of the vapor density of water is hereby obviated, and its volume-equivalent made to correspond with that of other compound bodies. This system has been made the basis of elementary teaching by Professor Brodie, at the University of Oxford; by the author at Winchester College, Hants; and by its chief English exponent, Dr. Williamson, at University College, London.

In the erection of a new Museum at Oxford University, England, designed to afford room for the various collections, pertaining to the several departments of natural and physical science, belonging to the university, a curious and interesting feature has been introduced into the plan and architecture of the building. Thus, in the main hall there are, on the ground-floor, thirty-three piers and thirty shafts; on the upper floor, thirty-three piers and ninety-five shafts. Thus one hundred and twenty-five shafts surround the court; and if we include the capitals and bases of the piers, there are one hundred and ninety-one capitals and bases. The material of each of these shafts has been carefully selected, under the direction of the Professor of Geology, from quarries which furnish examples of many of the most important rocks of the British Islands. Thus, commencing in the lower arcade, on the west side, we have, first, a column of Aberdeen gray granite; next, Aberdeen red granite; then, porphyritic gray granite of Lamonna; then, syenite from Charnwood; then, mottled granite, Cruachan, Scotland; then, red granite from the Isle of Mull. Succeeding these are the metomorphic rocks, the serpentines, porphyries; the English, Welch, and Irish marbles, breccias, gypsum, etc., etc. In the upper corridors the same order is preserved, — no two columns being of the same material. Furthermore, the capitals and bases of the columns represent various groups of plants and animals, illustrating different climates, and various geological epochs, — all mainly arranged according to their natural orders. A series of sculptured portraits of the great in science also constitutes a marked feature of the building. Mr. Ruskin, who has taken an active part in the designing and construction of this museum, thus sums up its object: "To make Art expressive rather than curious — fixed rather than portable — publicly beneficial rather than privately engrossed, — to convey truthful information of form, and promote intelligence, has been attempted and carried out in the building." The expenditure contemplated is upwards of £60,000.

The following résumé embraces most of the geographical explorations and investigations for the last two years.

The Geographical Society of St. Petersburg, has sent a number of naturalists to Siberia; and a learned Finn, Dr. Nordenskiold, of Helsingfors, has pursued his observation as far as Spitzbergen. He there discovered anthracite coal, and such a multitude of seals and walrusses as promises rich returns to fishermen in years to come. He has also ascended the Sneehättan Mountain.

On the American continent, an officer of the English Navy, Capt. Palliser, has been so fortunate as to find a passage through the Rocky Mountains, in British America.

In South America, the Frenchman, Dr. Plassard, who is settled in Ciudad Bolivar, has undertaken an excursion into the interior of Venezuelan Guyana, and found gold to the south of the lower Orinoco, toward the Yuruari.

At Rio Janeiro, Messrs. Capanema, Lagos, and Gonsalvo Diaz, are preparing for a second expedition into the interior of Brazil, which is almost entirely unknown, and in the possession of wild Indian tribes. They will have a military escort.

On the 27th of February last, the Sardinian traveller, Brun-Rollet, died at Khartoun, on the boundary between Nubia and Abyssinia. He had penetrated all the country bordering on the upper Nile, and discovered Lake No, in lat. 12 deg., and the Bhar Keilak, or Misselad, which belongs to the western basin of the Nile. In 1855, he published in Paris *Le Nil Blanc and Soudan.*

The Englishman, Coulthard, died a terrible death, by thirst, in the inner desert of Australia. A traveller, Babbage, found his body in a thicket, and a tin cup near by, on which he had scratched a few lines with a nail, which made known the frightful sufferings that preceded his death. Coulthard set out with two other Englishmen, Scott and Brooks, who probably have perished.

In the Southern Atlantic, the English Capt. Cubins believes that he has, within the year, found a new group of islands on the track of Australian-bound vessels.

But the great magnetic centre to which most discoverers instinctively turn, is still the interior of Africa. Those vast countries, which are represented in blank on our maps, have been attacked from all sides — east, west, north and south.

The renowned Dr. Robert Livingstone is now making an excursion in those countries which he discovered during his long journey from St. Paul de Loanda to Quilimane. He embarked last year, equipped with instruments for making scientific observations. He will first attempt to go up the Zambeze River in a canoe, which he has named "Ma Robert," or Robert's wife or mother, as the natives along the Zambeze have great respect for the wife and mother of a man whom they admire.

The English steamer, the *Rainbow*, sailed on the 6th January, 1859, out of Bonny into the Gulf of Benin, to explore the country along the Niger. Ladislaus Magyar, of Theresiopol, in Hungary, who, after the Hungarian insurrection, became a citizen of Brazil, has hit upon a rather singular but very prudent way to penetrate into the mysteries of inner Africa with the greatest possible safety and advantage. He has just married the daughter of the black King of Bihe, in Upper Guinea. He has become commander-in-chief of the armies of his father-in-law, and uses his authority and his soldiers to become acquainted with the countries lying in his neighborhood.

Jules Braouerec, commander of the corvette *Oise*, is now exploring the wholly unknown country through which the Gaboon River runs.

The Swedish discoverer, Anderson, has travelled Ovampo, on the west coast of Africa, south of Benguela, in the direction of the Cunene River.

On the east and south coast of Africa, two English officers, Capt. Burton and Lieut. Speke, have found and measured a great lake, between 3 deg. 30 min. and 8 deg. 40 min. south latitude — not to be confounded with lakes Nyassa and Ukerewe, so much talked of in late years. Until this discovery, there was ground for belief in a great central sea in Africa, stretching from 12 deg. south latitude to the Equator; but this discovery is conclusive that the great bodies of water which have hitherto been discovered at widely distant points are separate lakes.

The French missionary, Leo des Avanchers, is travelling through the country which lies to the eastward of this great lake. The German traveller, Albert Roscher, has gone in the same direction, having left Zanzibar with the hope of penetrating far into the interior.

Pedro de Gamitto, governor of the Portuguese forts Tete and Sena, on the Zambeze, is making preparations for new explorations in Central Africa, of which he has already given such interesting descriptions in his book "Muata Cazembe."

Messaga, the Sardinian missionary, is now exploring the interior of Abyssinia; so, also, is Bayssiere.

The Upper Nile is the object of untiring exploration. It would be strange if, before the end of this century, its whole course were not as well known as is now that of the Thames, the Seine, or the Rhine.

Mr. McCarthy, son of the geographer, has it in contemplation to travel on a new track to Timbuctoo from Algiers, where he has lived these eight years. According to his plan, he will pass through Laghoult and Goleah, then make a circuit to the east to get out of the way of a tribe of Arabs who have been bejuggled by a new prophet, and then continue his journey by Ghadames, Ghat, and Lake Tsad.

Other travellers, also, such as Capt. Magnan, Baron Kraft, and Yussufben Gallabi, are bent on discovery, starting from Algiers, or other northern points. Asia, too, is being explored by many travellers; but as yet we have few details of their discoveries. Kriel has been sent by the Vienna Academy into Asiatic Turkey. Rey is exploring some hitherto neglected portions of Syria and Palestine.

A Russian scientific expedition is engaged in the exploration of Chorasan, while a detachment of the French troops in Indo-China is escorting a scientific corps through that country. Many other savants have received missions from the Ministry of Public Instruction, or from the Paris Museum. Beside this, the Catholic and Protestant missionaries are coming more and more to consider it a part of their duty to send home precise and comprehensive ethnographic and geographic intelligence of the countries through which they travel.

M. Hochstetter, the naturalist of the recent Austrian Scientific Exploration Expedition, declares, as the result of his observations, that the abundance of the remains of extinct primitive animals found in Australia is most astonishing. While Australia has always been considered the newest continent, he has met there with the most ancient and primitive forms in Flora and Fauna, proving Australia to be the oldest continent of the earth. While Europe had to go through several earth revolutions, Australia's continent, since the primeval period, has not been covered with the sea, and has developed itself undisturbedly. He also states, that he has found in New Zealand organic remains, which make him conclude that these islands are of a much more ancient date than has been hitherto supposed.

Among the recent publications of the Smithsonian Institution, is a new and revised edition of "Directions for Meteorological Observations." In addition to the directions given in the first edition, there have been added instructions for noting periodical phenomena, earthquakes, auroras, etc., and special remarks suggested by the experience of previous years. This publication forms an octavo pamphlet of seventy pages, and is now, perhaps, the most convenient and complete work for the purpose to be found in the English language.

Communications for the Annual of Scientific Discovery will receive attention if addressed to the Editor, care of Gould & Lincoln, 59 Washington Street, Boston, Mass.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

THE GREAT EASTERN.

The *Great Eastern*, steamship, the principle of whose construction and history has been given in previous numbers of the *Annual of Scientific Discovery*, has, during the past year, been fully completed. The following detailed descriptions of her machinery and fittings are necessary to complete the record:

The motive agents of the *Great Eastern* are paddle-wheels and a screw.

Paddle-Wheels. — The paddle-wheels are fifty-six feet in diameter, and their weight is one hundred and eighty-five tons. Provision has been made, when the ship is deeply laden, for reefing — that is, drawing in the floats — ten feet, although, as every float would have to be treated separately, it is not likely it will be made much use of. The floats are thirteen feet by three feet, and thirty in number to each wheel. The wheels are connected to the engines by friction-straps, so that they can be disconnected at any time, if it should be necessary to use the screw by itself. The forgings connected with the paddle-wheels are of the following weights and dimensions: Two paddle-cranks, each seven feet between the centres, and weighing, when forged, eleven and a half tons; when finished, ready for putting on to the shafts, seven tons four hundred. The paddle-shafts, each thirty-eight feet long, and weighing thirty tons. We have next the large, intermediate crank-shaft; its depth of throw is five feet one inch; thickness, two feet nine inches; greatest diameter, two feet seven inches; length over all, twenty-one and a half feet; weight, thirty-one tons. The two friction-straps, for disconnecting paddles, are each ten feet inside diameter, and fifteen inches thick; and the weight of each is nine tons twelve hundred weight.

Paddle-Wheel Engines. — The engines for the paddle-wheels, which were designed and built by Mr. Scott Russell, are oscillating engines, of the following dimensions:

Nominal horse power, ...	1000
Number of cylinders, ...	4
Diameter of each cylinder, ...	74 in.
Length of stroke, ...	14 ft.
Strokes per minute, ...	14

The weight of one of the cylinders, including piston and piston-rod, is thirty-eight tons. Each pair of cylinders, with its crank, condenser, and air-pump, forms in itself a complete and separate engine, and each of the four cylinders is constructed so as to permit instant disconnection, if required, from the other three; so that the whole form a combination of four engines, complete in themselves, whether worked together or separately. The two cranks are connected by a friction-clutch, so that the two pairs of engines can be connected or disconnected at a moment's warning, and by a single movement of the hand. The engines are provided with expansion-valves, throttle-valves and governors, all constructed on the most improved principles, and arranged for working in the most efficient manner. The combined paddle-engines will work up to an indicator-power of three thousand horses of thirty-three thousand pounds when working eleven strokes per minute, with steam in the boiler at fifteen pounds upon the inch, and the expansion-valve cutting off at one-third of the stroke. But all the parts of the engines are so constructed and proportioned, that they will work safely and smoothly at eight strokes per minute, with the steam at twenty-five pounds, and full on without expansion (beyond what is unavoidably effected by the slides), or at sixteen strokes per minute, with the steam in the boiler at twenty-five pounds, and the expansion-valve cutting off at one-fourth of the stroke. Under these last-named circumstances, the paddle-engines alone will give a power of about five thousand horses.

Paddle-Engine Boilers. — There are four boilers for the paddle-engine, seventeen feet nine inches long, seventeen feet six inches wide, and thirteen feet nine inches high, each weighing about fifty tons, and containing forty tons of water. They are tubular boilers, manufactured of wrought plate-iron, with brass tubes of three inches diameter. There are ten furnaces in each boiler, five on either side, and two boilers in each boiler room. Each boiler room is supplied with air by four ventilators or shafts, seven feet long by five feet wide, which go up to the upper deck, where they are grated over, and up two of them there are gangways, one to each stoke-hole. These paddle-boilers are in two distinct sets, and each set is equal to supply, with steady, moderate firing, steam for an indicator of one thousand eight hundred horse power; though, with full firing, each set of two gives steam to the amount of two thousand five hundred horse power, or five thousand horse power in all.

The Screw-Propeller. — The screw-propeller, which is twenty-four feet in diameter, and forty-four feet pitch, is by far the largest ever made. Its four fans, which were cast separately, and afterwards fitted into a large cast-iron boss, have been compared to the blade-bones of some huge animal of the pre-Adamite world. The weight of the screw is thirty-six tons. The propeller-shaft, destined to move the screw itself, is one hundred and sixty feet in length, and weighs sixty tons. The after-length of this shaft, forty-seven feet long and weighing thirty-five tons, was made at the Lacefield forge. This portion of the shaft, the heaviest piece of wrought iron in the ship, was manufactured this enormous length in order that the junction of it with the remaining portions should not interfere with the floor of the after-cabins. The other lengths of the propeller-shaft, consisting of different pieces, each twenty-five feet long and sixteen tons weight, were made in London for Messrs. James Watt & Co., the builders of the screw-engines.

The Screw-Engines. — The screw-engines, designed and built by Messrs. Watt & Co., are horizontal direct-acting engines of —

Nominal horse power,	1600
Number of cylinders,	4
Diameter of each cylinder,	84 in.
Length of stroke,	4 ft.
Number of revolutions per minute,	50

They are the largest ever made for marine purposes; and, as is the case with the paddle cylinders, each of the four is in itself a complete and separate engine, capable of working quite independently of the other three. The combined screw-engines work up to an indicator-power of four thousand five hundred horses of thirty-three thousand pounds, when working at forty-five strokes a minute, with steam in the boiler at fifteen pounds, and the expansion-valve cutting off at one-third of the stroke. They are, however, made to work smoothly, either at forty strokes per minute, with steam at twenty-five pounds, without expansion, or at fifty-five strokes a minute, with the expansion cutting off at one-fourth of the stroke. Under these circumstances, they will be working at the tremendous power of six thousand five hundred horses.

Screw-Engine Boilers. — The boilers for these engines are similar to those for the paddle-engines, but a trifle larger and heavier. They are ten in number, and the whole are so arranged that all or any of them can be used with either set of engines. The weight of the screw-engines and boilers is one thousand five hundred tons. To communicate between the different stoke-holes and engine rooms, there are two perfectly water-tight tubes, six feet high and four feet wide, running through the ship, the openings into which can be closed by water-tight doors. Through one of them the various steam-pipes go, and the other is used as a passage for the engineers and stokers. There are ten donkey-engines to pump water into the boilers, and two auxiliary high-pressure engines of seventy horse power, working with forty pounds; but these, as with the other auxiliary engines, are made to work at sixty pounds. Both these, besides having to do all kinds of odd jobs about the ship, such as work the capstans, attend to the drainage and water supply of the ship, etc., are connected with the screw-shaft abaft the ordinary disconnecting apparatus, so as to enable them to drive the screw, if necessary, when disconnected from its main engine. It will thus be seen that the paddle and screw engines, when working together at their highest power, will exert an effective force of not less than eleven thousand five hundred horse power.

The Coal Bunkers. — The coal bunkers are on either side, above and between the boilers, and are capable of containing about twelve thousand tons of coal. The distance to Port Philip, Australia, is nearly twelve thousand miles, which, at the rate of eighteen miles per hour, would take thirty days to accomplish. The estimated consumption of coal per day of twenty-four hours is about one hundred and eighty tons. Therefore, some five thousand tons would be consumed in the outward voyage.

The Masts, Rigging, etc. — A writer observes that, "We all know, even on a calm day, what a wind meets the face looking out of a railway train going at that pace; and, consequently, it can be understood that sails, except on extraordinary occasions, would act rather as an impediment than as an assistance to the ship's progress. It is not probable, therefore, that they will be much resorted to, except for the purpose of steadying or of helping to steer her." In case, however, of a strong wind arising, going more than twenty-five miles an hour in the direction of her course, she will be provided with six masts, five of them iron, the after-mast wood. The first, fifth, and sixth, are two feet nine inches in diameter; the second, third, and fourth, are three feet six inches The second and third carry square sails, and all carry fore-and-aft sails. The standing rigging is seven and a half inch wire rope, except for the sixth mast, which is hemp rope. There is not to be a particle of iron about this mast, for it is intended to carry a compass on it. The quantity of canvas that can be set is about six thousand five hundred square yards.

The *Great Eastern* is to carry no bowsprit, and no sprit-sail. The writer quoted above suggests that "the reason for this departure from the ordinary rig is to avoid her ploughing too deeply in the sea. Her bow is also without a figure-head; and this peculiarity, together with her simple rig, gives her the appearance of a child's toy boat. If beauty is nothing more than fitness, this form of bow is undoubtedly the most beautiful."

The ship is fitted with Brown's patent capstans, and they are so arranged that they can be worked either by hand or steam. There are three forward and two aft. The bower chains are two inches and seven-eighths in diameter; each link weighs seventy-two pounds, and each cable will be one hundred and twenty fathoms long. The four large bower anchors are seven tons' weight each, Trotman's patent. In addition to these, there are two smaller anchors at the bows, each weighing five and a half tons, and two at the stern, each weighing six tons. The bower anchors of the largest man-of-war weigh five tons. There are six hawse-holes forward, and four aft.

The anchors, with their accessories, would alone form the cargo of a good-sized ship. These, together with their stocks, weigh upwards of fifty tons. If we add to this, ninety-eight tons for her eight hundred fathoms of chain cable, and one hundred tons for her capstans and warps, we shall have a total weight of something like two hundred and fifty tons of material dedicated to the sole purpose of making fast the ship.

The rudder-post and frame, which were forged in one piece by the Lancefield Company, are of the following weights and dimensions: The post is eighteen inches diameter at journal, and the weight is twelve and a half tons; the upper part of the post is five tons additional, and the rudder-band and cover are four and a half tons; the total length of the rudder is sixty-two feet, and the total weight is twenty-two tons.

Accommodations for Passengers, Cargo, etc. — The *Great Eastern* is designed to carry eight hundred first-class, two thousand second-class, and one thousand two hundred third-class passengers, independently of the ship's complement, making a total of four thousand guests. For the accommodation of these, whole streets and squares of apartments have been constructed. The first thing that arrests the attention, on descending into the saloons, is the handsome and roomy entrances and the spacious stairs, so unlike the cramped-up companion and stair-way so often found on board ship. The first-class saloons and sleeping cabins are in the fore part of the centre of the vessel, the second class abaft them, and the third class still further aft, which arrangement is the reverse of that generally adopted. The largest saloon is nearly one hundred feet long, thirty-six feet wide, and thirteen feet high. Above it are two other saloons, one above sixty feet long, and a smaller one, about twenty-four feet long; both are twenty-five feet wide and twelve feet high; the smaller of the two is for a ladies' cabin. The sleeping cabins are about fourteen feet long by seven or eight feet wide, by seven feet four inches high, — quite large rooms; each room is ventilated by two brass scuttles of fourteen inches in diameter. There are, besides these, six other saloons, with their different sleeping cabins, all of the same height as those we have described, and nearly as large. The total length thus occupied by the cabins is three hundred and ten feet.

The separate compartments into which the hotels for the accommodation of passengers are divided, are as distinct from each other as so many different houses; each has its splendid saloons, its bed-rooms or cabins, its kitchen and its bar; and the passengers are no more able to walk from the one to the other than the inhabitants of one house can communicate through the parti-walls with their next-door neighbors. The only process by which visiting can be carried on, is by means of the upper deck, or main thoroughfare of the ship. The saloons, together with the sleeping apartment, extending over three hundred and fifty feet, are located in the middle instead of extreme aft, according to the usual arrangement. The advantage of this disposition of the hotel department must be evident to all those who have been to sea, and know the advantage of a snug berth, as near as possible to the centre of the ship, where its transverse and longitudinal axes meet, and where, of course, there is no motion at all. The passengers are placed immediately above the boilers and engines; but the latter are completely shut off from the living freight by a strongly arched roof of iron, above which, and below the lowest iron deck, the coals are stowed, and prevent all sound and vibration from penetrating to the inhabitants in the upper stories.

There are two large holds, devoted exclusively to cargo, one at each end of the cabins. They are both sixty feet long, and are the whole depth and breadth of the ship; each is capable of holding one thousand tons of cargo. The total quantity of space appropriated to cargo will be regulated entirely by circumstances. It would be quite easy to stow six thousand tons in the hold and various other unappropriated places. The crew and officers are berthed forward. The captain has a splendid suite of rooms, within easy distance of the paddle-boxes.

The *Great Eastern* has twenty ports on the lower deck, each five feet square, to receive railway wagons. She has also sixty ports on each side, two feet six inches square, for ventilation, and an abundance of dead-lights. The lower ports are sixteen feet above the water when the ship is loaded. The bulwarks are nine feet six inches high forward, and slope down to above five feet high amidships and aft. The massive wrought-iron deck is covered with teak planking, placed about six inches distance from the iron. The weight of the whole ship when voyaging, with every contemplated article and person on board, is estimated at not less than twenty-five thousand tons.

WINANS' STEAMER.*

The inventor of this curious vessel has, since her first construction, increased her length and sharpness, until she is now 244 feet long, and absolutely pointed at both ends. Her breadth of beam, or diameter (for she is perfectly round), is the same as at first — 16 feet. The greater length and sharpness have augmented the speed, and have increased the cleanness of her movement, until improvement on the latter point seems hardly possible. The objects which Mr. Winans seeks to accomplish in this form, are precisely those which the projectors of the *Great Eastern* hope to attain in that form, to wit, avoidance of motion, and capacity for uninterrupted application of the motive power, by which great average speed will be obtained. The Winans steamer is designed to go *through* the waves, thus avoiding the tossing which the vast proportions of the *Great Eastern* are intended to remedy; and her propelling wheel, being midship, and of the full size of the vessel, must always be one-half submerged, and therefore in a condition to receive the full working power of the engines. If she rolls upon either side, or plunges through a wave, her propeller can never be *less* (though often much more) than half submerged, — its ordinary condition in smooth water.

A correspondent of the Portland *Argus*, thus describes an experimental trip in this vessel, down the Potomac, a distance of seventeen miles and back. "The time occupied in this trip of 34 miles, was just 2½ hours from the time the fastenings were cast off from the wharf until she was again at her moorings, and we upon *terra firma*. The performance of this marine locomotive (for such it may appropriately be styled) was admirable. When she started, her steam was not up, and, for a mile or two, she moved rather slowly through the smooth water, scarcely appearing to disturb its surface, or to give any indication, by jar or sound, that there was a steam-engine on board. But the revolutions of the propelling wheel gradually became quicker, and her speed greater, until it reached the rate of about 16 miles an hour. Still there was scarcely any perceptible jar from the machinery, so perfectly was it adjusted, and the disturbance of the water by the passage of the vessel was marvellously slight. So clean, indeed, was her movement, that a skiff would scarcely have felt any agitation in crossing her wake."

BISHOP'S FLOATING "BOOM DERRICK."

This derrick, the invention of Albert D. Bishop, of New York, has been for some time before the American public, but has only recently been introduced into England. During the past year, however, a single machine has been exhibited on the Thames, at London, which is reported capable of lifting a thousand tons at a pull. Its construction is thus described by a correspondent of the *N. Y. Times:*

The machine consists, first, of a flat-bottomed boat of 257 feet in length, and 90 feet beam, or about the length of an ordinary steamship, and 12 feet broader than the *Great Eastern*. The depth is 14 feet, the draft of water is only 4 feet, the bow and stern are sharp, the ground-plan is rhomboidal, and resembles a compositor's type-case, being divided into 87 water-tight departments, 14 feet square, extending from the bottom to the deck. The whole of this structure is of heavy boiler-iron. Bulwarks, some 7 feet high, surround

* See *Annual of Scientific Discovery*, 1859, p. 47.

the deck. In the centre of the deck, lengthwise, and near one side of the vessel, is erected a pier, at the top of which is a boom extending over the water on the side where the weight is to be lifted, and over the deck on the other side. The pier and boom resemble a cross, and constitute the derrick proper. A wrought-iron arched truss, of 65 tons weight, passes from stem to stern; two trusses of 50 tons each cross the deck diagonally, and two more immense trusses pass under the legs of the derrick. The object of them all is to distribute the weight of the derrick and its load equally over the whole deck, and to enable the vessel to resist the leverage of the derrick. The pier is composed of three wrought-iron legs, forming a tripod, each 80 feet high, and weighing, together, 65 tons. They are surmounted by a horizontal plate, or disk, near the edge of which is a trough filled with cannon balls. A similar plate rests on the balls. On the top plate lies the boom. The balls between the plates are simply rollers, so that the boom can swing round like a crane. To illustrate its action, place a row of marbles all round a dinner-plate, in the groove or depression near its edge; put another plate, bottom upwards, on the top of the marbles; the top plate can then be revolved around its own centre with very slight friction, under a great weight. The boom, or cross, is a girder of wrought iron, 120 feet long, projecting 60 feet each way from the pier, and weighs 80 tons. Surmounting the boom is a king-post, or cylinder of wrought iron, 60 feet high, 7 feet in diameter, and weighing 60 tons. From its top to the ends of the boom extend massive iron cables. The end of the boom over the deck is fastened directly to the deck by cables when mere lifting and no swinging is required. But when weights are to be transferred from the sea to the deck, or thence to the dock, these cables from the boom are fastened to a car which runs on the underside of a circular railway extending round and fastened to the legs of the tripod or pier. As the boom swings, the car rolls with it. Suspended in a row from the other end of the boom are 10 sets of gigantic, iron four-fold pulleys. The chain cables working in them pass along the boom over fixed rollers down to the deck, and under similar rollers along the deck, to their ten respective "crabs," which stand in a row on the side opposite to the derrick, and by which they are hauled in. All or a part of the pulleys or lifters may be worked at once, as circumstances require. The crab is a massive frame, holding a windlass consisting of a shaft attachable by a clutch to the main shaft from the engine, and two other shafts so geared to the first that they move more slowly. The two last shafts are simply grooved rollers, a foot in diameter, standing say four feet apart. The pulley-chain passes around the pair of rollers (not each roller separately) several times, and thence into the hold below, but is not fastened to the rollers. The chain has such great friction on the rollers that it will either raise the weight, stop the engine, or break,—it cannot slip. If the ordinary windlass were used, it would have to be of immense diameter to hold several hundred feet of chain, while, if the chain were to wind upon it in two or more layers, it would jerk, bind, and give trouble generally. The two rollers revolve with and upon the periphery of the wheel which drives them, so that their rolling friction is reduced to the minimum. Altogether, these crabs are extremely well designed and adapted. In the middle of the vessel, and attached to the shaft moving all the crabs, are two oscillating steam engines of thirty-horse power, each with Barran's cup-surface boilers, the latter being under the deck.

So far, we have a tractive power of 1000 tons on the 10 sets of pulleys. But suppose them to be attached to a sunken ship of that weight. After a few hundred tons had been exerted, our huge derrick, vessel and all, would begin to careen, and would ultimately pull itself over upon its beam-ends, the sunken ship sticking in the mud as before. Here comes in the chief feature of the improvement. The entire hull, as we have seen, is a honeycomb of water-tight compartments, — those on the side opposite the derrick being capable of holding 1700 tons of water. Two pair of steam pumps, of two feet stroke above each, capable of throwing 60 tons a minute, fill up these compartments from the sea, as fast as the strain on the pulleys increases, so that the sunken vessel on one side, and the water-cells on the other, just balance each, and the empty compartments under the derrick hold the whole mass afloat. The entire draft of water in this case will be only nine feet. The pumps also throw out the water as the strain decreases. One of their most useful offices will be to free stranded ships.

How to propel this great craft was not a simple question. There not being draft enough for either screws or paddles, an old device was rejuvenated, viz.: On each side two skeleton drums, resembling two paddle-wheels, were placed, one near the bow, and the other near the stern. Over these pass endless chains, on which are secured the floats or paddle-boards, some twenty-four being immersed at a time. So the vessel crawls like a centipede at the rate of seven knots an hour. The four propelling engines are of eighty horse power each, and are entirely under the deck. It is evident that this craft cannot be easily wrecked, for its width will prevent its capsizing; and, although seas may sweep its deck, they cannot break through nor strain it, for the entire hull is a girder of almost immeasurable strength. Should it collide and fill half its compartments, the rest will keep it afloat.

It having been impossible to secure a large vessel near London, on which the giant could try its hand, its only experiment has been the lifting of a couple of smaller ones. Six of the pulleys were secured by chains, forming a cradle, under an old brig of 300 tons, weighing some 270 tons, and drawing some ten feet of water. In fourteen minutes it was raised about twenty feet in the air; the engines making ninety-four revolutions per minute. A small iron steamboat, weighing sixty tons, was then run underneath, and attached to the suspended brig. The engines being again started, both vessels were raised high in the air, presenting a singular spectacle never before witnessed. The derrick sank but thirteen inches under this increased body of 335 tons. This is, perhaps, the greatest weight ever raised at a dead pull. The machinery is so arranged as to be quickly and easily handled by a few men, and the entire demonstration on this occasion was satisfactory.

The method of raising a sunken ship would be as follows: The derrick being on one side of the ship, an accompanying steamer takes out two chains, and, dropping them so wide apart as to embrace both stem and stern of the sunken ship, returns them to the derrick. A new instrument here comes into use. It is a bar of iron five feet long, with large holes in both ends, and a pear-shaped mass of iron, weighing a ton and a half, suspended from the middle. Both chains having been passed through one of these "divers," at one side of the sunken ship, and through another at the other side, both divers are dropped to the bottom, and tend to draw together, and hold the chains under the ship. By hoisting more on one chain than on the other, one end of the ship may be raised a little, and the sticking of the mud thus overcome by a great leverage. When one end is raised, the other chains are similarly slipped under, without the aid of living divers, till they form a cradle under the ship, which is then lifted bodily, the pressure of the water of course assisting, till it reaches the surface. It is then either pumped out, careened, made tight and set afloat, or held up and towed into ten or twelve feet of water, or if it weigh less than 1000 tons, is deposited on the dock.

The measurement of the great derrick is 5000 tons. Its cost was $250,000 — equal to that of a first-class Sound or North River steamer.

The steamer *Ericsson*, of 2200 tons, which, it will be remembered, sunk off the Jersey coast some years since, was lifted to the surface of the water by a derrick of only 300 tons capacity. But the great derrick, with a capacity of 1000 tons, will raise to the surface the largest ship ever sunk, pump it out at the rate of 60 tons of water a minute, and hold it fast till it is either put into floating condition, or stripped of its valuables. All it requires is a good hold, and this it can get, deeper than divers ever sounded. As to ordinary vessels of 200 or 400 tons, whose actual weight would be within the capacity of the great lifter, it would simply pick them up from the bottom, carry them ashore, and land them high and dry on the dock.

EXPERIMENTS WITH SCREW-PROPELLERS.

A series of experiments with screw-propellers has recently been made in England, with a view merely of testing the relative qualities of the common screw with Griffith's propeller. The common screw used by the British Admiralty, consists of a sixth part of the whole helix; Griffith's propeller has a spherical central base, one-third the diameter of the screw, with the blades made tapering. The driving surface of the former is at the extreme ends of the blades; that of the latter lies towards the centre, nearest the sphere.

The first trial was with a common screw, which had a diameter of 18 feet; the speed obtained was 11·823 knots per hour. On a second trial, with its diameter increased to 20 feet, the speed was 11·826 knots; but there was a great increase of vibration. The leading corner of each blade was now cut off, and on the third trial, with this change, a speed of 12·032 knots was obtained. Both corners of the blades were now cut off, and a fourth trial made; but even with a greater number of revolutions, less speed — 12·012 knots — was secured. The highest speed was therefore achieved with the leading corner of the screw cut off. With a Griffith's propeller of 20 feet diameter, and 32 feet pitch, the first trial gave 11·981 knots per hour; on a second trial, with an alteration of pitch to 26 feet 5 inches, a speed of 12·269 knots was the result; on a third trial, with a still further reduced pitch, and 43¾ revolutions per minute, there was much less vibration than on former trials, but the speed was only 12·158 knots.

It was found during these trials that the leading edge of the screw is the part which affects the steering of a vessel most, and causes the greater part of the vibratory action. It was also demonstrated that an increased diameter of the common screw was better than an increased pitch to reduce the speed of the engines, with an augmented speed in the vessel; but it had the effect of promoting the vibration, which is an evil to be avoided, if possible. By increasing the diameter of the Griffith's propeller, additional vibration was not experienced, because its chief acting surface is not at the extremities of the blades. These experiments seem to have established the fact, that a propeller having a sphere at its central portion, combined with tapering blades, gives better results with less power than the common screw-propeller.

DUTY OF STEAMSHIPS.

A committee of the British Association for the Advancement of Science — of which Mr. Fairbairn was chairman — appointed to consider the above subject, at the meeting for 1858, recommends that all the owners of steamships adopt means to register their efficiency. The rule which they lay down for testing vessels, is, to multiply the cube of the speed by the square root of the cube of the displacement, and divide the product by the consumption of fuel per hour in hundred-weights. Thus, if a steamer, A, performed a voyage of 7200 miles in 652 hours, on an average speed of 11·04 knots, and the consumption of coal was 47 cwts. per hour, and the mean displacement 2934 tons, — the coëfficient of dynamic duty indicating the merits of the performance would be —

$$(11{\cdot}04)^3 \times (2934)^{\frac{2}{3}} \div 47 = 5870.$$

Suppose another steamer, B, having a displacement of 840 tons, average speed 12·78 knots per hour, consumption of coal 50·3 cwts., then the coëfficient of duty is —

$$(12{\cdot}78)^3 \times (840)^{\frac{2}{3}} \div 50{\cdot}3 = 3693.$$

In the first case, A performs as much work with 1 cwt. of coal as B with 1 1-16th cwts. It is only by computing the amount of coal used, with the displacement of the vessel and its speed, that we can arrive at any data regarding the efficiency of steamers. The cause of superiority in one vessel may be in its form, or the machinery; but, whatever it may be, there is no possibility of finding this out, unless the displacement, speed, and coal consumed, are known. A series of statistics of the performances of steamers under such a test, would lead to a close investigation as to the causes of superiority in one over another, and the result would be a general adoption of those improvements by which the advantages were secured. At present there are steamers which do the same duty as others with one-fourth less fuel; but no person can really tell whether this is owing to their models, or machinery, or some other cause.

WIARD'S PATENT ICE-BOAT.

This is a steamboat on runners, intended to navigate the Northern rivers and lakes in winter, when closed with ice of sufficient thickness to support its weight with safety. It is constructed with a water-tight hull, so that in case it should break through the ice, or come to open places in the river, it will float on the water without harm to itself, cargo, or passengers. We copy the following from a pamphlet on the subject, written by the inventor:

"It is safe to say that not less than twenty-two thousand miles of ice-road are embraced within the limits of the United States and Territories. In addition to this immense field, there are still others in the British Provinces and the north of Europe. By means of the ice-boat, remote regions of our country, shut out in winter, will be brought into constant connection with the cities of Chicago, St. Louis, Washington, New York, and Boston.

"In the winter of 1858–9, I constructed, at Prairie-du-Chien, my first ice-boat. It was my intention to have it completed in time to make a trial of its speed upon the ice of the Mississippi River, between Prairie-du-Chien and St. Paul, in the spring of 1859; but in this I was disappointed, by the reason of the breaking up of the ice in that river a month earlier than usual. The boat, however, was completed, and is seventy feet in length, twelve feet in width, and when resting upon the water, loaded, displaces about one foot in depth of water. Its upper part is similar to a railroad car, and is warmed by steam. It will accommodate one hundred passengers. It is propelled by an engine acting on a single driving-wheel. Adhesion is given to the wheel by means of penetrating or sharp flanges. Its velocity is controlled by a steam-brake. The runners are so adjusted that it may be made to run through snow five feet deep. The cabin of the boat is twelve by forty feet, and I estimate its weight, when loaded with passengers and freight, at twelve tons. It is my firm conviction that its ordinary speed will be from twenty to forty miles, and on clear, solid ice, its speed may be increased to from forty to eighty."

THE NAPOLEON DOCKS AT CHERBOURG, FRANCE.

The naval works at Cherbourg, France, recently completed by the French Government, after having been in the process of construction for seventy years, at a cost of $15,000,000, are of the most gigantic description. In general terms, the breakwater may be described as presenting a mass of rubble stone, having a slope, from the bed of the sea to the level, of nearly 22 feet below high-water line of spring tides, towards the roads, in the ratio of one of base to one in height (1 to 1). The top of the mass then has a much more gentle inclination; for, in the width of 19½ feet, its inner summit attains the level of 15¾ feet below high-water line, and there it stops against a wall, almost vertical, rising 7 feet above the same high-water line, or datum. There is a level platform at this height, of 20½ feet wide on the eastern arm, and 21 feet wide on the western arm; and beyond it there is a solid masonry parapet (about 5 feet high, and rather more than 8 feet wide) towards the sea. The outer line of this parapet is, in fact, in the continuation of the sea face of the wall, and the latter has been built of coarse and dressed masonry, laid with the greatest care, and composed of the very best materials, upon a general bed of hydraulic concrete, 5 feet thick, laid over the loose rubble hearting. The bottom of the concrete is about 29 feet below datum. Beyond the edge of the masonry which protects the foot of the vertical wall, the top of the rubble hearting of the breakwater has assumed a slope of 1 in 10 towards the open sea, under the influence of storms. This slope continues until the top line has descended to 47 feet below datum, and thence it continues to the bottom, at the rate of 1½ to 1.

The small materials used in the hearting of the breakwater are naturally exposed to be displaced by storms. Of late, however, a very effectual mode of protecting the sea slope has been adopted, consisting of huge artificial blocks, cubing not less than 26 yards, placed upon those portions of the breakwater which are most exposed to the effects of the sea. These blocks are composed of rubble masonry and of Portland cement mortar.

Returning, however, to the consideration of the general plan of these offensive and defensive works, we find that there is, at the apex of the angle formed by the meeting of the two branches of the breakwater, a large central fort, having a total development of about 509 feet, measured on the inner line of the parapet, which forms a very flat semi-ellipse. Behind this battery there is to be raised an elliptical central tower, measuring 225 feet on the major, and 123 feet on the minor axis. A casemated fort, of about 190 feet front, is to be formed on the western or longer branch, and two large circular forts are placed at the extremities of the breakwater, — that of the eastern end being 100 feet in diameter, and that of the western end about 133 feet in diameter.

The military port of Cherbourg consists of an outer harbor, $776\frac{1}{2}$ feet long, by $662\frac{3}{4}$ feet wide, with a *minimum* depth of water of $58\frac{1}{2}$ feet. The channel at the entrance is 206 feet wide at the narrowest point, and is usually 530 feet wide. The cost of this outer harbor was estimated at nearly £680,000. Beyond it, and communicating with it by means of a lock of about 130 feet long, and 58 feet 7 inches wide, is a floating basin 957 feet long by 712 feet 9 inches wide. There are on the opposite side of the outer harbor to this floating basin, four fine covered building-slips for 120-gun ships, and a graving dock close by a caisson, besides some uncovered slips for building smaller classes of ships. The building-slips for vessels of the line are 383 feet long, by 78 feet 8 inches wide. The graving-dock is 245 feet long, by about 78 feet wide, with a depth of water over the sill of about 27 feet 6 inches.

The inner floating harbor has been inaugurated. It is parallel to the first floating basin, and will communicate both with the outer harbor and the basin. It is about 2788 feet long by about 1312 feet wide, and is entirely excavated out of the solid rock, — a member of the transition series, extremely hard and tough. All round this marvellous sheet of water is a series of graving-docks and building-slips, of remarkable beauty, so far as we may judge of them by their present state, at least; and immediately beyond the quays are the various magazines, storehouses, sail-lofts, shops, etc., which, when complete, will render Cherbourg one of the most complete arsenals in Europe.

THE VICTORIA (ST. LAWRENCE) TUBULAR BRIDGE.

The present year will witness the completion of, perhaps, the greatest engineering work of our time, viz., that of the great bridge across the river St. Lawrence, of which the Britannia Bridge over the Menai Straits proves to have been but the precursor, as to Americans it will hereafter seem but as the shadow. The enterprise has been carried out under the auspices, and as a part of the "Grand Trunk Railway," which forms the connecting link between Montreal and the United States. In order that this road might be kept open in winter, a bridge across the St. Lawrence, near Montreal, was absolutely necessary; but the difficulties of crossing the river at this point seemed at first almost insuperable. Its width, even at the most available point is very formidable; its current is very rapid, its depth not insignificant. Besides this, the navigation of the river, not merely by steamboats and other vessels, but by enormous timber rafts, had to be provided for; so that unusual elevation, and unusual width between the piers, were both required. There was another obstacle, more formidable — far more formidable — than all. In the winter season, the St. Lawrence presents a field of ice from three to five feet thick. Whilst it is thus frozen, the river rises sometimes as much as twenty feet above its summer level. This rise of water might be provided for; but how was accident to be avoided, at the annually recurring period when the breaking up of the ice, with almost resistless power, sweeps almost every obstacle before it?

Could any bridge be devised to withstand these formidable difficulties? If possible, how was such a bridge to be constructed? The Directors of the Grand Trunk Railway, to whom these questions were so vitally important, took a course which will probably be thought to redound greatly to their enterprise and sagacity: they determined to take the opinion of the most eminent engineer whose advice and counsel they could obtain.

The Britannia Bridge across the Menai Straits was opened in 1849, and it was not, therefore, unnatural that, in 1852, the directors should look to Mr. Robert Stephenson, as the engineer most competent to advise them. Mr. Stephenson considered the subject of so much interest and importance, that he determined to go out to Canada, personally, for the purpose of dealing with it. He accordingly repaired there, at the end of the summer of 1853, and, after examining into the facts, made a public declaration of his opinion, that a bridge across the St. Lawrence was practicable. On the 2d of May following, Mr. Stephenson addressed to the Grand Trunk Railway Directors a report, in which he considered the whole question in three branches: first, as to the description of bridge best calculated to prove efficient and permanent; second, as to the proper site; and thirdly, as to the necessity for such a structure. Upon the first point, he did not hesitate at once to recommend the adoption of a tubular bridge, as the description of bridge best fitted for a permanent, safe, and substantial structure, in such a situation; on the second point, he was not a little influenced by considerations affecting the flow of the river, and "those almost irresistible forces" consequent upon the breaking up of the ice in spring.

Mr. Stephenson, on his arrival in Canada, met with numerous alarmists, who could graphically describe to him the effect of the ice, but he met with no one who had in any way measured or calculated the amount of its pressure. In considering the question whether a bridge could be constructed to withstand that pressure, it appeared to Mr. Stephenson to be of primary importance to ascertain really and precisely what that pressure was. This was a question of calculation; though, in the absence of any data, the difficulty was how to calculate it. And here, before the reader proceeds further, he may, perhaps, not without advantage, pause for a moment to ponder on the way to solve the problem, What is the amount of the pressure of ice four or five feet thick, in a running stream of a certain inclination, velocity, and breadth?

This problem puzzled Mr. Stephenson himself at first; but it was not long before he hit on an expedient. He first got at the inclination of the river; next at its velocity. He then assumed that the ice upon that river was what they told him it usually was, from four to five feet thick. He then inquired into the condition of the river, and he found that, about nine miles above Montreal, there was a fall called the Fall of Lachine, which, of course, separated the body of ice above the fall from the body of ice below it. Taking these data, he calculated what would be the pressure of nine miles of ice, from four to five feet thick, lying on a plane of a given inclination, and pressing against the piers of a bridge across the channel. The result of that calculation in figures it would be unnecessary, even if it were possible, to state; but, whatever were the figures, they enabled Mr. Stephenson at once to realize one all-important fact. He arrived at the conclusion that "the almost irresistible force" of this mass of ice would crush or sweep away any ordinary bridge, and that all the suggestions previously made for encountering the difficulty were only likely to result in disaster if carried into effect.

For, up to the period of Mr. Stephenson's report, great difference of opinion existed in Canada and elsewhere, as to the probable effect of the ice pressure. One party held that no bridge whatever could stand against it; another, whilst admitting the difficulty to be formidable, thought timber casings or fenders, such as those in use on the small rivers of Norway and elsewhere, would be an efficient protection for the piers. The proposal most forcibly impressed on Mr. Stephenson was to protect his piers by what is called a "crib-work;" that is to say, by large masses of timber in front of the piers, crossed and weighted, and as thick, or thicker, than the ice itself. It was evident from the first, that this extensive crib-work must be an additional obstacle and impediment to the free navigation of the river, and to the passage of the ice. But, beyond this, Mr. Stephenson's calculations convinced him that such a work would be entirely inadequate to protect such a structure as he contemplated, in such a river as the River St. Lawrence; and that, even if the crib-work stood, it would be subject to such abrasion and wear and tear, from its conflicts with the ice, that it would require to be reïnstated at least every two or three years. It was more than doubtful, to his mind, if such an arrangement would be capable of resisting the ice at all; and if it did not, the capital of the company would be wasted. Mr. Stephenson, therefore, at once determined that such a work was undesirable; and that such enormous stakes as those at issue could not be left dependent upon the uncertainty of such an expedient.

The abstract methods he had taken to ascertain if any bridge would withstand the almost irresistible pressure of the ice, had not alone convinced Mr. Stephenson that no such projects would avail as those proposed in Canada. They had equally satisfied his mind as to the amount of resistance requisite to encounter the pressure against which it was needful to provide. Knowing what timber would not resist, he equally knew what resistance could be afforded by substantial masonry. "Cribs" he felt were useless; but there were methods by which the pressure could be resisted, independently of "cribs." Mr. Stephenson decided on the adoption of stone piers, to carry the tubes at wide intervals, each pier having, on the side opposed to the course of the stream, large cut-waters of solid stone work, inclined against the current, up which, as it were, the ice would creep, and break itself to pieces by its own weight and pressure. He arranged that these wedge-shaped cut-waters should present angles to the ice sufficient to separate and fracture it as it rose up upon the piers, but at the same time so obtuse as not to be liable themselves to fracture. These piers, therefore, were devised to answer the double purpose of piers and ice-breakers. They exhibit, as now constructed, every indication of massiveness and power to resist pressure, as well as of stability to support the superstructure. Experience, indeed, has proved the piers suited for all the purposes for which they were designed. During the four years the structure has been in progress, it has entirely fulfilled all the conditions its originator anticipated; and it has withstood, in the most satisfactory manner, the most violent pressures which have followed the break-up of the ice.

Whilst the piers of this bridge are thus peculiar in their design, in order to meet the peculiar circumstances of the country and the climate of Canada, the superstructure is an elongated repetition only of the design for the Britannia Bridge. The Victoria Bridge is indeed remarkable for its extreme length, but its several tubes are not so long as those of the Britannia Bridge, and are only otherwise distinguishable, inasmuch as that they are the longest tubes yet constructed without the adaptation of the cellular principle. It deserves notice, however, that these tubes, in all their details, were designed, plate by plate and rivet by rivet, in the office of Mr. Stephenson, and were calculated for every strength and strain, and prepared and arranged in all their details, under the sole superintendence and supervision of his relative, Mr. G. R. Stephenson. With such nicety were all the arrangements respecting these plates conducted, that, under the directions of that gentleman, every plate and piece of iron was punched in England before it was sent out to Canada; and elaborate and detailed drawings and instructions were sent by the same hand, to show the method of connection. On the arrival, therefore, of each separate cargo of iron in Canada, little remained to those upon the spot but to fasten together the various pieces, and place them in their order and position as directed.

The Victoria Bridge, with its approaches, is only about 60 yards short of two miles, being five and one-half times longer than the Britannia Bridge across the Menai Straits. The bridge proper consists of 24 spans of 242 feet each, and one in the centre of the river, — itself an immense bridge of 330 feet. The spans are approached by a causeway, on each side of the river, each terminating in an abutment of solid masonry, 240 feet long, and 90 feet wide. The causeway from the north bank is 1400 feet long, and that from the south bank 700 feet. The iron tubes, within which the road runs, are 60 feet above the high-water level of the St. Lawrence, and the total weight of iron in the tubes is upwards of 100,000 tons.

ON THE SEWERAGE OF LONDON.

London has justly boasted of being the best-drained city in the world, and pointed to her two thousand miles of subterranean passages, through which the sewage of two millions of inhabitants flowed to the sea, as a prouder wonder than the labyrinth of Crete. The object of all London drainage up to the present time, however, has been to make the Thames the great main sewer of the metropolis; — all the sewers of the city, on both sides of the river, running due north and south, and all discharging into the Thames within a distance of about six miles. Most of the sewers, moreover, owing to their low level, are so completely tide-locked, that it is only at dead low water that they can empty themselves at all, and thus for twelve hours this sewage of both sides of London is pent up, and gives off its miasma, through an elaborate system of drains, into every street and house. But as the sewage can only escape at dead low water, the returning tide in the river churns it up and down, keeping all its abominable "flotsam" and "jetsam" opposite the city, until the tide turns, when it runs out, and is replaced by a quantum of some two million gallons of fresh filth, to be operated on in a similar manner. The consequence is, that the Thames itself has been converted into a mere open sewer of the worst kind.

This evil has been greatly increased by the very perfection to which the drainage of the city has been carried of late years. Within the last ten years, seven or eight hundred miles of drains have been built to remove the mischief of private cess-pools, attached to almost every house, and which had grown into a nuisance of the most flagrant character. But this accuracy of cleanliness for each house only aggravated the horrors of the river, inasmuch as it increased the amount of sewerage to the extent of two hundred thousand gallons daily, containing three hundred tons, at least, of organic matter, which in this case is the mildest term for filth of the most loathsome description.

About three years ago, the waters of the Thames, which had gradually been getting more and more full-flavored, began to give off a stench so dreadful, that precautionary measures had at once to be adopted to mitigate the immediate danger; and, as a palliative, an immense amount of lime and chloride of lime was put in daily. During the past summer (1859) this treatment had to be increased, and no less than one hundred and ten tons of lime, and twelve tons of chloride of lime, were thrown into the river daily, at a cost of £1500 per week; an expenditure which it is calculated must be doubled next year, and so on until the evil is overcome. A sum of £20,000, moreover, was also expended during the past summer in flushing the sewers, to aid in the discharge of their contents in times of extreme low water.

The magnitude and importance of this growing evil have at last compelled the attention of Parliament, and measures have been adopted to put an end to it forever.

The great difficulty has been to decide on the most feasible method of doing the work, the necessity of which was denied by nobody. Finally, however, the plan of Mr. Bazalgette, the Chief Engineer of the Board of Works, has been adopted, and is already in progress. It is on a scale adequate to the Augean labor undertaken. It consists of three gigantic main tunnels, at different levels, which intercept the existing sewers at right angles, thus receiving all their contents formerly empted into the river, and conveying them, parallel with the banks of the river, about eight miles to Barking, where an immense reservoir is to be prepared to receive them. This reservoir is to be a mile and a half long, by about one hundred feet wide and twenty-one feet deep, capable of containing no less than seven million cubic feet, or double the average of eight hours' accumulation of sewage. The object of the narrowness of the reservoir, compared with its length, is to admit of its being bricked over with arches, and covered with earth, so as to prevent the escape of foul gases. During the time the sewage is in this reservoir it is to be deodorized, and experiments are now going on to ascertain the best method of doing this. At high tide the contents of the reservoir will be emptied into the river by immense outfall pipes extending to the middle and bottom of its bed, sixty feet below the surface. It is believed that with these precautions, the sewage, after deodorization, being poured into so vast a body of water, at so great a depth, will cease to be any longer an agent of mischief.

These works are now going on with great rapidity, and in the most thorough and profuse manner. The estimated time for their completion is five years, and the expense £4,000,000 ($20,000,000). At the point where the several sewers unite, the whole are enclosed in a single tunnel of the most massive description, powerful outer haunches or buttresses supporting the tube outside, while the whole is inclosed in what may be almost termed an embankment of concrete. More than two thousand men are at present employed on the work, and the whole will require about forty million bricks, and many thousand tons of mortar, to complete it. So vast is the undertaking, and so colossal are its proportions, that but for its having an important and most beneficial purpose in view, it would almost remind the spectator of the gigantic and meaningless works which the Egyptians seem to have created, apparently only to excite the astonishment of after ages.

THE ORDNANCE SURVEY OF GREAT BRITAIN.

The National Survey of Great Britain is based upon a system of triangulation extending over the whole country. The distances between the trigonometrical sections are derived from the measured base-line on Salisbury Plain, and on the north shore of Lough Foyle, in the north of Ireland. This most important branch of the work has been executed with the greatest accuracy — the difference between the measured lengths of the bases of verification and their computed lengths not exceeding two and one-half inches in seven miles. The average length of the sides of the triangles in the principal triangulation is about sixty miles, but many of the sides exceed one hundred miles in length. The primary triangulation is next broken up into smaller triangles, the sides of which are from five to ten miles in length, and this secondary is again broken into triangles, the sides of which are about one mile long, to form the tertiary or minor triangulation. The men employed to make the detailed survey, then, actually measure the length of each side of the minor triangles on the ground, noting in their "field-books" every fence, stream, or other object they may cross; they then measure cross lines from one side of the triangle to the other, and, by taking offsets from the measured lines to every object on the face of the country, they obtain in their field-books the data for plotting accurate plans upon any scale which may be required. The length of every measured side of a triangle, therefore, is checked by the computed trigonometrical distance, and the accuracy of the lines within each triangle is checked by the plotting, and thus no errors can escape detection. By this method perfect accuracy is obtained, not only in every part of the detail of the survey, but every object is in its correct relative position to every other object, however distant. The levels engraved on the plans are all given in relation to one datum level,— that for Great Britain being the level of mean-tide at Liverpool.

The scales which have been adopted for the plans are as follows: Town maps, 60 inches to the mile, or 1-500 of the actual linear measure; parishes, 25·334 inches to a mile, or 1-2500 of the actual measurement; counties, 6 inches to the mile; and the general map of the kingdom, 1 inch to the mile. The parish plans are engraved upon zinc, and the remaining plans on copper. Zincography is now generally adopted, instead of lithography, on account of the facility of handling zinc plates, rather than lithographic stones, which are necessarily heavy, and are constantly liable to be broken. The reduction of the scale of the one-inch plans from those of larger size, is done by means of photography. The collodion process is employed for the purpose of taking the negative copy. The lens of the camera used is a single achromatic meniscus, three and one-half inches in diameter, with a principal focal length of twenty-four inches. The plan to be reduced is attached to a board, which can be adjusted by a screw to any height that may be required, and turns upon a centre pivot. The camera is placed opposite to it on a table which runs upon wheels upon a small tramway laid down on the floor of the photographic room, and the required scale of the reduction is obtained by tracing on the ground glass of the camera a rectangle corresponding on the reduced scale to the rectangle of the plan to be reduced. The curvature of the image, and the indistinctness of outline from spherical aberration, are both remedied by reducing the diaphragm in front of the lens to a small aperture. From the negative thus obtained on glass, as many positive copies on paper as are required are then taken in the usual way. The introduction of this method has greatly lessened the cost of reducing the plans, and also saves an immense quantity of time and labor. The six-inch map is engraved in sheets three feet by two feet, the sheets of each county being made to fit together by the marginal lines, so as to form, if required, a single plan.

A considerable saving in the cost of engraving the Ordnance Maps is effected by using steel punches to cut the woods, figures, rocks, etc., on the copper plates; the work is thus done much more quickly than by hand, and boys are employed at it in the place of skilled engravers. A portion of the writing, also, on the copper plates, is engraved by machine (Becker's patent), and the parks and sands are ruled by a machine with a steel dotting-wheel, the pressure of the wheel and the interval between the dots being regulated according to the tint required to be produced. The ink used in the copper-plate printing consists of Frankfort black with a mixture of Prussian blue, ground with burnt oil in a mill constructed at the Ordnance Map Office, at Southampton, for the purpose. After printing, the impressions are first dried between millboards, and are then placed between glazeboards, and pressed in an hydraulic press, after which they are ready to issue. — *London Times.*

RAILROAD AXLES AND THE FORCES THEY HAVE TO RESIST.

From a Prussian journal for architects and civil engineers, we derive the following report of a series of experiments, made by Superintendent Woehler, of one of the largest railroad lines in Prussia, with different axles, and under different circumstances.

The forces which act on these axles may be divided into two classes, one class containing those forces which tend to effect a flexion or bending of the axle, and the other containing those which effect a torsion or twisting of the same. Two simple and ingenious apparatuses were attached to the axles, which, by means of steel points acting against zinc plates, indicated, after each trip, the degree of flexion and the respective torsion of the axle.

With the experiments on the flexion of the axles, it was necessary to ascertain that force which, when applied to the circumference of the wheel, corresponds to the flexion indicated by the steel point of the apparatus on the dial-plate. For this purpose two dynamometers are attached, one to each wheel and near to its circumference, and the two wheels are forced towards each other, until the apparatus on the axle indicates the same degree of flection which has been indicated by the steel point during the trip. It must, however, be remarked, that the apparatus, as it revolves with the axles, causes the index to deflect in opposite directions, producing a deflection twice as large as that produced with equal power by means of the dynamometer. The apparatus was so constructed that, during the motion of the train, one inch deflection of the index was equal to a side motion of the circumference of the wheel of 3-16 of an inch, or to a deflection of 3-32 from its normal position. The side-draught, which has to be applied to the circumference of the wheel in order to produce the same flection of the axle, or a one-sided deflection of the index of a half inch, is equal to 23½ cwt. for axles of 3¾ inches diameter in the hubs, and for wheels of 36¼ inches diameter. For axles of 5 inches diameter in the hub, and with wheels of 36¾ inches, the side-draught was found to be 70½ cwt.

With the experiments on torsion the apparatus was so constructed that, with axles of 3½ inches, one inch deflection of the index corresponds to a motion of 0·321 inches on the circumference of a wheel of 36¼ inches, which is also the double amount of the real deflection of each point of the circumference from its normal position. Each inch of deflection of the index, therefore, corresponds to an angle of torsion of 30 minutes. To produce this amount of torsion, a power equal to 18¾ cwt. had to be applied to the circumference of the wheel. With axles of five inches diameter, the angle of torsion corresponding to one inch deflection of the index, was found to be 21 minutes, which required a power of 44 cwt. applied on the circumference of the wheels of 36¾ inches diameter.

Experiments have been made with cars running on six and four wheels, and the results were collected in tables giving the number of miles travelled over by the cars, the weight of the cars with their respective loads, and the largest deflection of the indexes of both the apparatuses for flection and for torsion.

With axles of 3¾ inch diameter, made of cast steel, and running under cars with four wheels, and with a weight of 117·6 cwt. on each axle, the largest deflection of the index by flection was 3 1-16 inch, which is equal to a side-draught of 72 cwt. The tension of the extreme fibres of the axle in this case is equal to 252 cwt. per square inch, and the deflection of the wheel from its normal position is equal to 0·287 inches. The average deflection of the index, with covered cars running on four wheels, however, was found to be from 2¼ to 2⅝ inches, requiring a side-draught of from 51 5-6 to 62⅜ cwt.

The largest deflection of the apparatus for torsion, in the same case, was found to be 1 7-12 inches, which is equal to a power of 29 11-16 cwt. on the circumference of the wheel, producing a tension of the extreme fibres equal to 52 cwt. per square inch. The average deflection in this case was 1 1-12 inches, which is equal to a power of 20¼ cwt. on the circumference of the wheels.

If the two largest forces on flection and torsion act simultaneously, the extreme fibres of the axle sustain a power equal to the square root of $352^2 + 52^2$, which leaves 257 cwt. per square inch. This shows that the torsion increases but very slightly the tension of the extreme fibres produced by the flection of the axles.

Such a power would be amply sufficient to produce a considerable bend with wrought-iron axles, where the limit of elasticity is approached by a tension of the extreme fibres equal to 180 cwt. to the square inch.

With axles of five inches diameter, and a load of 153·15 cwt. per axle, the largest deflection produced by flection was 1 15-32 inches, which is equal to a deflection of the circumference of the wheel from its normal position of 9-64 inches, and which requires a side-draught of 102 35-64 cwt. The tension of the extreme fibres in this case is equal to 156 cwt. per square inch.

The largest torsion was produced with a load of 164-25 cwt. per axle. The deflection of the index was equal to 1-16 inch, which requires a power of 46¾ cwt. on the circumference of the wheel, and the tension of the extreme fibres is equal to 35 cwt. per square inch.

If an axle is calculated to run 200,000 miles, and the largest deflection takes place once in every ten miles, it (the axle) will break if it cannot be bent 20,000 times to this deflection from its normal position. In order to ascertain, therefore, the largest load which an axle it able to carry with safety, it is necessary to ascertain how far, and how often, the axle can be bent.

Careful experiments made in this respect show that the maximum load of a five-inch wrought-iron axle ought not to exceed 155 cwt.; that of a 4½-inch axle, 113 cwt.; that of a 4-inch axle, 79 cwt.; and that of a 3¾-inch axle, 70 cwt.

SUGGESTIONS RESPECTING RAILWAY SUPERSTRUCTURE.

The following excellent remarks on railroad construction, by John C. Trautwine, C. E. of Philadelphia, are from the *Journal of the Franklin Institute:*

"I would suggest to superintendents of railroads now in operation, the trial of a few rods in length of superstructure with string-pieces, and two sets of cross-ties. First place in the ballast-ties six by eight inches, two and a half feet apart from centre to centre; upon these place longitudinal sills, also six by eight inches; lastly, upon the latter place the smaller cross-ties supporting the rail, about three by six inches, and two or two and a half feet apart from centre to centre; the bottom of the longitudinals being about an inch above the ballast. The bottom of the string-piece is supposed to be elevated about an inch above the ballast. It appears to me that the elasticity insured to the rail, throughout its entire length, by the arrangement, will be found to diminish, to a very great extent, the destructive *pounding* action which the engines exert upon the rails of all the superstructures now in use. Experience would soon point out the proper dimensions, and distances apart, of the timbers to be employed for engines of any given weight, in order to insure the requisite degree of elasticity, which evidently admits of being varied to any extent which may be found desirable. The increased quantity of timber involved in this proposed plan, is an evident objection to it; but experience only can indicate whether the attendant advantages which it possesses may not more than counterbalance this objection, together with any others to which it may be liable. Besides the greater presumed durability of the rail, from the fact that no portion of it rests on a rigid support, we should secure a much more efficient rail-joint, inasmuch as the joints would rest *upon* the upper cross-ties, instead of *between* the ties, as in the present preferred practice; thus combining increased strength of joint with greater uniformity of elasticity. We also should elevate the rail more beyond the influence of snow. Moreover, should this expedient enable us to obtain that certain (uncertain?) amount of elasticity of rail which all engineers concede to be so important a desideratum, it will doubtless lead to the adoption of more efficient supports for the lower cross-ties themselves,—supports which may extend below the influence of rain and frost, and thus effect a very important reduction of expense for rectification of the track, besides dispensing with the use of ballast. The greatest objection in the employment of such supports, hitherto, has been the increased rigidity of track attendant on them, and by which the destruction of the rail is greatly accelerated. But if we can devise a means of modifying or entirely annulling this rigidity in the rail by a process entirely independent of the foundation on which the rail rests, then this objection vanishes; and the way seems to open for arriving at a much more perfect superstructure than has hitherto been used.

"I hope that the subject may be regarded by some of our intelligent superintendents as being of sufficient interest to induce them to make a trial of it, if only for a few lengths of rail."

GARDINER'S COMPOUND CAR WHEEL AND AXLE.

The invention consists of a compound axle of three parts, and a compound wheel of six parts. The journal part of the axle is about sixteen inches long, of sufficient length for the bearing, and passes to the centre of the hub of the wheel; the other part is of sufficient length to reach from centre to center of the hubs, constituting the main or middle part of the axle. It is joined to each end by the short axles, and so coupled together inside of the hub as to render it as strong as the solid axle. The wheel is pressed on the short axle in the ordinary way, giving the result of a loose and tight wheel on the same end of the axle, — so that, while running on a straight line, the wheels and axle revolve together in the ordinary manner; but, upon striking a curve, they act independently, adjusting themselves, whatever the radius may be, without causing the least tension on the axle. The short parts of the axle can be made of cast steel with advantage — the difference in cost being more than equalled by its superior durability — the steel axle lasting four or five times as long as one made of wrought iron. As there is no twist on the main axle, it will last for many years, the short ones only wanting to be renewed. In this way, the cost of axles for a term of years will be reduced nearly fifty per cent., to say nothing of the prevention of accidents, now so frequent from the breakage of axles. An important feature is, that the axle can be as well made from old axles, which have been worn out at the journals, and can be applied to an ordinary cast wheel, or to the improved wheel described as follows: The side-plates and tire are made of wrought iron; the hub is of cast iron, and consists of three parts — a centre and two side pieces. The side-plates will outlast several tires, which can be renewed whenever they wear out. The whole wheel can be made at a little over half the cost of the ordinary wrought-iron wheel, and will save over three-quarters of a ton on the weight of an eight-wheeled car. — *American Railway Review.*

IMPROVEMENT IN HORSE RAILROADS.

The *Cincinnati Gazette* notes a new kind of rail on exhibition in that city, adapted to street railroads. It is designed to dispense entirely with wooden cross-ties, and can be put down at much less expense than the ordinary way. The rails are joined together, and made continuous by means of a splice-wedge inserted in cleets about ten inches long, cast with the rail. Trenches are opened in the pavement, eighteen inches wide, and from eight to twenty inches deep, the bottom compacted by the use of a rammer, and the rail put in. At the ends and in the middle of each rail, a block or plank, about ten inches surface, is laid crosswise of the track; the gravel is then replaced, and the pavement closed in. The weight of the rail is from eighty to one hundred pounds per yard, and the cost per mile, when laid, from $6000 to $8000.

ON AN IMPROVED CONSTRUCTION OF AXLE-BOXES AND COUPLING-RODS FOR LOCOMOTIVE ENGINES.

The following paper was read before the Institution of Mechanical Engineers, London, by Mr. W. A. Fairbairn: This construction of axle-box has for its object the introduction of an elastic cushion or spring of vulcanized india-rubber between the axle-boxes and framing of locomotive engines, for the purpose of allowing the wheels to accommodate themselves to curved portions of the railway, and thus diminish the wear on the flanges of the wheels and on the faces of the axle-boxes. The india-rubber spring is placed in recesses formed in the jaws of the horn plates upon each side of the axle-box, and a metal plate, with a smooth, case-hardened surface, is interposed, upon which the axle-box slides vertically with the inequalities of the road. The force of the spring action of the india-rubber is made sufficient to keep the axles of the wheels at right angles to the straight portions of the railway, but to yield to the friction of the rails upon the wheels in curved portions, and by this means to allow the axles to assume such a position as will place the wheels at a tangent to the curve. The elasticity of the india-rubber serves also to keep the axle-boxes at all times in close contact with the faces of the horn blocks, so as to secure a good fit, and obviate the necessity for that constant lining which they ordinarily require, in consequence of the wearing away of the working faces.

That the leading and trailing wheels may have still further flexibility of adjustment, a small play is permitted to the axle-box laterally, in the direction of the axle, by making the recesses in the axle-box, which receive the face-plates, wider than the plates themselves by $\frac{1}{2}$ inch. But to keep the axle-boxes in position in straight portions of the road, these plates are made wedge-shaped in plan, so that the elastic pressure of the india-rubber on the face-plates restores the axle-boxes to their central position, whenever the pressure on the flanges of the wheel is relieved. The inclination of the wedge is made such that $\frac{1}{4}$ inch movement of the axle-box laterally, in either direction, compresses the india-rubber $\frac{1}{8}$ inch.

The india-rubber is employed in the form of rings or washers $\frac{13}{16}$ inch thick; and it is found convenient, in order to maintain an accurate fit between the working surfaces of the axle-boxes, that these washers, when in position, should be compressed $\frac{3}{16}$ inch, which is equivalent to a pressure of about one ton on each side of the axle-box, tending to maintain the contact of the working surfaces. With this pressure, the axle-boxes slide more freely on the case-hardened surface of the plates, than in the usual construction; whilst the motion which permits the wheels to accommodate themselves to the curvature of the road does not in the least increase the oscillation of the engine, and prevents the excessive wear of the shoulders of the journals and the flanges of the wheels, which are such fertile causes of unsteadiness in ordinary engines.

In the case of the driving-wheels of the engine, it is not advisable to allow so much play to the axle-boxes; and hence, while the admirable fit between the working surfaces obtained by the above arrangement renders its employment advantageous, it is modified in this case by the use of a band of india-rubber, $12\frac{1}{2}$ by $2\frac{1}{2}$ inches, and $\frac{3}{8}$ inch thick, covered by a wrought-iron plate, case-hardened as before, but not wedge-shaped, since in this case all lateral play is to be avoided. A longitudinal play of $\frac{1}{32}$ inch only is allowed on each side, between the case-hardened plate and the horn-blocks, to permit the action of the india-rubber spring, which is compressed in this case, so as to exert an initial pressure of about fifteen tons on each side of the axle-box, to resist the action of the force driving the engine. Notwithstanding this large pressure on the working faces of the box, it is found, in practice, to fall readily with the weight of the wheel itself. In the case of the driving-wheel, the advantage derived by this construction does not consist in the adjustment given to the wheels, but in the perfect fit at all times maintained between the sliding surfaces; the elasticity of the india-rubber also forms an elastic cushion to receive the shocks of the machinery. A small strip of leather prevents the oil from gaining admission to the india-rubber. The perfect freedom of motion, the small wear of the axle-box, in consequence of the case-hardening of the slides, the ease with which the engine passes curves, and the diminished wear of the wheel-flanges, are important advantages, which have been derived, in practice, from this construction of axle-box.

A similar application of an india-rubber spring to the outside coupling-rods of an engine had also been made. In this construction of rods, the use of cotters for tightening the brasses was dispensed with, by employing a set-screw at the end of the rod, secured by a lock-nut from risk of working loose.

Mr. W. Fairbairn showed a specimen of the india-rubber lining from an axle-box that had run 17,000 miles in a locomotive engine; also, a model of the axle-box fitted up with india-rubber, and a specimen of one of the connecting-rod ends. He stated that it was requisite to take great care to keep oil away from the india-rubber: as in one trial, the india-rubber had lasted only a month, from neglect of this precaution; but, when properly protected from oil, its durability was found to be very great. A cap was now fixed over the india-rubber, as a more complete protection for this purpose. These axle-boxes and connecting-rods were working in several locomotives on the Chester and Birkinhead Railway, and they were found to be now as good and perfect as when first put in, though some had run as much as 17,000 miles; they were considered quite satisfactory, and the result of the axle-boxes was an improvement in reducing the wear of the wheel-flanges. The connecting-rods were screwed up at the ends, instead of being cottered, as in the usual manner; and this mode of construction he considered an improvement as regarded convenience and security from accident.—*Newton's Journal, Feb.* 1859; *Jour. Franklin Institute, April* 1859.

LOUGHRIDGE PATENT BRAKE.

The construction of this new railway brake is described by the *Scientific American* as follows: Alongside the throttle-lever there is a bent lever which communicates with a ten-inch friction-wheel, and presses it against the flange of the rear driver, at will. This causes it (the friction-wheel) and its shaft to revolve, and a chain attached to the brakes throughout the train is wound on the shaft. On the shaft is a ratchet-wheel with a pawl, so that as the chain is wound to any given strain, it is kept in place. In connection with it is a weighing-beam, by means of which the power may be graduated on the brakes to suit the condition of the rails. A weight sliding on the notched weighing-beam gives more or less power as it is slipped from or to the fulcrum, and, once gauged, the engineer cannot put more power on the brakes if he wished, or should not wish, to; but he can apply any degree less than the fixed maximum down to zero. The beam is fixed so that the engineer cannot slip the wheels, nor break the chain, but can get what power he wishes up to the slipping-point. And this is all that is requisite; for if the wheels are slipped, the retarding power is lessened rather than increased. To loose brakes, a small lever is pulled, and the pawl being thrown out of the ratchet, the chain is suffered to unwind. The great beauty of the contrivance is the weighing-beam; for if the power were not gauged, the engineer, by braking up too suddenly, would snap any chain that might be used. To relieve the enormous shock which comes upon the pawl as it is thrown into the ratchet, the inventor has attached to its end a long gun spring, which effectually absorbs the sudden strain. The lever once thrown back, the ratchet and pawl below hold the brakes in place, so that the engineer need only put on the required power, and may then give his attention to the working of his engine. Coming to a station, the speed of the train may be so controlled that the reverse gear need never be used. The cost of applying the brake to an engine is $75; to an ordinary car, but $30.

ON BOILER-PLATE JOINTS.

In the discussion of boiler-plate joints, Mr. Clark demonstrates that the bursting strain on the longitudinal seams of cylindrical boilers is double the strain on the circular seams. This is an important practical distinction, because it is clear that, to insure uniform working strength, the longitudinal seams must be doubly fortified; and, in the consideration of the means of soldering, four distinct kinds of riveted joints are compared, and their relative strengths determined from actual trials. Welded joints are likewise discussed, and should the reported results of their capabilities to resist bursting strains be corroborated by advanced experience, they promise to supersede riveting, if not entirely, at all events for the principal joints. In the order of tensile strength the joints are ranged thus:

1. Scarf-welded joint, ...	100
2. Double-riveted double-welt joint, . .	80 per cent.
3. Double-riveted lap-joint, . . .	72 "
4. Lap-welded joint, ...	66 "
5. Double-riveted single-welt joint, . .	65 "
6. Single-riveted lap-joint, ...	60 "

In this comparative statement the strength of the entire plate is represented by 100; and the trials were made with plates varying from $\frac{3}{8}$ to $\frac{1}{2}$ inch in thickness. The relative strength of single and double-riveted joints do not very materially differ from those deduced by Mr. Fairbairn. — *London Artisan, Dec.* 1858.

ON THE USE OF SUPERHEATED STEAM.

At a recent meeting of the Society of Mechanical Engineers, London, the President, Mr. Power, stated that, as the result of extensive experimentation, he had arrived at the conclusion that an advantage can be derived from the use of superheated steam, amounting to an economy of fuel of from twenty to thirty per cent. in marine engines, and that a moderate extent of superheating enables all the important advantages of the plan to be obtained. By so doing, there is nothing objectionable involved from extra tear and wear, complication of apparatus, or difficulty in lubrication. The real advantage in superheating the steam appeared to be in preventing the presence of water in the cylinder of the engine, thus insuring pure steam to work the piston, making it a real steam-engine, and not a working mixture of water and steam. In all condensing engines, the interior of the cylinder being open to the condenser during half the time of each revolution, the temperature of the cylinder is reduced to about 125°. When the steam is therefore admitted for the next stroke at a temperature of 260° Fah., it is robbed of considerable heat, and a quantity of water is thereby formed in the cylinder. A portion of this water may be evaporated again towards the end of the stroke by carrying the expansion down to a low pressure, but its effective value is lost during all the previous portion of the stroke. If, therefore, as much heat is added to common steam by superheating it before entering the cylinder as will supply the amount which is usually abstracted from it, not a drop of water is formed during the whole stroke; it remains dry steam to the end. The addition of 100° of heat to the temperature of steam insured the desired object with steam at twenty pounds pressure on the square inch, as used in marine engines.

THE UNIT OF HEAT.

Professor Rankine, at the late meeting of the Institution of Engineers of Scotland, observed: "I am happy to recognize evidence that the true principles of the Mechanical Action of Heat, founded on the idea that heat is not a substance, but a form of energy, are making their way amongst practical men, and are being usefully applied by them. As a means of facilitating that progress, by putting the expression of those principles into a shape more familiar to practical engineers than their present form, it was recently suggested by Mr. Stephenson, that, instead of the Unit of Heat commonly employed in scientific treatises, — viz., so much heat as one pound of water requires in order to raise its temperature by one degree, — quantities of heat should be expressed in terms of a unit which practical men oftener have occasion to think of — viz., so much heat as one pound of water at 212° of Fahrenheit requires, in order to convert it into steam, at the same temperature; or what is commonly called 'the latent heat of one pound of steam at 212° of Fahrenheit;' being, in fact, the unit of heat now commonly employed in comparing the effects of different kinds of fuel and different forms of furnace. This suggestion of Mr. Stephenson appears to be well worthy of consideration and discussion. The following is a comparison of different units of quantity of heat, British and French, reduced to their equivalents in units of mechanical energy, as a common standard of comparison, based on the experiments of Joule:

BRITISH UNITS.	Equivalent energy in foot-pounds.
One degree of Fahrenheit's scale in a pound of water,	772
One degree of the Centigrade scale in a pound of water,	1390
Latent heat of one pound of atmospheric steam,	745750

FRENCH UNITS.	Equivalent energy in kilogrammetres.
One degree of the Centigrade scale in a kilogramme of water,	4237
Latent heat of one kilogramme of atmospheric steam,	22730

One kilogrammetre = 7·23314 foot-pounds.
One foot-pound = 0 138253 kilogrammetres."

TRY-COCK FOR STEAM-BOILERS.

This invention combines in one steam-boiler try-cock, all the advantages secured from three or more try-cocks of the present construction. Its novelty lies in the use of a straight hollow tube, inserted in the end of the boiler, and arranged to move up and down on a hollow axis; said axis communicating with the passage of the tube, and with the passage of a try-cock. The tube has a pointer on its outer end, and opposite the same a dial or under plate is placed. A spring holds the under end of the tube down, and thus keeps the inner end above the level of the water in the boiler. By this arrangement, by simply elevating the outer end of the tube and opening the cock, the same end will be brought down into the water, and the height of the water indicated; for as soon as the tube enters the water, the latter will be squirted through the tube, and escape at the try-cock. As soon as this occurs, the engineer casts his eye to the dial, and ascertains the height of the water in the boiler. The inventor of this device is James Cummings, of Boston, Mass. — *Scientific American.*

COALS AND FURNACES — BURNING SMOKE.

It has long been a most desirable object, in burning bituminous coals, to consume all the smoke; and in England a law has been passed for the purpose of compelling all the owners of factories to use furnaces for the prevention of this smoke evil. In 1855 a prize of £500 ($2500) was offered by the Colliers' Association of Newcastle, and was contended for in December 1857, for the best method of burning bituminous coals in furnaces of multitubular boilers without smoke. On that occasion, the prize was awarded to C. W. Williams, of Liverpool, he having produced the best furnace and system of feeding the fuel to it. The report of the judges on the trials has but recently been published, and from it we obtain information which is of the utmost importance to consumers of bituminous coal.

It has been demonstrated, to the satisfaction of the most able engineers on the other side of the Atlantic, that bituminous coals can be burned in furnaces without producing smoke; and this by a very simple construction and arrangement of the furnace doors, and the method of feeding the coal. The whole system consists in having the furnace doors made with double plates, the inside one situated a few inches apart from the outside, so as to form a small chamber between them. The front and back plates are perforated with holes, or slits, and the air is heated as it passes through into the fire. The small holes deliver the air to the fuel in minute currents, and the fresh coals are fed to the fire by being laid right behind the door, the red coals being pushed forward every time the fresh are fed in. This arrangement of furnace doors, and the method of feeding, entirely prevents smoke, upon well-known principles. When fresh bituminous coal is thrown upon a red-hot fire, the more volatile part passes off as smoke; were this supplied with fresh air, and made to pass over a red-hot fire, it would ignite and be consumed. The air which passes through the holes in the furnace door, mixes with the volatile products of the fresh coal, and these are ignited as they flow over the fire on their way to the flue tubes. Of course, air is also admitted in the usual manner under the furnace bars, which should be half an inch thick at the top, and very thin at the bottom, and an air space of three-eighths of an inch left between them; such furnaces are made a little longer in front than the common kind; no other alteration is necessary, excepting perforating the door.

With furnaces so constructed, one foot of grate surface has evaporated four cubic feet of water per hour, from 60° Fahrenheit, which is double the amount usually obtained; and the economy of fuel has been over twenty-five per cent. With such furnaces, 11.30 lbs. of water have been evaporated with one pound of coal, and owing to the fresh coal being always placed close to the door, the heat in the fire-room is but low, while the doors are kept cool, and thus they last much longer. In employing bituminous coal in a multitubular boiler, the whole fuel should be perfectly burned in the furnace, the flame running the whole length of the fire: as the inflamed gases, if just ignited near the mouth of the tubes, are very liable to be extinguished when they enter them, and thus great loss of heat is sustained. Furnaces in which anthracite coal is burned, do not require such arrangements, because no volatile combustible matter is given off from this fuel.— *Scientific American.*

GRIFFIN'S IMPROVED GAS FURNACE.

An improved furnace, for laboratory and manufacturing purposes, has been patented during the past year, by Mr. Griffin, the well-known chemist, of London; by which, standing on a table, or any other convenient place, an intensity of heat can be obtained, sufficient to melt the most refractory substances, without any other fuel being used than the ordinary gas used for lighting the house. The construction of the furnace is as follows:

Attached to a large retort-stand, by a horizontal arm, is a small metal box between two and three inches in diameter. This box is divided into two parts internally; the upper part being connected by a flexible tube with the gas-piping of the room; the under part is in like manner connected with a pair of double bellows. On the top of the metal box is fixed a burner, consisting, in most instances, of sixteen jets, each of which is formed of two tubes, the outermost of which is short and only reaches into the upper part of the metal box, while the inner tubes are long enough to penetrate the division, and to reach the lower part of the box. This burner, with its sixteen tubes, forms a small flat cylinder on the top of the box, around which, and fitting it exactly, is placed a large flat disk of porous earthenware, in shape like a millstone, and of a thickness equal to the height of the burner. Over this burner is placed a plumbago crucible with a lid, and supported by a semi-globular stand of the same material, like an inverted basin, pierced all over with small holes, and having a large hole in the centre to receive the bottom of the crucible; over this latter is placed a second, but larger cup, similarly pierced with small holes. Round the crucible, thus supported and covered, is placed a large cylinder made of porous earthenware, of the same diameter externally as the flat disk, and with exactly sufficient space in the centre to admit the crucible, cover, etc. This cylinder has a small hole in the side, through which to watch the crucible, and this hole is stopped with a plug. On the top of the first cylinder any number of others may be placed as required, and space between the crucible cover and the top of the highest cylinder may be filled with pieces of earthenware or pebbles, and the whole covered with a piece of tile. When the gas is turned on, it passes at first into the upper chamber of the metal box, and thence between the inner and outer tubes of the burner, where it comes into contact with the air which is forced by the bellows through the long tubes; this current of air produces rapid combustion of the gas, which, rushing out through the holes of the stand under the crucible, entirely surrounds the latter with a most ardent flame. The object of the earthenware cylinders and pebbles is solely to prevent the escape of the caloric. This is effected in so perfect a manner, that the hand can be placed with impunity on any part of the apparatus while the inside is glowing with a white heat.

By means of this furnace, it is stated, three pounds of copper can be melted in ten minutes, at an expense of a cent and a half.

FIRE GRATES AND CHIMNEYS.

A commission, appointed by the Board of Health in England, consisting of Mr. Fairbairn and Professors Wheatstone and Playfair, have made a report on grates and fire-places, in which they recommend some changes. They urge, for all parlor grates, the use of a greater amount of reflecting surface, to direct more heat into the room, and they advise the flue of the chimney to be much smaller than those in common use — a reform which we have also frequently advocated. They state that the flue of a chimney does not require to be made more than nine inches in diameter at its widest part; a narrow chimney diminishes the quantity of ascending air, and a tendency to smoke. Chimneys always draw better when they are kept warm: therefore, whenever it is possible, they should not be built on the outer walls of houses, such as gables. As a general rule, the grate should be situated at such a position in the fire-place where it can be seen from the greatest number of points in the room, and a good frontage of fire-surface should always be exposed. — *Scientific American.*

ON THE RELATIVE VALUES OF COAL AND COKE IN LOCOMOTIVE ENGINES.

In a paper on the above subject, read before the Society of Arts, London, May 18th, 1859, by B. Fothergill, Esq., the author stated that his object was to lay before the Society the results of a series of experiments which he had made with coal and coke in locomotive engines, and which had led him to the conclusions that coal was decidedly superior to coke in respect to heating power, and consequently more economical; that a plentiful supply of steam could be generated by it for working engines at high velocities, and for drawing heavy trains; that coal-burning engines could be made to consume their own smoke, and that the fire-boxes and tubes, when coal was used, were found to last longer. His experiments had been conducted upon the London and South-Western Railway, and were made, at the request of the directors, to ascertain the value of an invention which had been patented by their locomotive superintendent, Mr. Joseph Beattie, and which the author proceeded to describe in detail. The contrivance consists in so dividing the fire-box as to increase the amount of heating surface, and to diminish the indirect or tube surface, whilst the combustion chamber affords sufficient space for the introduction of a series of fire-tiles, for the purpose of retaining a portion of the heat given off from the combustion of the gases, and for diffusing the unconsumed carbon, as well as effecting a complete mixture of the air with the gases, and thereby producing a mass of flames, which is brought in contact with the direct heating surface of the combustion chamber before it enters the tubes, at the same time preventing practically such an escape of smoke from the chimney as could be deemed a nuisance. In addition to the practical experiments made by the author on the South-Western Railway, a series of accurate analyses, with the view of ascertaining the composition and heating power of various kinds of coke and coal, had been made; and from all these investigations it appeared that a saving of from 8½ to about 10¾ lbs. of coke per mile — which, of course, represented a larger quantity of coal — was effected by the use of coal in the patent fire-box described, as compared with the quantity of coke consumed in the ordinary engines, under similar circumstances. With regard to the durability of the tubes, it had been found, that in the coke-burning engines, about 91,000 miles was the average duration of a set of tubes, whilst of the experimental engines burning coal, one had already run 181,000 miles, and the tubes were still in good condition. The author, therefore, expressed a strong opinion in favor of the advantages of coal over coke for locomotive engines.

ON THE INTRODUCTION OF PRESERVATIVE SOLUTIONS INTO RAILWAY TIMBER.

The following is an abstract of a valuable paper on the above subject, communicated to the *Journal of the Franklin Institute,* Jan. 1859, by F. Hewson, C. E.:

The use of timber upon our railroads is considered indispensable; it is everywhere found in the superstructure of our tracks, and forms the chief material of our bridges; its renewal is the most expensive item of repairs. The life of a sill seldom extends beyond eight years, and the rate of annual depreciation being 12½ per cent., can be applied to the estimate for the durability of the bridges, and those structures which are unprotected against the assaults of heat and moisture, the active and unfailing agents of decay.

Upon the 25,000 miles of the railway lines in the United States, it is here estimated that 3125 miles of the timber superstructure of their track are annually renewed, requiring an outlay of $3,500,000 to furnish the supply.

These prefatory data show the importance of seeking some effectual method of arresting this enormous waste of capital. The chief obstacle to this end has been the great outlay required in the outset for the apparatus employed by the usual process, which is so inconvenient in character as to preclude their adoption in the construction of our railroads. These objections of expense and inconvenience are applicable to the systems of Kyan, Bethell, and Sir William Burnett, — systems which have been adopted upon the leading works of Europe, by engineers distinguished alike for their genius and soundness of judgment.

Kyan's process is the simple immersion of the timber in corrosive sublimate dissolved in water; it requires the employment of two tanks or reservoirs, into one of which the solution is pumped, while the timber is being withdrawn. It has been severely tested in the dockyard of Woolwich, and has been employed with success on the Bavarian state railways. The writer has not been able to find any evidence against its efficacy. The solution is an expensive one, besides being an active poison, which renders its adoption dangerous.

Bethell's process requires a strong cylindrical tank of iron, a steam-engine, an air-pump, a force-pump, and a large wooden cistern or reservoir. When the timber is placed inside the cylinder, which is air-tight, a vacuum is obtained, and the solution, which is either coal-oil or pyrolignite of iron, is forced, under a heavy pressure, into the timber.

Sir W. Burnett's process employs chloride of zinc, with the same apparatus and mode of operation used by Bethell.

There has been a want of confidence relative to the treatment of timber by other systems. The process of boiling timber, or heating it to a high degree of temperature, and suddenly plunging it into the solutions, have been condemned by the highest authorities.

In the *Ordnance Manual*, for the use of the officers of the United States army, edited by Major Mordecai, it is stated that "kiln-drying is serviceable only for boards and pieces of small dimensions, and is apt to cause cracks, and impair the strength of the wood, unless performed very slowly; and that charring or painting is highly injurious to any but seasoned timber, as it effectually prevents the drying of the inner part of the wood, in which, consequently, fermentation and decay soon take place. Boucherie also mentions his want of success in rarefying, by a regular heat, the air included in the interior of the wood, and then plunging it at once into the solutions which he wished to introduce, though by this method he caused different liquids to penetrate materials of a very compact nature; and he succeeded in forcing tar into stones and bricks to a very great depth." The same authority states "that it is infinitely more advantageous to act upon wood in its green state, than to prepare it after the time necessary for its complete dessication had sensibly altered it."

Tredgold, in his able and lucid manner, accounts for the effects upon the durability of timber, produced by these processes, which have thus been condemned. He says that "it is well known to chemists, that slow drying will render many bodies less easy to dissolve, while rapid drying, on the contrary, renders the same bodies more soluble; besides, all wood in drying loses a portion of its carbon, and the more in proportion as the temperature is higher. There is in wood that has been properly seasoned a toughness and elasticity which is not found in rapidly dried wood; and this is an evident proof that firm cohesion does not take place when moisture is dissipated at a high heat."

The employment of Bethell's and Burnett's process upon American railways, are open to serious objections, both on account of the expense of apparatus, and difficulty of locating it along the route under construction. What is wanted is some process which shall be cheap, simple, and efficacious. Boucherie's system of introducing the solutions longitudinally, through pores or tubes of the timber, by the pressure of a column of any convenient height, is a step in the right direction to meet these necessities. In a recent improved process, brought out by Mr. John Reed, Jr., of Glasgow, the following course is pursued: "After the tree has been felled, a saw-cut is made across the centre, through about nine-tenths of the section of the tree, which is slightly raised at the centre by a lever or wedge, so as to open the saw-cut a little; a piece of string or cord is placed around the edge of the saw-cut, and lowering the tree again, the cut closes on the string, which thus forms a water-tight joint; an auger-hole is then bored obliquely into the saw-cut, from the outside, into which is driven a hollow wooden plug; a flexible tube is fitted on the plug, the end of which is made slightly conical, so that the tube may be pushed tight upon it; the fluid flows from a cistern, at an elevation of from 30 to 40 feet."

Mr. Reid further adds, that the timber is most successfully operated upon within ten days after being felled, in which event, the process with a log 9 feet long will occupy twenty-four hours. If the timber is felled three months, three days are required; if four months, four days.

To expedite the longitudinal transmission of solutions, an ingenious apparatus has been contrived by John L. Pott, Esq., of Pottsville, some idea of which can be formed by the following description:

It consists of a force-pump, to the cast-iron frame of which is bolted a strong cylinder, also of cast iron, 9 feet long, the inside diameter being 12 inches. Into the further end of the cylinder a hollow cast-iron collar is accurately fitted, but can be withdrawn and replaced at pleasure, the joint being water-tight. From the sectional end of the collar which is foremost in the cylinder, there extends a rectangular punch, sharpened and edged with steel, the area of which being less than the cross section of the railroad sills in use. This is driven by beetles into the end of the sill placed in the cylinder, and then firmly secured by strong bolts connected with the apparatus. This plan of cylinder-head makes a water-tight joint, and at the same time allows the sap to escape, and secures a greater pressure at the end of the sill which lies against the pump. The power is applied by hand, with a crank. The writer, experimenting with this apparatus, found that in certain classes of timber which were freshly cut, the sap would be driven out with great force, rapidly followed by the solutions. This was noticed especially with the rock, red, and black oak sills. Under a heavy pressure, varying from 1000 lbs. to 1500 lbs. per square inch, working for about two minutes, the sap for a few seconds would be ejected from the end of the sill; this would flow sometimes in jets, like the discharges from the common garden watering-pot, and at other times trickling in frothing exudations. It was found that in white oak sills, under the enormous pressure of 1320 lbs. per square inch, the maximum gain in weight was 11½ lbs. per sill, or 3·8 lbs. per cubic foot. In black oak, under 800 lbs., the maximum gain was 17½ lbs. per sill, or 5·8 lbs. per cubic foot. In red oak, under 1400 lbs., the maximum gain in a sill was 29 lbs., or 9·6 lbs. per cubic foot. In chestnut, under 1500 lbs. per square inch, the maximum gain in a sill was 13 lbs., or 4·3 lbs. per cubic foot. Upon cutting the sills most successfully operated upon into thin cross sections of two inches in thickness, they were found to be so fully saturated, that by striking them violently against a board, the solutions would exude and cover the surface with moisture. Though it required but two minutes in operating the pump for the complete impregnation of the sills, yet the time occupied in adjusting and removing the sill, and in filling and draining the cylinder, amounted to eighteen minutes; and the saturation of 25 sills was the average work accomplished in ten hours.

After a close analysis of the cost and details of the various systems, the writer has been induced to select capillary attraction as the agent for introducing the solutions by the correct way shown to us by nature in the vegetative process, viz., by expelling and following the sap longitudinally, through the pores and tubes of the timber.

Preceded by a number of satisfactory experiments, the following plan has been adopted: The sills are placed vertically, with but-ends down, in a tightly caulked rectangular tank, 14 feet long, 5½ feet wide, and 8 feet deep, built of three-inch plank, supported by upright stays, and further secured by transverse bolts, which prevent the sides from spreading. When the tank is packed with sills, sufficient solution is added to fill it to the top of the sills. In this simple apparatus, the pressure of a column 7 feet in height is thus maintained at the but-end of a sill, the sap is expelled, and the preserving solution takes its place. A tank holding 100 sills will cost about $70, and weighing when empty about two tons, can easily be transported.

In order to ascertain the relative extent or degree of absorption of the popular solutions by the different classes of timber, the writer caused to be divided into three equal parts, a rock oak, a white oak, and hemlock sill; each, as thus divided, was placed vertically in separate casks, which were filled with the solutions.

Cask with the chloride of zinc, one pound to 10 gallons of water.
" blue vitriol, one pound to 12½ gallons of water.
" the pyrolignite of iron (density 1·104), 1 part pyrolignite to 6 parts water.

After the duration of one week,

The white-oak stick in the chloride of zinc,	gained in weight,	6·8	per cent.
" " blue vitriol,	"	7·9	"
" " pyrolignite of iron,	"	10·7	"
The rock stick in the chloride of zinc,	"	4·8	"
" " blue vitriol,	"	4·6	"
" " pyrolignite of iron,	"	5·6	"
The hemlock stick in chloride of zinc,	"	9·7	"
" " blue vitriol,	"	10·1	"
" " pyrolignite of iron,	"	7·6	"

The blue vitriol is absorbed more readily by the hemlock, and the oaks prefer the pyrolignite.

For the impregnation of the heavy timbers used upon bridges and other structures, a large wooden cistern, 4½ feet diameter in the clear, and 27 feet deep, was constructed of three-inch seasoned white-pine plank, tightly caulked in the seams, and bound with iron hoops; two courses of three-inch plank were laid transversely, and firmly secured at the bottom of the cistern. This, when finished by the carpenters, was sunk into the ground, until the top edge stood three feet above the surface. A hoisting crane is used in lifting the timber; the sticks being placed in a vertical position in the cistern,—which should always be kept filled to its top edge with the solution,—in this way a pressure of a column of 27 feet in height is maintained at the but-end of the timber.

The following table shows the quantity of solution introduced into a cubic foot of the different woods, the solution consisting of one part of pyrolignite of iron and six parts of water:

Kind of timber.	Number of cubic feet.	Average Absorption per cubic foot.	Maximum absorption per cubic foot.
White oak,	542	0·53 gallons.	2·72 gallons.
Rock oak,	833	0·71 "	2·04 "
Red oak,	89	0·93 "	1·87 "
Black oak,	67	0·85 "	1·45 "
White pine,	163	1·10 "	2·04 "

Timber freshly cut will receive the solutions more readily than when dry. Some pieces of white oak, which had been felled three months, absorbed per cubic foot, 76 per cent. more than the same description and sizes of timber which had been twelve months felled. It was also observed that in pushing some freshly-cut beams, with a sudden downward force, into the cistern, the sap would appear on the top of the beam, often in quantities to fill a wine-glass.

These facts confirm the opinions of Boucherie, and show that the drying and seasoning of timber, to prepare it for impregnation, is an unnecessary waste of labor. The expense of impregnating railway timber, with the process advocated by the writer, is but trifling. The labor required is involved only in lifting and carrying the timber; and to this must be added the cost of the solutions absorbed. A statement of the cost of preserving sills with the usual antiseptics is here given.

CHLORIDE OF ZINC.

In proportions used by Brunel, viz., one pound to 10 gallons of water — cost of chloride of zinc, 9 cents per pound.

Labor at tank, lifting and carrying the sills,	1·0 cent.
Solution absorbed, 2 gallons,	1·8 "
Cost per sill,	2·8 "

BLUE VITRIOL.

In the proportion adopted by Boucherie, viz., one pound to 12½ gallons of water — cost of blue vitriol, 14 cents per pound.

Labor at tank, etc.,	1·0 cent.
Solution absorbed,	2·24 "
Cost per sill,	3·24 "

PYROLIGNITE OF IRON.

In the proportions adopted by the writer, viz., 1 part of pyrolignite to 6 parts of water — cost of pyrolignite, 23 cents per gallon.

Labor at tank, etc.,	1·0 cent.
Solution absorbed,	6·5 "
Cost per sill,	7·5

The writer does not claim that this method of impregnating timber by capillary attraction is superior to any process extant, for such an assumption at this period would certainly be premature and somewhat arrogant. The question of its efficacy hangs upon a single point, which is this: Does it introduce a sufficient quantity of the preservative solutions to produce the desired effect? From the mass of data condensed in the tables given above, it appears that the average degree of absorption varies in the different classes of woods. The average of the sills impregnated in the tanks range from 0·521 to 0·78* of a gallon per cubic foot. The averages of the timbers in the cistern, from 0·531 to 1·101 of a gallon per cubic foot.

ON THE CONNECTION BETWEEN THE STRUCTURE AND THE PHYSICAL PROPERTIES OF WOOD. — BY PROF. KNOBLAUCH.

The author seeks to ascertain whether any connection is ascertainable between the structural relations of various kinds of wood and their observed physical properties, such as their powers of resonance and conduction of heat, etc., in the same way as was done for one and the same wood by Savart in respect to resonance, and more especially by Tyndall in respect to the conduction of heat.

The primary object was to trace the difference in the conduction of heat shown by different woods, according as the heat has to traverse the wood in a direction parallel with, or at right angles to, the direction of the grain. For this purpose, slabs of the woods to be examined were bored through, perpendicular to their planes, and then covered as uniformly as possible with a coating of stearine. A hot wire, exactly fitting the bore, was introduced into the latter, and continually turned round during the experiment. By this means the coating of stearine around the orifice was melted; but, as we should expect, not in concentric circles, but in elliptic zones, whose major axes invariably coincided with the direction of the grain. The great difference in the behavior of different kinds of wood (about eighty sorts were examined) under these circumstances is at once apparent. With some, the ellipses are tolerably circular; by others, more elongated; while by others, again, the major axes are so extended as to be nearly twice the length of the minor ones. The eccentricity of these ellipses, which furnished a graphical expression for the conductive power of the wood in the directions between which the structural difference was greatest, made it possible to divide the different kinds of wood into four distinct groups. In the first, the ratio of the minor to the major axis of the ellipse is on the average as 1 to 1·25. To this group, Acacia, Box, Cypress, King-wood, etc., belong. In the second, and by far the most numerous group, containing Elder, Nut, Ebony, Apple, several dye-woods, etc., the mean value of this ratio is 1 to 1·45. In the third group, to which Apricot, Siberian, Acacia, Brazil-wood, Yellow-

* American gallons.

wood from Puerto Cabello, etc., belong, the ratio is as 1 to 1·60. In the fourth group it is as 1 to 1·80; and to this division belong Lime, Tamarind, Iron-wood, Poplar, Savanilla (yellow), etc. Hence, the conducting power of all woods in the direction of the fibre exceeds that in the perpendicular direction by no means in a constant manner, but in one which depends upon the nature of the wood. This superiority is in the first group so small, that the warmth in the direction of the fibre traverses a path only a quarter more in length than that traversed in the same time in a perpendicular direction. In the last group, on the other hand, the length of the path in the first direction is about twice that in the perpendicular one.

In order to investigate the relations of resonance, two rods were cut from each kind of wood — the one being taken in the direction of the grain (Langholz), the second perpendicularly across it (Hirnholz). On suspending these rods freely (their length was 470 millims., breadth 20 millims., and thickness 8 millims.), and striking them with a stick, the piece cut with the grain always gives a more sonorous tone than the corresponding cross-grain piece. Nevertheless, the difference of resonance in the tones of the width and cross-grain pieces of one and the same wood, of the first of the groups described (say beech), is unmistakably less than the difference between the tones of the with and cross-grain pieces of any member of the second group. In the second group this difference is less than in the third; and in the third, again, less than in the fourth (as with with and cross grain pieces of poplar). When, therefore, the fibres of all kinds of wood are set in vibration, the purity of resonance is greater when such vibrations are transverse than when they occur in other directions (as when the rods are cut across the grain). But this superiority of resonance is not constant; it depends upon the nature of the wood. The difference in this respect, in the first group of woods, is so small, that the resonance of two with and cross grain pieces resembles that of two not very dissimilar masses of stone when struck. In the last group the difference is so great, that the tone of the with-grain piece, when struck, has a metallic ring, while the dull sound of the cross-grain piece reminds one of a piece of pasteboard when struck. The division of the woods examined, derived from their thermo-conductive power, is accordingly supported by their acoustic relations.

By supporting the two ends of the rods employed in the above experiments, and loading them equally in the middle, the degrees of deflection which they undergo will give us an insight into their structural relations; for the greater their compactness, the greater the resistance they will offer to bending; and the less compact they are, the more easily they will yield. The difference in vertical height of the middle points of the bent and straight rods was taken as measure of deflection. A lever was employed to determine this measure, the end of which passed over an enlarged scale, in order that the readings off might be the more exact. The unit of this measure was a matter of indifference, inasmuch as in the comparison to be instituted, relations only had to be determined. Although, as was to be expected, in all cases the with-grain piece was much less flexible than the corresponding cross-grain piece, yet an important difference was noticeable in the different groups. This is best seen by calculating the relation between the bending (measured as above described) of the with-grain and that of the cross-grain wood; that is, the same weight being applied (say 100 grs.), by dividing the number given by the lever with the cross-grain piece by that given with the with-grain piece. This relation (called "ratio of deflection" in the following table) has, in the first group, the mean value of 1 to 5: in the second, 1 to 8; in the third, 1 to 9.5; in the fourth, 1 to 14. The division of the groups is therefore also supported from this point of view.* The difference in the structure in the different directions is least in those woods which show the least difference with respect to direction in their thermo-conductive and resonant properties; and the difference in the former is greater or less as the two latter differences are greater or less.

Hence a definite relation may be established between the different phenomena described; and this is true to such an extent, that the knowledge of one of them, *e. g.*, the mechanical or state of cohesion, is sufficient to deduce the others, those of warmth or resonance.

Thus, merely to adduce one example, especial experiments had shown that in petrified woods a difference of structure in the directions parallel with, and perpendicular to, the direction of the grain had been preserved; and, in fact, the thermal curve was an ellipse whose major axis was parallel to the fibres. As in the petrified example, this difference in mechanical structure was much less than in the living wood; so, also, while in the living Conifer the ratio of the axes was as 1 to 1.80, in the petrified specimen it had sunk to 1 to 1.12.

The following table contains the names of the woods examined, arranged according to the groups mentioned:

GROUP I.

Ratio of the axes of the thermal ellipse 1 to 1·25. Mean ratio of deflection 1 to 5·0.

Acacia.	King wood.
Box.	Satin wood.
Lignum-vitæ.	Salisburia (*Gingho*).
Cypress.	

GROUP II.

Ratio of axes of thermal ellipse 1 to 1·45. Mean ratio of deflection 1 to 8·0.

Elder.	Snake wood.
Alder.	Zebra wood.
White Thorn.	Purple wood (*Amaranthus*).
Arbor-vitæ.	Settin.
St. Lucian wood.	Coromandel wood.
Gymnocladus canadensis.	Angica wood.
Beech (2 species, white and red).	Cocoa wood (*Gateado*).
Plane.	Apple.
Elm.	Pear.
Oak (two species).	Cherry.
Ash.	Plum.
Maple.	Sandal (red).
American maple.	Caliatour.
Cedar of Lebanon.	Costarica (red wood).
Australian cedar.	Bimas sapan.
Mahogany.	Cuba (yellow wood).
Palisander.	Viset (yellow wood).
Ebony.	Campeachy blue wood.
Palm.	Tobasco blue wood.
Rosewood.	Domingo blue wood.

* The diversity of nature, even with one and the same kind of wood, of course did not admit of the boundaries of the groups being drawn with great exactness, or of the subdivision of the groups into secondary ones.

GROUP III.

Ratio of axes of thermal ellipse 1 to 1·50. Mean ratio of deflection 1 to 9·5.

Apricot.	Pernambuco red wood.
Pistachio.	Japan red wood.
Siberian Acacia.	Puerte-Cabello yellow wood

GROUP IV.

Ratio of the axes of the thermal ellipse 1 to 1·8. Mean ratio of deflection 1 to 14·0.

Willow (two examples).	Weymouth fir.
Chestnut (three examples).	Magnolia.
Lime.	Iron wood.
Alder.	Tamarind.
Birch.	Palmassu.
Poplar (three examples).	"Kistenholz."
Aspen.	Caoba (Havana Cedar).
Pine.	Savanilla yellow wood.
Fir.	

ON THE MEASUREMENT OF RUNNING WATER BY WEIR BOARDS.

The following report on the above subject has been presented to the British Association by Prof. James Thompson, of Belfast, Ireland: The experiments proposed to be comprehended in the investigations to which the present interim report of progress relates, have for their object to determine the suitableness of triangular (or V-shaped) notches in vertical plates for the gauging of running water, instead of the rectangular notches in ordinary use. The ordinary rectangular notches, accurately experimented on as they have been, at great cost and with high scientific skill in various countries, with the view of determining the necessary formulas and coëfficients for their application in practice, are, for many purposes, suitable and convenient. They are, however, but ill-adapted for the measurement of very variable quantities of water, such as commonly occur to the engineer to be gauged in rivers and streams. If the rectangular notch is to be made wide enough to allow the water to pass in flood times, it must be so wide that for long periods, in moderately dry weather, the water flows so shallow over its crest, that its indications cannot be relied on. To remove in some degree this objection, gauges for rivers or streams are sometimes formed, in the best engineering practice, with a small rectangular notch cut down below the general level of the crest of a large rectangular notch. If, now, instead of one depression being made, for dry weather use, in a crest wide enough for use in floods, we conceive of a large number of depressions, extending so as to give to the crest the appearance of a set of steps or stairs, and if we conceive the number of such steps to become infinitely great, we are led at once to the conception of the triangular instead of the rectangular notch. The principle of the triangular notch being thus arrived at, it becomes evident that there is no necessity for having one side of the notch vertical, and the other slanting; but that, as may in many cases prove more convenient, both sides may be slanting, and their slopes may be alike. It is then to be observed that, by the use of the triangular notch, with proper formulas and coëfficients, derivable by due union of theory and experiments, quantities of running water from the smallest to the greatest, may be accurately gauged by their flow through the same notch. The reason of this is obvious from considering that, in the triangular notch, when the quantity flowing is very small, the flow is confined to a small space, admitting of accurate measurement; and that the space for the flow of the water increases as the quantity to be measured increases, but still continues such as to admit of accurate measurement.

Farther, the ordinary rectangular notch, when applied for the gauging of rivers, is subject to a serious objection from the difficulty or impossibility of properly taking into account the influence of the bottom of the river on the flow of the water to the notch. If it were practicable to dam up the river so deep that the water would flow through the notch as if coming from a reservoir of still water, the difficulty would not arise. This, however, can seldom be done in practice; and, although the bottom of the river may be so far below the crest as to produce but little effect on the flow of the water when the quantity flowing is small, yet when the quantity becomes great, the "velocity of approach" comes to have a very material influence on the flow of the water, but an influence which it is usually difficult, if not impracticable, to ascertain with satisfactory accuracy. In the notches now proposed, of triangular form, the influence of the bottom may be rendered definite, and such as to affect alike (or, at least, by some law that may be readily determined by experiment) the flow of the water when very small, or very great, in the same notch. The method by which I propose that this may be effected, consists in carrying out a floor, starting exactly from the vertex of the notch, and extending both up-stream and laterally, so as to form a bottom to the channel of approach, which will both be smooth and will serve as the lower bounding surface of a passage of approach, unchanging in form, while increasing in magnitude at the places, at least, which are adjacent to the vertex of the notch. The floor may either be perfectly level, or may consist of two planes, whose intersection would start from the vertex of the notch, and, as seen in the plan, would pass up stream perpendicularly to the direction of the weir-board; the two planes slanting upwards from their intersection more gently than the sides of the notch. The level floor, although theoretically not quite so perfect as the floor of two planes, would probably, for most practical purposes, prove the more convenient arrangement.

With reference to the use of the floor, it may be said, in short, that by a due arrangement of the notch and the floor, a discharge orifice and channel of approach may be produced, of which (the upper surface of the water being considered as the top of the channel and orifice) the form will be unchanged, or but little changed with variations of the quantity flowing; very much less, certainly, than is the case with rectangular notches. The laws regulating the quantities of water flowing in such orifices as have now been described, come naturally next to be considered. Without, however, in the present interim report, attempting to enter on a detailed discussion of theoretical considerations on this subject, I shall here merely advert briefly to the principal results and methods of reasoning.

By theory I have been led to anticipate that the quantity flowing in a given notch should be proportional, or very nearly so, to the $\frac{5}{2}$ power of the lineal dimensions of the cross section of the issuing jet, or to the $\frac{5}{2}$ power of the head of water over the vertex of the notch. This head is to be understood, in the case of water flowing from a still reservoir, as being measured vertically from the level water surface in the reservoir down to the vertex of the notch; or in the case of water flowing to the notch with a considerable velocity of approach over a floor arranged as above described, the head is to be considered as measured vertically from the water surface, where the motion is nearly stopped by the weir-board at a place near the board, but as far as may be found practicable, from the centre of the notch. The law here enunciated, to the effect that the quantity flowing should be proportional to the $\frac{5}{2}$ power of the head, I consider should hold good rigidly in reference to water flowing by a triangular notch in a thin vertical plate, from a large and deep reservoir of still water, if the water were a perfect fluid, free from viscidity and friction, and from capillary attraction at its surface, and from any other slight disturbing causes that may have minute influence on the flow, the flow being supposed to be that due simply to gravitation resisted by the inertia of the fluid. The like may be said of water flowing from triangular notches with shallow channels of approach, having floors as described above, when due attention is given to make the passages of approach so as really to remain unchanged in form for a sufficient distance from the notch, while increasing in magnitude as the flow increases (such being supposed according to my theory to be possible), and if due attention be paid to the measuring the heads in all cases in positions similarly situated with reference to the varying dimensions of the issuing streams.

In illustration of these statements, or suppositions, I would merely say, that, if two triangular notches, similar in form, have water flowing in them at different depths, but with similar passages of approach, the cross section of the two jets at the notches may be similarly divided into the same number of elements of area; and that the areas of the corresponding elements will be proportional to the squares of the lineal dimensions of the cross sections; or, as from various considerations may readily be assumed, proportional to the squares of the heads; also the velocities of the water in the corresponding elements may be taken as proportional to the square roots of the lineal dimensions, or to the square roots of the heads. From these considerations, supported by numerous others, it appears that the quantities flowing should be proportional to the products of the squares of the heads into their square roots, or to the $\frac{5}{2}$ power as already stated.

The friction of the fluid on the solid bounding surfaces of the passages of approach, where the water moves rapidly adjacent to the notch, may readily be assumed, from all previous experience in similar subjects, not to have a very important influence even on the absolute amount of the flow of the water; and if we assume (as is known to be nearly the case for high velocities, such as occur in notches used for practical purposes, unless usually small) that the tangential force of friction of the fluid per unit of area of surface flowed along, is proportional to the square of the velocity of flow, it follows by theory that the friction, though slightly influencing the absolute amount of the flow, will not, according to that assumption, at all interfere with its proportionality to the $\frac{5}{2}$ power of the head. And this condition will very nearly hold good if the assumption is very nearly correct.

How closely the theory thus briefly sketched may be found to agree with the actual flow of water, will be a subject for experimental investigation; and whatever may be the result in this respect, the main object must be to obtain for a moderate number of triangular notches of different forms, and both with and without floors at the passage of approach, the necessary coëfficients for the various forms of notches and approaches selected, and for various depths in any one of them, so as to allow of water being gauged for practical purposes when in future convenient, by means of similarly formed notches and approaches. The utility of the proposed system of gauging, it is to be particularly observed, will not depend on a perfectly close agreement of the theory described with the experiments; because a table of experimental coëfficients for various depths, or an empirical formula slightly modified from the theoretical one, will serve all purposes.

To one evident simplification in the proposed system of gauging, as compared with that by rectangular notches, I would here advert, namely, that in the proposed system the quantity flowing comes to be a function of only one variable, namely, the measured head of water, while in the rectangular notches it is a function of at least two variables, namely, the head of water and the horizontal width of the notch, and is commonly, also, a function of a third variable very difficult to be taken into account, namely, the depth from the crest of the notch down to the bottom of the channel of approach; which depth must vary in its influence with all the varying ratios between it and the other two quantities of which the flow is a function.

The proposed system of gauging also gives facilities for taking another element into account, which often arises in practice, namely, the influence of back water on the flow of the water in the gauge, when, as frequently occurs in rivers, it is found impracticable to dam the river up sufficiently to give it a clear overfall free from the back or tail water. For any given ratio of the height of the tail water above the vertex of the notch, I would anticipate that the quantities flowing would still be, approximately at least, proportional to the $\frac{5}{2}$ power of the head as before, and a set of coëfficients would have to be determined experimentally for different ratios of the height of the tail water above the vertex of the notch.

With the aid of the grant placed at my disposal by the Association at last year's meeting, for the purpose of these researches, I have got an experimental apparatus constructed and fitted up at a place a few miles distant from Belfast, and I have got some preliminary experiments made on a right-angled notch in a vertical plane surface, the sides of the notch making angles of 45° with the horizon, and the flow being from a deep and wide pool of quiet water, and the water thus approaching the notch uninfluenced by any floor or bottom. The principal set of experiments as yet made were on quantities of water varying from about two to ten cubic feet per minute, and the depths or heads of the water varied from two to four inches in the right-angled notch.

From these experiments I derive the formula $Q = 0{\cdot}317\ H^{\frac{5}{2}}$, where Q is the quantity of water in cubic feet per minute, and H the head as measured vertically in inches from the still water level of the pool down to the vertex of the notch. This formula is submitted at present temporarily, as being accurate enough for use for ordinary practical purposes, for the measurement of water by notches similar to the one experimented on, and for quantities of water limited to nearly the same range as those in the experiments; but as being, of course, subject to amendment by more perfect experiments extending through a wider range of quantities of water.

It will be readily observed that the experimental investigations indicated in the foregoing report as desirable, are such as would require for their completion and extension to large flows of water a great expenditure both of time and money, like as has already been the case with researches on the flow of water in rectangular notches. All that I can myself, for the present, propose to attempt, is to open up the subject with experiments on moderately small flows of water.

STRENGTH OF WOODEN WATER-PIPES.

The *Scientific American* publishes the following report of a series of experiments concluded by Israel Marsh, Esq., of Rochester, N. Y., with a view of determining the strength of wooden water-pipes to resist hydraulic pressure.

Pipes of various sizes were subjected to pressure so great as to burst them, but they bore a far greater amount than any spectator supposed them capable of bearing. The largest pipe tested had a bore of eight inches in diameter; the smallest had a bore of one inch and five-eighths through a pine scantling of three and a half inches. These scantlings were put together in sections, and sustained a pressure equal to a head of one hundred and eighty feet, and subsequent experiments showed that they would sustain a far greater pressure before bursting.

The following is the report of Mr. Marsh, regarding his experiments; and the results, as placed in a tabular form, will be found very convenient for future reference by hydraulic engineers and others:

Hydrostatic pressure was applied to the pipe by means of a double-acting piston-pump, with an air-chamber attached; and the amount of pressure acting upon the whole interior surface of the pipe was ascertained by means of a piston, which was cylindrical in form, and made equal in area to one square inch, and fitted to an opening in the pipe, which conveyed the water from the pump to the wooden pipe, and of a scale-beam graduated so as to indicate any amount of pressure from forty to two hundred pounds. The opposite side of the beam was graduated to indicate in feet the height of a vertical column of water, which would produce a corresponding pressure. Some of the pipes used in these trials were made of round logs, and others of square scantling; but they were all made of white pine timber. The following is a statement of the pressure to which the pipe was subjected, in which the last column indicates the pressure at which the pipe burst:

No. of Exp'ts.	External Dimensions Inches.	Internal Dimensions. Inches.	Length. Feet.	Pressure Applied.		
				Pounds per Inch.	Water Pressure Sus.	Pipe Burst.
1	$3\frac{1}{2}$ Sq.	$1\frac{5}{8}$	8	86 8-10	200	
2	$3\frac{1}{2}$ Sq.	$1\frac{5}{8}$	8	85	195	207
3	$3\frac{1}{2}$ Sq.	$1\frac{5}{8}$	8	$60\frac{3}{4}$	140	
4	$3\frac{1}{2}$ Sq.	$1\frac{5}{8}$	8	$60\frac{3}{4}$	140	
5	$3\frac{1}{2}$ Sq.	$1\frac{5}{8}$	8	78 1-10	180	190
6	6 Sq.	$2\frac{1}{2}$	8	90	207	218
7	6 Sq.	3	8	75	172	184
8	6 Sq.	3	8	$82\frac{1}{2}$	190	195
9	14 D.	6	5	$82\frac{1}{2}$	190	
10	20 D.	8	4	86 8-10	200	
11	14 D.	6	5	$73\frac{3}{4}$	170	180
12	6 D.	3	8	65 1-10	150	
13	14 D.	6	5	65 1-10	150	
14	$3\frac{1}{2}$ D.	$1\frac{5}{8}$	8	$134\frac{1}{2}$	310	
15	20 D.	8	4	$81\frac{1}{2}$	190	200
16	12 D.	4	5	$73\frac{3}{4}$	170	180

WORK OF WATER-WHEELS BY NIGHT AND DAY.

The following note, on the above subject, has been addressed to the editors of the *Scientific American*, by a correspondent in East Pepperell, Mass:

In the course of my business of building and putting in water-wheels

(Blake's patent), I have often heard it asserted, by mill owners and others, that water-wheels will do more work in the night than in the daytime. To demonstrate the fallacy of such an assertion by actual and scientific experiments, I have, with great care and with the use of every perfect apparatus for testing water-wheels, observed their performance in several successive days and nights, namely, five experiments in the middle of the day and three in the middle of the night, on a wheel of 18 inches in diameter, running without resistance under a fall (H) of eight and more feet; running the wheel for 2000 revolutions at each experiment; and the time being calculated by noting the sounds for every 100 revolutions, by the bell-hammer attached to the wheel-shaft, which is a good time-keeper.

I give below the results of each experiment opposite the fall (H) which actuated the wheel, in revolutions per second; and I then reduce the revolutions to what they would have been had the fall (H) been the same in every experiment, having one in each series, night and day, equal to 8.41′ feet. I reduce R to that H by the fomula as $\sqrt{}$ H: R=$\sqrt{}$8·41′: R′.

DAY EXPERIMENTS.

H	Revolutions.	H′	R′.
8.410 feet,	4.901960	8.41 feet,	4.90196
8.515 "	4.962230	"	4.93154
8.290 "	4.889975	"	4.92524
8.422 "	4.926108	"	4.92260
8.4216 "	4.950544	"	4.94713

Mean revolution, 4.92569; mean temperature of water, 70.7°; barometer (mean height), 29.93 inches.

NIGHT EXPERIMENTS.

H	Revolutions.	H′	R′.
8.41 feet,	4.88997	8.41 feet,	4.88997
8.61 "	4.98753	"	4.93949
8.42 "	4.93827	"	4.93533

Mean revolution, 4.92159; mean temperature of water, 70.7°; barometer (mean height), 29.91 inches.

On comparing the results of the two series of experiments, it will be seen that there was a difference of 0.00410 in favor of the wheel's revolution during *daytime*.

NEW APPARATUS FOR DEEP-SEA SOUNDINGS.

The following description of a new apparatus for effecting deep-sea soundings, devised by Lieut. Trowbridge, U. S. N., is derived from a communication addressed by the inventor to Prof. A. D. Bache, Superintendent Coast Survey, and published in *Silliman's Journal* for May, 1859:

"In the method of sounding hitherto employed," says Lieut. T., "the influence of the friction of the water upon the line, or 'endwise resistance,' as it is called by Prof. Airy, was known to exist, but the amount of this endwise resistance in pounds, and its ultimate effects at great depths, had not been determined. It was supposed that by making use of a weight of thirty or forty pounds and a small fishing-line, this resistance would be reduced to an inappreciable amount, or at least that its effect in retarding the descent of the lead would not be sufficient to destroy confidence in the results."

Lieut. T., however, claims that his own investigations prove that a weight, such as is ordinarily used in sounding, will be practically held in suspension

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at no very great depth, even when the line used is the smallest that will sustain the weight with safety in the air; and in confirmation of this conclusion, the fact is well established, that, notwithstanding repeated experiments, made by the most skilful officers, and with the utmost care, the bottom of the ocean has never been reached in its deepest parts; and even where the bottom has been attained, and specimens brought to the surface, the uncertainties of the results have given good grounds for controversy with regard to the depth.

These failures and uncertainties do not arise from the magnitude of the distance to be measured, nor from the impenetrability of the fluid through which the lead has to pass; distances infinitely great and infinitely small in the universe above and around us, have been measured with precision; and the unexplored depths of the ocean are occupied by a medium freely and equally penetrable at all depths. Yet in this field — a field daily traversed by the commerce of the world — a distance of a few miles only has baffled all attempts to measure it.

The difficulty lies in the simple cause stated above, viz., the "endwise resistance" or friction upon the sounding-line, which prevents the lead from going to the bottom where the depth is great. The apparatus now devised is designed to avoid this friction upon the line, while at the same time the line is not dispensed with, but is made use of, as in the ordinary mode. Experiments have demonstrated, that an iron globe or sphere, when falling freely on the ocean, will attain a maximum velocity, within twenty-five feet of the surface, which will be kept up, without sensible increase or diminution, to the bottom. For a thirty-two-pound iron shot, this uniform velocity is about sixteen feet per second. When attached, however, to a small line, — this line being uncoiled from a reel on the deck of the vessel, and drawn down by the weight of the sphere, — the friction of the water on the line causes a remarkable change in the rate of descent. Nearly the same maximum velocity at starting is attained; but the velocity becomes rapidly reduced, until the sphere becomes suspended nearly motionless in the water.

Taking the simple case of a thirty-two-pound shot attached to a small fishing-line: the shot attains its maximum velocity of sixteen feet per second within twenty-five feet of the surface; but before a hundred fathoms of the line is drawn into the water, this velocity is reduced to eight feet per second — a diminution of half the velocity, from the friction of one hundred fathoms of line. At five hundred fathoms, the velocity is again reduced half, or to four feet per second; and at three thousand fathoms, to about one foot per second. Whereas, at this depth, if there is no line attached, the shot will fall with its original velocity of sixteen feet per second, undiminished. Below this depth we may determine, in the same way, the circumstances in the two cases; the shot falling freely, still retains its uniform velocity of sixteen feet per second, at four, five, and six thousand fathoms depth; while, with the line attached, at five thousand fathoms, the velocity is reduced to a few inches per second; and at six thousand fathoms, the descent is not perceptible under ordinary circumstances.

The time of descent becomes an important element also in practice. In the two cases given, the shot falling freely will descend to the depth of three thousand fathoms in twenty minutes, and to the depth of six thousand fathoms in forty minutes; while, with the line attached, it will require two hours to descend three thousand fathoms, and eight hours to descend six thousand fathoms. These effects have been proved to be due to the friction alone; and the amount of which, in pounds, has been determined for different cases, in which different forms of weight and different sizes of line were used; and the entire inapplicability of the ordinary mode of sounding for great depths, or even for ordinary depths, where the object was to obtain a correct knowledge of the depths, has been demonstrated.

Methods have been proposed, in which a line is dispensed with, by detaching a float at the bottom, when the plummet strikes, and watching for the return of the float to the surface; but this is impracticable, as there is no material applicable, within our knowledge, that will float to the surface from the bottom of the sea, on account of the great pressure, which condenses the bulk, so as to render bodies, specifically lighter than water at the surface, heavier than water at even moderate depths.

A line must therefore be used to bring back to the surface any machine by which the depth may be registered in the descent, and the motion of this line, in an extended form in the water, must be avoided.

The apparatus which Lieut. T. has devised is designed to secure this object, by attaching to the sinker a tube or case, in which the sounding-line is compactly coiled, and from which it will be discharged freely, thus causing the plummet to carry down the coil, while one end of the line is held fast at the surface, — the line being uncoiled from the descending sinker in the manner that a spider, falling from a height, gives but a thread in his descent, by which he retains communication with the point above, to which the thread is attached. The motion of the line in an extended form through the water being thus avoided, all the conditions of free descent are secured, and the plummet will descend to the greatest depths, with a rapid and uniform velocity. The depth is ascertained in the manner heretofore known as Massey's method, by a helix or curved blade, which is caused to revolve by the motion of the apparatus through the water. Instead of Massey's Indicator, however, which, from its faulty construction, does not give accurate results, Saxton's Current Meter, a much more delicate instrument, has been adopted to this purpose.

A specimen-tube is also used, differing somewhat from those now in use in construction, but not in its essential points. The lower end of the line is attached to the register and to the specimen-box, which weigh together only two or three pounds, and as the line is hauled in from the bottom, it brings up the register and specimen-box, leaving the plummet and attached case at the bottom. Besides overcoming the principal difficulty in sounding, there are other important advantages secured by this arrangement, which simplify, rather than complicate, the problem. These are as follows:

First: There is no strain upon the line, in the descent, except from its own weight, no matter to what depth or with what velocity the plummet may descend. It is possible, therefore, to employ a very small line; a single thread of silk may in fact be extended to the bottom of the ocean. This permits of the use of a line which may be coiled compactly within a small space, the strength of the tide being made just sufficient to insure its being hauled in with safety, bringing up, at the same time, the specimen-box and the register. The strain brought upon it, in hauling in, will depend upon the velocity of the upward motion, which may be regulated accordingly.

Second: A rapid and uniform descent being secured, the indications of a revolving register will be reliable, when attached to this plummet; while in the present mode of sounding, the slow motion of descent at great depths, renders such a mode of registering the depth uncertain and unreliable.

Third: There being no strain upon the line in the descent, and the motion being uniform, it is practicable to determine the depth by the time of descent, making use of a small insulated wire as a sounding-line, and determining the instant that the weight strikes the bottom by an electrical signal transmitted through the line. An apparatus was devised as long since as the year 1845, for ascertaining the moment when the weight strikes the bottom, by electricity; but in the mode of sounding heretofore employed, no particular advantage would result from this, while the danger of breaking the electric continuity is very great, owing to the strain brought upon the line in the descent. And the plummet, as now used, descends with such a varying velocity, that, even with the time of descent given, no calculation will give the depth. The method has therefore never been put in practice. Whereas, in the method proposed, there is no strain upon the line in its descent, and the plummet will fall through each successive hundred fathoms in the same time; the time of descent will thus furnish a simple means of calculating the depth.

In this process it will not be necessary to recover the line, and the time required to sound the ocean at any point, need only be that required for the plummet to sink to the bottom, moving with any velocity which may be desired.

Many experiments have been made on the best method of coiling the line so as to secure its uncoiling with certainty, and without the possibility of strain upon the line, or the occurrence of a kink.

Much attention has also been given to the quality and size of line to be used. Upon these points the practical working of the apparatus in a certain degree depends; but, being merely mechanical questions, they are easily settled.

The importance of the problem which is thus sought to be solved, in connection with the survey of the coast, has never been questioned. A knowledge of the configuration of the bottom of the sea, adjacent to the coast, is necessary to the solution of many questions of importance to navigation and to science, and especially that of the ruling feature of the Atlantic coast, the Gulf Stream. But besides these considerations, the question has become one of great public interest, in connection with the laying of submarine telegraphs, the risk of such enterprises being diminished in proportion to the accuracy with which the depth of the sea is known at every point of any proposed line, and the ultimate practicability of such operations across the Atlantic being yet to be demonstrated by new and more accurate soundings.

EXPERIMENTS WITH BELTING.

It has long been a question of great interest to all who use belting to drive machinery, whether leather or vulcanized rubber hugged the pulley the best, and hence was less liable to slip. To satisfactorily determine this question, Mr. J. H. Cheever, of New York, has instituted a series of experiments, by means of a simple device of three pulleys, which we may designate as B, C, and D, mounted on an axle or shaft in a frame. Pulley B was covered with rubber; C was a polished iron pulley, such as is ordinarily used in machine-shops; and D was covered with leather. In the first experiment, a leather belt of good quality, three inches in diameter and seven feet long, was placed over the pulley, with thirty-two pounds suspended from each end. Weights were then added at one side until it began to slip over the pulley, and the results were as follows:

Leather belt on iron pulley slipped at 48 lbs.
" " leather " " " 64 lbs.
" " rubber " " 158 lbs.

The next experiment was with vulcanized rubber. A three-ply belt of the same diameter, length, and thickness as the leather one, was chosen, and being loaded with thirty-two pounds to keep it "taut," weights were added, as in the former instance, and the result was as follows:

Rubber belt on iron pulley slipped at 90 lbs.
" " " leather " " 128 lbs.
" " " rubber " " 183 lbs.

MINING ENTERPRISE.

The deepest coalpit in Great Britain, and probably in the world, has, after nearly twelve years' labor, during which some important mining problems have been solved, been completed, and opened at Dunkinfield, Cheshire, England. The shaft of this extraordinary pit is 686½ yards deep, and the sinking of it has cost nearly £100,000. The undertaking was commenced in 1847, by Mr. Francis Astley, who is lord of the manor of Dunkinfield, a township of 1263 acres in extent, and containing valuable beds of coal. By September 1848, the shaft of the pit had been sunk 220 yards, when the works were stopped by the tapping of a copious spring of water, which rendered it necessary to put in pumps and drive a tunnel 80 yards long. In about fourteen months this work was completed, and 43 yards added to the depth of the pit. Shortly afterwards another spring was encountered, which stopped the works three months. At the end of five years from the commencement, a depth of 476 yards had been attained, — the last 163 yards having occupied twenty-nine months, in consequence of the difficulties which had to be overcome, the rock pierced through being very hard, and another tunnel 400 yards long having had to be made. At this point the sinking of the shaft was suspended for a time, and the mine was worked for coal; but in 1857 it was determined to sink the shaft to the Black-mine, a further depth of 216½ yards. Operations proceeded steadily, in the face of many difficulties and discouraging predictions; but the enterprise was recently successfully completed by the workmen winning the Black-mine, a fine seam of coal 4 ft. 8½ in. thick, and calculated to last thirty years at 500 tons per day. In sinking the shaft, twenty-two workable seams of coal were passed through, as well as eight other seams, varying from 1 to 6 feet thick, and in the aggregate 105 feet in thickness. The shaft is generally 12 ft. 6 in. in diameter, but near the bottom it expands to a diameter of 19 ft. 2 in. It is lined with bricks 9 inches thick, with strong rings of stone at intervals of 8 yards. At the bottom of the shaft is an incline nearly half a mile long. The pit is fitted with very powerful machinery. Another shaft of the same depth is sunk as an air draught. — *London Times*.

ON THE INFLUENCE OF CHEMICAL MANUFACTORIES ON ANIMAL AND VEGETABLE HEALTH.

A recent inquiry on the above subject, instituted by the Belgian government, merits attention. For some years, a notion had grown into a belief that certain manufactories were prejudicial to health and vegetation; and so much disquiet arose thereupon, especially in the province of Namur, that the governor reported it to the home department at Brussels. A commission was appointed — two chemists and two botanists — who, commencing their inquiry, pursued it carefully for several months, confining themselves to factories in which sulphuric acid, soda, copperas, and chloride of lime were made. The two chemists watched the processes, and noted the escape of gases from the chimneys. They consider soda-factories to be the most noxious, and tall chimneys more hurtful than short ones, because of the greater surface over which they diffuse the vapors; and tall chimneys, by quickening the draught, discharge gases which otherwise would be absorbed in the passage. Hence, contrary to the commonly received opinion in this country, they hold that there is less dispersion of deleterious vapors with a short chimney than a tall one.

The botanists, on their part, show, as might be anticipated, that the effect on vegetation is most shown in the direction of the prevalent winds, and more during rains and fogs than in clear weather. They establish beyond a doubt the hurtful influence of smoke, due to the presence of hydrochloric and sulphuric acid, and they find that the greatest distance at which the mischief is observable is 2000 metres (a little over an English mile); the least, 600 metres. They enumerate thirty-four kinds of trees which appear to be most susceptible of harm, beginning with the common hornbeam (*Carpinus Betulus*), and ending with the alder; and between these two occur, in sequence, beech, sycamore, lime, poplar, apple, rose, and hop. As regards the effect on the health of men and animals, the commission find the proportion of deaths per cent. to be lower now in the surrounding population than before the factories were established: from 1 in 58 it has fallen to 1 in 66. One reason for this improvement may consist in the better means of living arising out of the wages earned in the factories. However, the commission wind up their report with an assurance that health, either of men or horses, suffers nothing from the factories, and vegetation so little, that farmers and graziers may dismiss their fears, and the government refrain from interfering.

SCIENTIFIC *VERSUS* PRACTICAL INSTRUCTION.

The following testimony of Liebig as to his famous school at Giessen, is worth considering in these days of schools of practical science. — *Silliman's Journal.*

"The technical part of an industrial pursuit can be *learned:* principles alone can be *taught.* To learn the trade of husbandry the agriculturist must serve an apprenticeship to it: to inform his mind in the principles of the science, he must frequent a school specially devoted to this object. It is impossible to combine the two; the only practicable way is to take them up successively. I formerly conducted at Giessen a school for practical chemistry, analysis, and other branches connected therewith, and thirty years' experience has taught me that nothing is to be gained by the combination of theoretical with practical instruction. It is only after having gone through a complete course of theoretical instruction in the lecture-hall that the student can with advantage enter upon the practical part of chemistry. He must bring with him into the laboratory a thorough knowledge of the principles of the science, or he cannot possibly understand the practical operations. If he is ignorant of these principles, he has no business in the laboratory. In all industrial pursuits connected with the natural sciences, in fact, in all pursuits not simply dependent on manual dexterity, the developement of the intellectual faculties by what may be termed school learning, constitutes the basis and chief condition of progress and of every improvement. A young man with a mind well stored with solid scientific acquirements, will, without difficulty or effort, master the technical part of an industrial pursuit; whereas, in general, an individual who is thoroughly master of the technical part may be altogether incapable of seizing upon any new fact that has not previously presented itself to him, or of comprehending a scientific principle and its application." — *Liebig, Letters on Modern Agriculture, edited by John Blyth, M. D.*

NOVEL GEOGRAPHICAL EXPOSITION.

A gentleman of Cumberland, England, has recently converted a level and verdant plain on his estate into a map of the world, of great and singular interest. It really gives learners an expertness in geography, much beyond what they acquire from books and maps. The spot is about 300 yards in length, from east to west, and 180 in breadth, from north to south. It is inclosed by a wall of dwarf dimensions. Thirty-six marks are made on it (east and west), and eighteen on the north and south, fixing the degrees of longitude and latitude at ten degrees, or 600 miles asunder. Four pieces of oak timber are laid down, 30 feet long and 8 inches square, with holes at the distance of 3 inches, or five miles from one another, — thus making 36 inches a degree, and comprising in ten a distance of 600 miles. The scales afford an opportunity, by cross log lines, of determining particular towns and cities, in the same manner as we operate with scale and compasses on paper. The continents and islands are made of turf, the sea is gravel, and the boundary is a border of box at particular places on this novel ocean of gravel. Posts are set up, indicating trade-winds, currents, etc. — *London News.*

CONSUMPTION OF GAS SMOKE.

A little invention for the prevention of gas smoke has recently been patented and introduced in London. It consists merely of an ornamental circlet of metal, across which is stretched a sort of sieve of fine platina wire, and it is intended to be placed as a cover on the top of the globe or chimney. The result is most remarkable. The smoke appears to be instantly annihilated, and the flame both increases in bulk and becomes brighter and more clear. The photogenic improvement is stated to be from twenty-five to thirty per cent. All effluvium from the gas is destroyed, and the discoloration of the ceiling and decorations of the room prevented by the use of this simple apparatus. — *London Literary Gazette.*

PATENT GAS REGULATOR.

Mr. Herbert W. Hart, of Birmingham, England, gas engineer, has introduced a method of regulating the pressure of gas in its transmission to gas burners, by the introduction of a regulator in the main pipes through which the gas passes, whereby a steady and nearly uniform pressure is maintained at the burners, whatever may be the pressure from the source of supply. This regulator consists of a chamber filled with fibrous material, so that the gas in its passage must pass through or amongst the fibres. In preparing this permeable fibrous body, the patentee takes layers of felt, or other fibrous material, and makes up a sufficient thickness according to the initial pressure of gas, the fibres being disposed transversely to the passage of the gas, and held together by perforated or other porous plates. By means of suitable connections between these porous plates, he causes the fibres to be compressed more or less, according to the density of the body required, which will also be according to the initial pressure of the gas. The fibrous material being held somewhat loosely together, the pressure of the gas produces this effect. The greater the initial pressure becomes, the more the fibres are compressed together, rendering it more difficult for the gas to permeate. Thus, by the self-action of the gas on the regulator, the exit pressure is regulated and rendered uniform. In order to intercept the grosser impurities of the gas before passing through the regulator, a little loose wool is placed between the ingress passage and the body of fibrous material before mentioned, which latter also has a similar effect in filtering and purifying the gas.—*Mechanics' Magazine*, No. 1830.

BACHELDER'S COAL-OIL LAMP.

This lamp is designed for burning all kinds of coal oils without employing the common glass chimney, and thus avoiding the expense of their breaking and the inconvenience of the lamp getting out of order from that cause, and also to obtain the greatest amount of illumination from the combustion of a given amount of oil. The invention consists in the use of tapers or wick-tubes, placed below and on both sides of a flat wick-tube or main illuminating burner, in combination with a suitable cap, thus supplying sufficient oxygen completely to burn the oil without a chimney, and also without raising the cap so as to obscure a large portion of the flame. The lower part of the cap is screwed upon the lamp in the usual manner. Above this is a reticulated ring, for the purpose of admitting air under the wick-cap, which is slotted at the top to fit a flat wick. This ring is removable for the purpose of cleaning. By the contraction of the cap near the top, the air is concentrated upon the flame. Into the lower part of the cap are inserted the usual wick-tube, and likewise two very small and short wick-tubes. By this arrangement, the lamp, when trimmed and lighted, has a stronger draft on account of the tapers in the short tubes; consequently the outer cap may be lowered upon the main wick-tube, so that the illuminating flame is almost entirely above the cap. In other lamps, where the draft is to be produced by the wick-cap alone, it is necessary to elevate this cap, so as to give a considerable volume of heated air in the upper part of the cap, in order to create sufficient draft; but this elevation of the cap obscures more of the flame, and lessens the illuminating power of the lamp. On the contrary, by the use of the small draft-lights, the top of the cap may be adjusted about half an inch lower upon the illuminating burner without causing the lamp to smoke; consequently it is practicable to secure a greater illuminating power from a given amount of oil, and to dispense altogether with glass chimneys, which are liable to break, difficult to keep clean, and otherwise objectionable.—*Journal Franklin Institute, Oct.* 1859.

NEW VENTILATOR.

A correspondent of the New York *Tribune* proposes a plan for ventilating rooms warmed by stoves, which is as follows: Apply a vertical pipe to the front of the chimney, into which the lower end should enter below the stove-pipe, and the upper end approach within a few inches of the ceiling. In its operation, the foul air from the top of the room rushes down and into the chimney, to fill a partial vacuum occasioned by the draft from the stove-pipe above. By applying a damper to the pipe, its capacity may be adjusted as desired.

THE NEW (ENGLISH) IRON STEAM RAM.

The following article, descriptive of a new engine for maritime warfare, we copy from the *London Times:*

The recent battles in Italy, sanguinary as they have been, afford, after all, but slight indications of the real progress which has been made in destructive branches of the art of war; and it is only when a naval engagement takes place, that maritime powers will see, with dismay, the awful effects of the weapons which science has placed in their hands. An engagement between two hostile fleets, in the present day, would probably not last an hour, for by that time two-thirds of all the ships engaged would be sunk or blown up. The time when ships lay yard-arm to yard-arm, firing into one another for a whole day, has gone by forever. It will be short and sharp work now-a-days. It is a perfect knowledge of this fact, and a certainty that wooden ships, after receiving one, or at most two, well-concentrated broadsides, must sink immediately, that is leading maritime powers at the present moment to see if science cannot devise some means for rendering their ships invulnerable, at least for a time. But, while securing this object, a still more awful element is introduced into the art of naval warfare, since these iron-cased monsters are to be used not alone for defence, but for running down and sinking by wholesale the vessels of the enemy.

The attempts to make iron shot-proof vessels have hitherto proved downright failures, both in the French and English navies. Efforts in this direction have therefore been discontinued, and the French emperor has set to work to see if he cannot case large vessels with sufficient iron to give a fair immunity from the effects of shot, whilst their prodigious strength and weight may be turned to awful account in running down opposing first-rates. The idea was a good one; but it went no further than an idea, as, instead of building ships specially constructed for the purpose, the two vessels which the emperor is now, with such vain secrecy, having coated with iron plates, are old sailing three-deckers, which can never carry a sufficient weight of iron to answer the purpose, and which, even when fitted with machinery, will never, it is said, attain a rate of more than four or five knots an hour, or so. The English Government have very wisely determined to adopt a different plan, and to build a wrought-iron vessel of immense size, strength, and steam power, specially adapted as a vessel of war, and for running down ships of the largest kind, not even excepting the *Great Eastern* itself. The contract for this tremendous engine of modern war has been taken by the Thames Iron Ship-building Company, and sufficient progress has been made with the iron work to be used in her, to make certain that she will be afloat and fitting for sea by June 1860. Her dimensions will be: extreme length, 380 feet; breadth, 58 feet; depth, 41 feet 6 inches; and her tonnage no less than 6177 tons. The weight of the empty hull will be 5700 tons. The engines are to be by Penn & Sons, of 1250 horse power; and of these we shall give a description on another occasion. Their weight, with boilers, will be 950 tons. She will carry 950 tons of coal, and her armament, masts, stores, etc., will amount to 1100 tons more. Thus, at sea, her total weight will be 9000 tons, which will be driven, when so wanted, through the water against an enemy's ship at the rate of sixteen miles an hour. It is difficult, by mere description, to give an adequate idea of the tremendous strength with which this vessel is to be built. The keel, or rather the portion to which the ribs are bolted, is made of immense slabs of wrought scrap iron, an inch and a quarter thick, and three feet six inches deep.

From this spring the ribs, massive wrought-iron T-shaped beams, which are made in joints about five feet long by two deep, up to where the armor-plates begin, five feet below the water-line. These beams are only three feet eight inches apart, while, for a distance of ten feet on each side of the keel, they are bolted in at only half this distance asunder. Five feet below the water-line the armor-plates commence, and, to give room for these, the depth of the rib diminishes to about half, or nine inches. Over the ribs, and crossing transversely, are bolted beams of teak, a foot and a half thick; and outside of these again come the armor-plates. Each of these plates is to be fifteen feet long by four feet broad, and four and a half inches thick. Several of them have been made, by the company, of puddled iron, of annealed scrap iron, and of scrap iron unannealed: and experiments are now being made at Portsmouth, with a view of testing practically which best withstands the tremendous attack of 68-pounders. It is almost needless to say that each plate is the very perfection of material and manufacture. These ponderous slabs go up to the level of the upper deck. The orlop deck will be of wood, and twenty-four feet above the keel. The main deck will be of iron, cased with wood, and nine feet above the orlop. The upper deck will also be of wrought iron, and seven feet nine inches above the main. All the decks are carried on wrought-iron beams of the most powerful description, to which both the ribs and iron decks are bolted; while along the whole length of the vessel, from stem to stern, are immensely solid wrought-iron beams, at intervals of five feet inside the ribs, which are again crossed by diagonal bands, tying the whole together in a perfect network.

The armor-plates are not intended to shield the whole vessel, only the fighting portion — about 220 feet of the broadside — being thus protected. This broadside, however, will mount fourteen of the Armstrong 100-pound guns, which, with two broadside-guns on the upper deck, and two pivot-guns of the same kind forward, and two aft, will give her a total armament of thirty-six guns, each throwing 100-pound shot over a range of nearly six miles. Neither the bows nor stern have any of the large armor-plates, but are coated with wrought-iron plates of nearly one inch and a half thick, over two feet of teak, which will offer sufficient resistance to prevent most shots from going through. But, to compensate for this apparent deficiency, both bows and stern are so crossed and recrossed in every direction with water-tight compartments, that it is a matter of perfect indifference whether they get riddled or not; and each of these ends are shut off from the engine-room and fighting portion of the ship by continuous massive wrought-iron transverse bulkheads; — so that, supposing it possible that both stem and stern could be shot away, the centre of the vessel would remain as complete and impenetrable as ever, still offering, in all, twenty-four inches of teak coated with five inches of wrought iron to every shot. But both stem and stern are built, inside, of such immense strength, that coating with armor-plates would be almost superfluous. The bows, at the spot where the whole shock must be received in running down ships, are, inside, a perfect web of iron work, strengthened back to the armor-plates with no less than eight wrought-iron decks, an inch thick, and crossed and recrossed in all ways and methods with diagonal bracings and supports. In the design sent into the Admiralty by the Thames Shipbuilding Company, the shape of the bows was made exactly after the outline of the neck and breast of a swan when swimming. Thus the point that would strike an enemy's vessel was the breast, which was placed under the water-line.

In the Admiralty model, according to which the "ram" is to be built, the bows form an obtuse angle, the point of which is just level with the water, receding back at a rather sharp slope, both above and below it. This peculiar shape, however, will be concealed under the usual figure-head and forward gear, with a light artificial cut-water of wood; so that, apparently, the vessel will be an ordinary frigate of the largest size. The Admiralty, no doubt, intend by these devices to disguise her real character; but we need hardly point out how utterly futile such an attempt would be. The very idea of attempting to conceal the real purpose of a vessel so remarkable, and the only one of its kind afloat, seems absurd. Coming up into action with other first-rates in line of battle, no doubt she would pass muster unobserved; but under such circumstances, even if as well known to the enemy as to the English, the knowledge would avail nothing to the former. Once a general engagement was commenced, the "ram" would be able to pursue her mission of destruction by running into the sterns of the enemy's vessels almost without hinderance. When such is avowedly her purpose, it seems, to say the least, unwise to cumber her with the masts and rigging of a line-of-battle ship. The shock of striking the first vessel would bring down all her masts by the board like reeds, and leave the ram's decks so encumbered with wreck as might even render her almost useless for further efforts. The mode in which she attacks will be to run straight at the enemy, taking him in the stern or quarter, all the men retiring to the stern to avoid injury from falling spars. When about half the vessel's length from the enemy, the engines are to be stopped, and the engineers stand by to reverse the engines, in order to clear her from the wreck of her antagonist, before the latter goes down. It is calculated that, striking a line-of-battle ship in the stern, the ram would sink her within three minutes. The bowsprit will, we believe, be telescopic, in order to be housed on board, with the anchors, before striking the enemy, that there may be no chance of becoming entangled with the wreck of the sinking vessel. It has, however, yet to be explained how she is to get rid of her own masts and spars, and, above all, what precautions will be adopted to prevent the rigging fouling her screw. The cost of the hull will be about £200,000, and her engines about £75,000, and her fittings for sea about £45,000 more, or £320,000 in all.

VULNERABILITY OF IRON PLATES.

A series of experimental trials have been recently carried on at Portsmouth, England, with a view of ascertaining the amount of resistance offered by iron and steel plates, when opposed to heavy ordnance at a short range. The practice was made both from a 32-pounder and a 95-cwt. gun, the latter throwing a solid 68-pound shot, with sixteen pounds charge of powder, — the distance of range 200 yards. At this distance, the results of the experiments have demonstrated, in the clearest possible manner, that no iron or steel plate that has yet been manufactured, can withstand the solid shot from the 95-cwt gun, at a short range. The first shot would not penetrate through the iron plate, but it would fracture it, and on three or four striking the plate in the same place, or in the immediate neighborhood, it would smash to pieces. As the results of the trial affected the steel plates, it proved that a steel-clothed ship could be far more easily destroyed than a wooden-sided one, and that on the smashing in of one of the steel plates, the destruction of life on the armed ship's decks, supposing the broken plate to be driven through the ship's side, would be something dreadful to contemplate, from the spread of splintered material. At from 600 to 800 yards, iron-clothed ships would be in comparative safety from the effects of an enemy's broadside. But it must be borne in mind that the effects of concentrated firing have yet to be ascertained on the sides of an iron or steel clothed ship; and account also must be taken of the damage the wood-work forming the inner sides of such a ship would receive from the driving in of the broken plates, and which, so far as the present experiments have illustrated, would appear to prove that an iron or steel clad ship, on receiving a concentrated broadside from a frigate armed in a similar manner to the *Mersey*, and struck near her water-line, must sink then and there, with her armor on her back.

JAMES'S RIFLED CANNON AND PROJECTILE.

A new projectile, invented by Hon. Charles T. James, of Rhode Island, and which is intended to be used in connection with a rifled cannon, is a cast-iron cylinder, surmounted by a solid conical (canoid) head. The diameter of the cylinder is ·02 of an inch less than the bore of the gun; its length is nearly equal to the calibre of the gun; while the length of its conical head is about one inch greater than that of the cylinder. The cylinder retains its full diameter for a quarter of an inch of its length at each end; then, for its intermediate length, its diameter is shortened one-half an inch, forming a recess in its body, which loss of diameter and external surface of the cylinder is replaced by a compound filling of canvas, sheet-tin, and lead.

The rings at the end of the cylinder, formed by shortening its diameter, constitute the bearings of the projectile, when introduced into the gun for loading. The solidity of the canoid is continued into, and thereby forms the solid portion of, the head of the cylinder. The base of the cylinder has a central cavity or opening of 1·95 inches in diameter, which extends into the body 1·5 inches, and from which (like mortises in the hub of a wheel for spokes) there are eight rectangular openings, enlarging as they approach the circumference, in the recess of the body of the cylinder.

When the charge is fired, the gas evolved by the burning powder, in its effort to expel the projectile and to escape from the gun, is forced into the cavity and through the rectangular openings against the compound filling, which is thereby pressed into the grooves of the bore, and by its firm hold in them, the rifle-motion is imparted to the projectile. The canvas and tin, in the order named, constitute the exterior of the filling, and are moulded in the recess to the body of the cylinder. This is done by enveloping with canvas the strip of tin, which must be equal in length to the greater circumference of the cylinder, and in width equal to the length of its recess. The strip of tin, when covered with canvas, is formed around the cylinder opposite the recess, and firmly secured there by an iron collar clamp, after which the space between its inner surface and the body of the cylinder is filled with melted lead, which, readily adhering to the tin and iron, forms a compact mass in the recess around the cylinder body.

The following are some of the results of practice with an ordinary six-pound gun (rifled, 15 grooves, and carrying the new projectile), recently made at Chicopee, Mass., under the direction of a Board of Officers attached to the Ordnance Department of the United States army, Major W. A. Thornton, chairman.

The gun was first placed at a distance of 674 yards from the target. The quantity of powder used at each firing was one and one-fourth pounds, the service charge for a six-pound round ball, while the weight of the new projectile was over 12½ pounds. Eighteen shots were fired at a cloth target four feet square, fastened on a board frame eight feet square. The shots varied from the centre, from three and one-half inches to four feet, fourteen of them entering the boards. The gun was carried back to 867 yards, or nearly half a mile from the target, elevated at such an angle as should carry a six-pound round ball to the centre of the target, and fired. The shot passed over the top of the board frame at an elevation of about twenty feet, cut off four pine trees (one six inches in diameter) without deviating apparently from a direct line, and was lost. This shows the greater range of shot from rifled guns. This charge of one and a fourth pound of powder would carry, by calculations in engineering, a round shot of six pounds weight to the target, and no more; but in this case, a shot of more than double weight goes over the target at such a height and force as to probably double the distance to the target. The gun was then lowered, and five shots fired, two of which entered the board within about two feet of the centre. A twelve-pound rifled gun was then placed in the same position (867 yards distant), and nineteen shots fired. Five of these entered the board at from three and a half to four feet of the centre. Great difficulties were encountered in arriving at exactness, inasmuch as the guns had no sights perfectly adapted to them.

At a subsequent trial, with the same weight of powder, projectile, and gun as in the first described experiments, a range of at least three and one-half miles was attained; beyond this point the course of the ball was lost; but the entire range was supposed to be as great as four and one-half to five miles. A like result, with the same conditions of powder and weight of projectile, has probably never been equalled.

In a report on the above experiment, officially submitted to the Secretary of War, the Board say:

"The depth of the grooving in Mr. James's gun is so shallow, as in no case to materially impair the strength of the gun, while it is sufficient to firmly hold the projectile and compel it to take the rifle flight. The perforation of the largest in all instances, and the obtaining of the projectiles after firing, freely indicate that they invariably impinged point foremost; and farther, in having one imbedded in damp earth, its spiral motion was plainly indicated in the sand to the close of the flight. The grasp of the rifling is further shown by the increased range obtained while using the same charge of powder and elevation, in projecting masses of double the weight of the usual spherical balls. The merits of the projectiles consist in their answering fully the expectations desired of them — their ready fabrication and adaptation to guns, their ease of loading, as it required but little more force to send the projectile to the bottom of the bore than is needed to move a body of like weight on a smooth surface; the certainty of the expansion of the filling, and its firm, true hold in the grooves of the gun; the greased canvas wipes the rifling clean, and leaves the bore in a condition to receive readily the next charge, and which is also a sure protection to the bore from injury in loading, and when the gun is discharged. These conditions commend the guns and projectiles to the favorable consideration of the government."

THE ARMSTRONG GUN.

The "Armstrong rifled cannon," which has excited so much attention during the past year, and which has been adopted by the British Government, is constructed as follows: Each gun is made in about three-feet lengths, and on much the same principle as the twisted gun barrels. Thin bars of the best wrought iron, about two inches broad, are heated to a white heat, and in this state twisted and welded together in spiral rolls round a steel bar or core, smaller in diameter than the bore of the gun. Over this, when cold, another twist of the same kind is made, with the spiral running in a contrary direction, and so until three or four layers have been put on, according to the calibre of the gun and the thickness required. The whole is then reheated and welded together for the last time, under the steam hammer. The edges of the three-feet lengths are next planed down so as to admit their joining and lapping over, and over these edges are forced on thick wrought-iron rings, which, being welded down at a white heat, of course contract so as to make the joint almost stronger than if made in one piece. In the breech an opening is cut down into the chamber, but the breech itself is separate from the gun, and is worked backwards by a powerful screw. When the gun is to be loaded, the breech is worked back, and a wedge-shaped piece, fitting into the opening of the gun, lifted out, but not to admit the introduction of the charge, which is pushed forward with a ramrod at the back, working through the large screw in which the breech turns into the chamber, where the rifling begins. The wedge is then replaced, the breech screwed close by a single turn of the lever handle, and the gun fired. The operation of loading and firing can be performed, we believe, three times in one minute. Apart from the simple but effective mechanism of the breech, the great merit of this gun consists in the manner in which it is formed in spirals of metal bands, which give it such an enormous increase of strength that one-half the thickness of iron can be dispensed with. Thus, an ordinary long thirty-two-pounder weighs 57 cwt., and requires 10 lbs. of powder to throw a ball to its utmost effective range, 3000 yards. Sir W. Armstrong's thirty-two-pounder only weighs 26 cwt., and a charge of 5 lbs. of powder throws its shot 5½ miles, or nearly 10,000 yards. In a thirty-two-pounder of this latter kind there are no less than forty-four rifle grooves, having one pitch in ten feet, or making one complete twist round the inside in a gun of that length. A greater pitch would no doubt give greater impetus to the shot, but the risk of "stripping" the lead was so great that it could not be attempted. The shot used are iron, and cylindrical, and at first were completely coated over with lead; but this plan has just been altered, and the shot have now only two rings of lead ¼ inch thick, and 1½ inches broad, one at the shoulder and one at the base of the cone. Both these rings are dovetailed, so to speak, into the iron shot, so as to leave about one-tenth of an inch to fit the rifling. Thus, when the cartridge is ignited, the ball is forced forward from the chamber into the narrow bore, which it fits so closely, being actually too large for it, that there is no windage whatever, and every portion of the explosive force is applied to projecting the ball. The gun on which the government experimented for months before adopting it, was actually fired 3500 times, and was then returned as still serviceable.

In a speech made by the inventor at a banquet given in his honor, at Newcastle, England, he describes some peculiarities of the gun as follows: The projectile for field purposes admits of being used indifferently either as solid shot or shell, or common case or canister. It is composed of separate pieces, bound together so compactly that the shell has been fired through a solid mass of oak timber nine feet in thickness, without sustaining a fracture. When used as a shell it divides into forty-nine separate regular pieces, and into about one hundred indefinite and irregular pieces. It combines the principle of the shrapnel and percussion shell. It either explodes as it approaches or as it strikes the object. The percussion arrangement is, that the shell, while in the hands of a friend, is so safe and quiescent that it may be thrown off the top of a house without exploding; but when among enemies, it is so sensitive and so mischievous that the slightest touch will cause it to explode.

The reason of this is, that the shock which the projectile sustains in the act of firing puts the percussion arrangement from half to full cock, and it then becomes so delicate that a shell has been exploded by being fired against a bag of shavings. Moreover, the fuse may be so arranged that the shell explodes at the instant of leaving the muzzle. In that case, the pieces spread out like a fan, and act as grape shot.

Two targets, nine feet square, were placed at a distance of 1500 yards from the gun, and seven shells fired at them; the effect of these seven shells was, that the two targets were struck in 596 places, and with so much force that although one of the targets was three inches thick, it was riddled through and through with the fragments. Similar effects were produced at much longer distances, extending in some cases to 3000 yards. I leave you to conceive what would be the effect of these projectiles in making an enemy keep his distance. For breaching purposes, or for blowing up buildings, or for ripping a hole in the side of a ship, a shell of a different construction is used.

FRENCH RIFLED CANNON.

The rifled cannon introduced by Napoleon III., and used with such effect in the recent battles in Italy, were of bronze, loaded at the muzzle, and of two calibres, 12 for siege, 4 for field guns.

They each have six twisted rifles, the rifles being about an inch wide and the third of an inch deep. In the bottom there is a narrow chamber to receive the powder, like the carbine of Delavigne, and like the old shell-guns, still in use in the French artillery. The projectile rests on the border of this chamber. This projectile is of a cylindro-spherical form, resembling the ball of the infantry; is in iron, and is hollow and conical, like the latter. The cylindrical base of the bullet is pierced in six places, and into these six drills are introduced as many plugs of pewter. It is these six pieces of pewter, placed in the circumference of the base of the ball, and corresponding to the six rifles of the gun, which perform the important duty of "slugging." They are forced into the rifles by the explosion of the powder, and thus give to the bullet the precision and the force of the carbine ball.

Sometimes the projectiles are filled with balls, and are made to explode at a given distance. To effect this, the match, which is in communication in the interior of the projectile with the fulminating material, is marked exteriorly with various figures, indicating the distance to which it will carry before exploding. The match is cut according to the desired distance at which the gunner wishes to throw the ball — at 400 or 600 yards, or further. The rammer of the cannon is hollow at its base, so as to embrace the conical head of the projectile, the same as the ramrod of the *balle-à-tige* or Minié guns. The "sight" is mobile, and is fixed in the right of the cannon. The distance to which these guns will carry with precision is 2600 metres; the total distance to which they carry is 4500 metres. (The metre is 39 37-100 inches — a little more than a yard.)

The effects of this new artillery upon masonry is illustrated in the following report of experiments made at Vincennes, in 1858. Two similar heavy blocks of masonry having been chosen, a battery of 25 (old plan) was mounted before the first at 36 yards, the usual distance for making a breach. A battery of 12 (new plan) was placed before the other at about double that distance — namely, 77 yards. It required half the number of shot from the new cannon to make as wide a breach as was made by the old one. The balls entered the masonry 32 inches deep, and then exploded, throwing off large cones. The charge of the new cannon was 2 lbs. 10 ounces of powder; the charge of the old one was 18 lbs.

NOVELTIES IN WAR IMPLEMENTS.

Mallet's 36-inch Mortars. — These gigantic mortars were described in the *Annual of Scientific Discovery* for 1858, page 87. Since then additional trials have been made with them at Woolwich, England. In the first instance, a charge of 50 lbs. of powder was used, which obtained a range of about 340 yards to each 10 lbs. of powder. A minute examination of the wedges, keys, rings, etc., having been made, and pronounced "all right," a second charge of 60 lbs. of powder, etc., was introduced. The second round, like the first, was highly successful, the range in this instance exceeding 2000 yards, the shell alighting beyond the butt, in a ditch which separates the marsh from the adjoining property, and creating a tremendous eruption of water, black earth, etc. According to the prescribed arrangement of adding 10 lbs. of powder to each successive charge, the third round contained 70 lbs.; and although the monster gun had stood the first two rounds well, an additional degree of caution was observed by every one present to stand clear of its proximity the instant the match was ignited. The effect of the third round was less successful, as one of the steel cotters broke asunder, and was rendered useless; but as the former experiments had shown the necessity of being provided against a similar casualty, the broken key was replaced, with some slight delay, by a second, wrought of malleable cast iron, supposed to be more durable. The mortar was then reloaded with an 80 lb. charge, and fired, with apparent success — the shell again mounting high in the air, and taking a flight over 2758 yards, considerably exceeding a mile and a half. The elevation of the mortar was frequently varied, and was ultimately reduced from 48 deg. 30 min. to 45 deg. At this stage of the proceedings it was found impossible to carry on the experiments, as one of the mainstays intended to secure the various segments constituting the barrel of the mortar was broken, and one of the principal wedges or cotters, a foot and a half in length, had escaped.

New War Missile. — Experiments have been recently made at Portsmouth, England, for the purpose of testing the practicability of charging hollow shot with molten iron, and discharging the same from ship's ordnance. The effects of these globes of liquid metal striking a ship, are supposed to be, that they would break, and, scattering the liquid metal on the wood-work of the ship, at once set her on fire. In the experiments in question, a furnace was fitted on the *Colossus*, an eighty-gun screw steamer, which proved capable of supplying, without any difficulty, fully one ton of molten iron per hour. The hollow iron shot were filled from this furnace, and then conveyed in an iron bucket to a boat, which pulled aboard the practice-ship *Excellent*. The average time from the metal being run off from the furnace until the missile left the mouth of the gun on its errand of destruction, was six minutes. To ascertain the effects of the practice, it was, of course, necessary that the shot should effect a lodgment in the object fired at; but this was found, from the rotten state of the hulk fired at, and the short range, — eight hundred yards, — to be a matter of too great difficulty. Ten shots were fired altogether, two of which burst; but the metal inside of them had lost too much of its liquidity, from the length of time it had been drawn from the furnace, to produce the effects intended in its liquid state.

Italian Infernal Machines. — The machines used by the Italian conspirators, in their diabolical attempt upon the life of the Emperor Napoleon in 1857, were constructed as follows: — Each consisted of a hollow iron cylinder, about four inches long and two and a half inches in diameter, divided into two transversely, and terminated at each end by a hemispherical cover. One of these covers was nearly an inch thick, and pierced with twenty-five apertures, over which fulminating caps were placed on the exterior. The other cover was considerably lighter, in order that when the missile was thrown from a window or elsewhere, the explosive end might with certainty strike the earth. The cylinder and covers were coated with bronze-color paint, to conceal the brightness of the metal. The cylinder was filled with fulminate of mercury, or some explosive substance of equal intensity, in consequence of which the murderous manufacturers had taken great precautions in charging them. Instead of screwing the two parts of the cylinder together, which might have been dangerous, they merely placed one part within the other, and soldered round the joint on the outside. Other careful arrangements were also adopted. The explosive force of these terrible missiles may be conjectured from the fact, that the fulminating powder employed is fifty times more powerful in its effects than common gunpowder. — *Mechanics' Magazine*, No. 1799.

Dennet's Improvement in Bayonets. — An improvement in the form of bayonets, and the mode of fitting and using them, devised by Mr. Dennet, of London, consists in forming bayonets of a lozenge, rhomboidal, or elliptic section, the sides of which forms may be grooved out; and bayonets so formed, instead of being used upon the musket, carbine, or rifle, as heretofore, are so fixed that the sharp edge is coincident with the longitudinal axis of the arm. The practice has heretofore been to expose one of the flat or grooved faces of the bayonet to the line of discharge, or flight of the bullet; this has been found extremely prejudicial to correct firing when the bayonet is fixed; as, from the reäction of the explosive force of the powder between the concave, or flat surface of the bayonet and the ball, the latter is caused to diverge from the correct line of flight.

NEW PROCESS FOR THE MANUFACTURE OF GUNPOWDER.

At the recent Cornwall Midsummer Sessions, an application was made on the part of Mr. Thomas Davey, one of the firm of Messrs. Bickford, Smith, & Davey, patent safety-fuse manufacturers, Tuckingmill, for a license to erect a gunpowder mill and magazine at a place called West Towan, in the parish of Illogan. Mr. Davey, on being asked what were the advantages of the powder he proposed to manufacture, replied: "Perhaps I shall best do this by reading to you the provisional specification: — 'The improvements in blasting-powder consist, first, in the employment of flour, bran, starch, or other glutinous or starchy matter, to replace a part of the charcoal now employed in the manufacture of powder; second, in a new mode of graining the same. By the substitution of the above-named, the component parts are formed into a paste, and are easily combined and grained without danger of explosion.' Gunpowder in present use is manufactured from certain proportions of nitrate of potash, sulphur and charcoal, which, by the dangerous process of trituration, are intimately combined; the mixture is afterwards pressed into cakes, dried, and then broken into grains of different sizes, according to the use for which the powder is destined. In our process, instead of grinding the powder, the nitrate of soda or potash is dissolved in sufficient water to make a thick paste of the whole, and it is thus kneaded, to make it homogeneous. It is then rolled into cakes, and cut into grains; or, while in a paste, pressed through a perforated or wire sieve, with apertures or holes of the size of the grain to be produced. The matter falls on endless canvas, which is put slowly in motion, and passes on through a drying-room, bearing with it a thin covering of the blasting composition divided in strings or long grains by the sieve, and after being dried, it is passed between two rollers, which break it into grains of a convenient size."

Mr. J. J. Rogers: "Then you consider there is no danger of explosion, the composition being wet?" Mr. Davey: "Not the slightest. We use 30 per cent. of water."

Mr. Rogers: "How do you prevent the coagulation of the wet particles after they have fallen down from the sieve?" Mr. Davey: "By keeping the canvas moving; but should there still be a slight connection between the particles, it is broken on being passed through the wooden rollers, after the composition is dried."

Mr. Reynolds: "What difference is there in the appearance of your powder and the powder manufactured by the old process?" Mr. Davey: "Ours is very like gunpowder-tea in appearance: it has no gloss."

Messrs. Freeman & Sons, granite contractors, had tried the new powder, and found that it possessed qualities superior to other blasting-powder, accomplishing all that was done by the latter at a saving of 37 per cent. in weight.

Captain N. Vivian, of Condurrow, said that he weighed the new powder before testing, and found that the same quantity in bulk weighed 33 per cent. less. He had six holes bored in very hard granite, and charged with powder, putting no more into them than he should have done of the old powder, and in every case it acted satisfactorily. It emitted much less smoke than the old powder, which in blasting a mine was a matter of very great importance. If it were sold at the same price in weight as the old powder, it would, of course, be much cheaper, as it was much lighter.

In answer to Mr. Reynolds, Mr. Davey said that the powder would be rather cheaper than that now used, as less nitre was employed in its manufacture, and the process was quicker. The Chairman said the Court would grant the application.

The *Mining Journal*, from which we take these particulars, observes:— "We understand a vast number of experiments have been made (with Mr. Davey's powder), and from the testimony of the leading managers, it appears certain that a saving of at least one-third in the expense will be effected. It is less dangerous than ordinary powder, produces very little smoke, and that of a less pungent kind than usual, not only enabling the miner to work in close places without the delay consequent on smoke, but greatly diminishing the unhealthy effects of it in the mines.—*London Engineer.*

THE IRON MANUFACTURE OF THE UNITED STATES.

From a statistical summary given by Mr. J. P. Lesley in his "Iron Manufacturers' guide to the furnaces, forges, and rolling-mills of the United States," we derive the following information respecting the iron manufacture in the United States:

The entire production of raw metal in the United States in 1856, was a little over eight hundred thousand tons (812,917), being an increase of 12 per cent. from 1854. For the year 1856 the whole iron production advanced only 6 per cent. over the previous year, but the anthracite branch of the manufacture reached the aggregate of 394,509 tons, being nearly one-half the whole iron product of the country, and showing an increase of thirteen per cent. over the previous year, a fact to be explained by the conversion of charcoal furnaces into anthracite furnaces. The industry naturally tends to concentrate itself about the geological centre of fuel in Pennsylvania, a fact shown by the decline of this branch of the iron industry outside of Pennsylvania by an annual rate of over six per cent., which raises the Pennsylvania anthracite increase to over twenty-two per cent.

The grand total of iron of all kinds, domestic and foreign, used in the United States in 1856, is set down at 1,330,548 tons, which it distributed thus:

	Domestic.	Foreign.	Total.
Rolled and hammered,	519,081	298,275	817,356
Pig iron,	337,154	55,403	392,557
	856,235	353,678	1,209,913

which results give 70 per cent. domestic to 30 per cent. foreign iron. The great facts demonstrated by the statistics collected by the American Iron Association are, that we have nearly 1200 efficient iron works in the United States, producing annually about 850,000 tons of iron, the value of which, in an ordinary year, is fifty millions of dollars, of which the large sum of $35,000,000 is expended for labor alone.

Mr. Whitney, in his *Metallic Wealth of the United States*, estimates the iron product of the world at 5,817,000 tons, of which 1,000,000 are set down for the United States, Great Britain producing that year 3,000,000. When we remember that, so late as 1845, the total product of the United States in iron had not reached half a million tons (486,000), and that in 1850 it was only 600,000 tons, it will be seen that the progress in this important industry, in the first six years of this decade, has been at the rate of over twenty per centum per annum. The operation of this law of increase will soon, it would seem, put an end to all importation of iron, and points even to an export of this great staple at no distant day. The stock and variety of iron ores and coal in the United States is such as seems adequate to meet the demands of the world, as fast as the laws of commerce will permit their development.

ENAMEL WITHOUT LEAD, ON BAR AND SHEET IRON.—BY M. PLEISCHL.

The author gives two recipes for the enamel, viz.:

(1)		(2)	
Silica,	from 39 to 50 parts.	Quartz,	from 30 to 50 parts.
Flint,	" 10 to 20 "	Granite,	" 20 to 30 "
Kaolin,	" 10 to 20 "	Borax,	" 10 to 20 "
Pipe clay,	" 8 to 16 "	Glass,	" 6 to 10 "
Chalk,	" 6 to 10 "	Magnesia,	" 10 to 15 "
Pulverized porcelain,	" 5 to 15 "	Feldspar,	" 5 to 10 "
Boracic acid,	" 20 to 40 "	Effloresced carb. soda,	" 10 to 20 "
Nitre,	" 6 to 10 "	Lime,	" 5 to 15 "
Gypsum,	" 2 to 6 "	Sulphate of Baryta,	" 2 to 8 "
		Fluor-spar,	" 3 to 10 "

Each of these substances to be powdered separately as fine as possible, mixed carefully, and fused into an enamel; this is again ground, and applied to the objects, which are then furnaced. The proportions indicated may vary very much with the different kinds of utensils which are to receive it. The coat should be thin, otherwise it will crack in heating or cooling, and the objects coated should be cooled as slowly as possible, so as to prevent the enamel from shrinking irregularly and cracking.—*Bull. Soc. Encour. de l'Indus. Nat. (Paris.)*

BRONZE OF ALUMINUM.—LETTER OF M. CHRISTOFLE TO M. DUMAS.

We have applied the aluminum-bronze to two uses for which its qualities of hardness and tenacity appear usefully applicable, and success has answered our attempt. The first is the manufacture, in this bronze, of axle-bearings, and rubbing surfaces for machines. We give as examples:

First, an axle-box which was placed on a polishing-lathe, making 2200 turns per minute; it lasted for nearly eighteen months; other boxes in the same condition do not last over three months.

Second, a carriage for a circular saw, making 240 turns per minute, which has lasted for a year without any apparent trace of wear: the carriages in common bronze do not last more than four months.

The second application is the employment of this bronze in the manufacture of guns of all kinds. We made a pistol-barrel, which, after having been tried at Paris, was afterwards at the Exhibition at Dijon. It underwent the tests in presence of the jury, and answered perfectly our expectations. We are aware that these experiments cannot be conclusive as to its application for artillery; but the comparative experiments which we have made with this metal, bronze, iron, and steel, have shown the immense superiority over those different metals.

The bars may be worked hot, as easily as the best quality of steel. — *Academy of Sciences of Paris.*

(The bronze here spoken of, is formed of 90 or 95 parts of copper, and 10 or 15 parts of aluminum.)

SILVER IN BELLS.

The public have heard more or less about the liberal use of silver in bell-metal, and how some apocryphal bells are supposed to contain at least half their weight of this precious alloy, a myth in which many people persist in believing even down to the present day. But silver is not a sonorous metal; and from experiments made with standard silver bells, it has been shown, beyond dispute, that they have very little sound, and that little, too, is of the harshest and most unmusical kind. With a view of definitely testing the effect of a slight admixture of silver upon the tone of a bell, Messrs. Mears made four very small ones of the same metal as the great bell for the Westminster clock. In one of these, 1*s.* 6*d.* worth of silver was put, in another 1*s.* worth, in the third 6*d.* worth, and in the fourth none. The mischievous effects of even this slight quantity of silver were here clearly shown; for that which had the least amount in it was the least injured in tone, and that which had none was the best sounding bell of all. — *London Times.*

DESTRUCTIVE EFFECTS OF RED LEAD UPON IRON.

Mr. Robert Lamont, who was, a few months back, requested by the managers of one of the largest steam packet companies in the kingdom to make a report on the merits of certain compositions used to a large extent in Liverpool for the preservation of iron ships, and to prevent fouling on the bottoms of such vessels, has come to the conclusion, so far as regards the use of red lead, or paints containing lead, quite at variance with the popular notion upon the subject, by declaring the use of that pigment for coating iron vessels to be most pernicious. And in this hypothesis he is confirmed by the opinion of Mr. Nathan Mercer, F. C. S., who, after inspecting the iron ship *William Fairburn*, the plates of which were coated with red lead prior to her late voyage to Calcutta, observes, that the extent to which the iron had been corroded could not fail to have attracted the attention of the most superficial observer. On a close inspection, he found the red-lead coating covered with blisters, from each of which, on being opened, a clear fluid escaped, and left exposed on the surface of the iron a number of brilliantly shining crystals of metallic lead. Mr. Mercer says each blister is, in fact, a galvanic battery in miniature, and that, as wherever there is electrical there must be also chemical action, the corrosion is easily accounted for. This action, he says, will continue as long as any red lead remains, and is necessarily at the expense of the iron. He also points out that the "sweat," so well known to every person interested in iron ships, is not, as is generally supposed, salt water, but a solution of chloride of iron manufactured in the blisters. Mr. Mercer considers this sweating is due, in a great degree, to the use of red-lead paint in immediate contact with iron; and he recommends, therefore, that it should never be used as a coating for sea-going vessels, unless special precautions are taken to prevent its coming into direct contact with iron. — *Liverpool Albion.*

IMPROVED MOULDING SAND.

Mr. J. W. Winter, of Maysville, Cal., recommends, in the *Dental News Letter*, a new kind of moulding sand. He says: "Take equal parts of soapstone and Bristol brick, pulverize finely; mix. It is superior to any other moulding sand, as it requires but little mixture to pack it firmly; and you can get a finer impression, and can pour your metal at any stage of heat without spoiling the die."

NEW BRONZING PROCESS (FOR BRASS).

A new bronzing process for brass has been introduced by Mr. Wagner. To obtain brass of a very deep-black color, he moistens the metal with a dilute solution of "azotate of protoxide of mercury," and he changes the film of mercury thus formed on the surface of the article into the black sulphuret of mercury, by washing it repeatedly with a solution of sulphuret of potassium. If for the solution of the liver of sulphur, we substitute a solution of liver of antimony or of arsenic, a fine brass-colored bronze ("un beau bronze de laiton") is obtained, varying in color from a deep brown to yellow brown. He prepares the sulphurets of antimony or of arsenic by boiling kermes (for the former) or of orpiment (for the latter) in a solution of liver of sulphur.

NEW PROCESS FOR GILDING THREAD.

Hitherto no other method has been known of producing "cloth of gold" in the loom than using metallic threads, which render the tissue stiff and heavy. By the process recently invented by the Messrs. Beurot, these objections are avoided. The silken or other threads are stretched close together, and are then dipped into a solution of azotate (nitrate) of silver, to which ammonia is added until the solution is perfectly limpid. After immersion for one or two hours, the threads are dried, and then submitted to the action of a current of pure hydrogen. The threads becoming thus metalized, become also good conductors of electricity, and are then gilt by any of the ordinary methods in use for electro-gilding.

ON THE PROSPECTS OF STEAM TILLAGE.

There is a certain little quiet philosopher who dwells in snug retirement beneath the surface of our fields; he seldom shows himself abroad, because he is aware that nature has behaved like a niggard towards him in the matter of personal graces. His eyes are small, dull specks, almost devoid of organization; his face is a queer long muzzle, tipped at the end with a lump of bone; his limbs are ungainly and short; and his coat is rough, and of uncouth cut; yet, notwithstanding all these disadvantages, he is far from repining. With a spice of practical wisdom that is beyond all praise, he sets to work to make the most of the circumstances in which he finds himself placed. Sensible that he never could have been intended for a gay denizen of the daylight, he keeps himself close at home in his underground retreat, and there contrives to turn strong arms, hard, brawny hands, a pair of sharp ears, and a keen, sensitive nose, to excellent account. He bores and delves for his living, and lucky indeed is the insect or worm that escapes his notice when his burrow chances to take the direction in which it lies. Behind his track, a long course of tunnelled galleries is stretched, attesting at once the ingenuity of his operations and the activity of his industry.

The old-fashioned tillers of the soil have, from time immemorial, regarded the proceedings of this subterranean worker with marked hostility. They never could bring themselves to tolerate his presence within their demesnes. If, by accident, they crossed him in his labors at any time, they dragged him forth and hung him up at once, without the benefit of judge or jury. Occasionally, they even went to the length of preaching a crusade against him, and organizing extensive schemes of indiscriminate massacre for the extinction of his race. Yet, in reality, this sorely oppressed creature was guiltless of all offence. He did no harm to the interests of his assailants, but rather made them his especial care. The objects he appropriated from the ground were neither useful nor harmless things; they were positively injurious pests that levied a tax upon the crops by most insidious forays. It would almost seem, indeed, that the persecution must have been instigated by the spirit of envy, rather than by that of retaliation; that it must have been the result of shame rather than of revengeful feeling. The farmers found the soil where the mole had worked not injured, but altogether too good for their liking. They saw the most barren earth changed beneath his touch into rich, productive mould. The wettest swamp dried itself up, as if by magic, after his operations. He did effectually and well, without eyes, what they bungled over miserably and did inefficiently with them. His every step made their incompetency only so much more manifest by contrast. He therefore received an abundant share of the meed that is too often awarded at first to the world's teachers and benefactors. Envy, hatred, malice, and all uncharitableness, were the recompense of his useful and suggestive labors.

All this has, however, in these table-turning days, been changed. Agriculturists now begin to reverence the mole, and look up to him for practical lessons; they study his mode of tunnelling, with heads intent upon gleaning some hint which may be applied in their own practice of draining; and they look upon the finely-ground material which he flings behind him, as he burrows on, with hearts set upon finding some means whereby they may imitate his doings upon an extended scale. Some enthusiasts among them even take his name as the symbol of future successes, and inscribe it upon their banners as the inspiriting word that is to lead to victory.

The amusing little volume which takes the generic name of the mole — *Talpa, or the Chronicles of a Clay-farm* — narrates that the author, having a stiff clay-farm of about 250 acres, which no one could do anything with, he was driven in self-defence to take it in hand himself; and he then goes on to chronicle how he vanquished difficulty after difficulty, until a stagnant waste became a series of fertile and valuable fields.

In the course of the work, we learn on what principle the teachings of the mole are applicable to agriculture: The natural food of vegetable life is water and air — not, however, water and air in their purest states; the water must contain minute quantities of saline and ammoniacal matters, and the air must be contaminated with slight proportions of the heavy carbonaceous gas that is exhaled from animal lungs. The water and air are in fact only vehicles of conveyance; they are not themselves really nutritious. They seem to be so merely because the substances they carry are, under ordinary circumstances, altogether inappreciable to the senses. Plants are helplessly fixed to the spots on which they grow; they cannot roam about in search of food, as animals can; consequently, provision must be made for bringing constant supplies to them. The rain that falls into the porous soil dissolves the saline and ammonical matters it finds there, and flows with its load through the rootlets into the interior of vegetable structures. Air takes up carbonaceous substance — of the nature of charcoal -- into a sort of gaseous solution, and then is blown by every puff of wind into the open mouths that gape upon the surfaces of vegetable leaves. Of water and saline, ammoniacal, and carbonaceous substances, all vegetable bodies are composed. A dilute solution of the fixed and ammoniacal salts is sucked up by the roots. An abundance of leaves is then pushed forth, and carbon drunk in by their myriad mouths. No other demand is made of the soil than a sufficient supply of saline and ammoniacal substances, and water enough for their solution and transport.

In order that the soil may be able to furnish these requisite matters, it is essential, in the first place, that it should have them ready for use in its substance; and in the second place, that its texture should be so loose and porous, that both water and growing roots may find an easy passage through it. In the old practice of farming, the strength of the soil was kept up by burying in it saline, ammoniacal, and carbonaceous matters, mixed indiscriminately together. So soon as Liebig had shown that the great proportion of the carbon found its way into the plant through the leaf, and not through the root, it was seen that there was great want of economy in the proceeding. When farm-yard manure is ploughed into the land, tons upon tons of carbonaceous substance are placed beneath the surface, which can effect nothing else there but their own escape from a useless position. Hence, the custom was slowly introduced of using only concentrated saline and ammoniacal manures, in the stead of the more bulky product of the straw-yard. Now a refinement upon even this refinement is advised. Professor Way says that the soil requires no manuring at all during many years, and that ultimately it will need only a slight dressing of saline materials. He has discovered that it can keep itself rich in ammonia. Clay is, according to his views, mainly composed of a series of ingredients that have the power of attracting this volatile and pungent body continuously from the air.* The ammoniacal constituents of vegetable nutrition are therefore given to the soil by the air, just as the carbonaceous constituents are to the leaves. The atmosphere is the grand reservoir of nourishment, and the soil plays a very subordinate part indeed. Out of its substance, nothing else is contributed than the very trifling proportion of saline or earthy matter that remains in the form of ash after any vegetable structure has been submitted to the process of burning. Even the poorest soils contain within themselves saline ingredients for multiplied crops of the richest kinds of grain.

It follows, from these data, that the only requirements in a good seed-bed are, that it shall be a layer of loosened and finely comminuted earth, which has been well turned over in the process of preparation. Break up the soil thoroughly, and open out its substance to the air, and it will maintain its own productiveness through lengthened years. In the first place, it will constantly throw more and more of its reserved bullion into active circulation; and in the second place, it will keep a sufficient quantity of floating capital always within call for the safe transaction of affairs. If Professor Way's

* These compounds are called, in the language of the chemists, double silicates of alumina and potash — alumina and soda, and alumina and lime.

notions are correct, abundant harvests of grain may be taken off the land, year after year, without any addition of manure at all, provided only a sufficient quantity of labor be judiciously bestowed in pulverizing its substance.

But here, again, if improved comminution of the soil, and not increased manuring, is the thing required, a great revolution must be made in a very important particular. A new form of apparatus must be contrived for attaining the end. The plough now in use is merely a barbarous implement, planned in rude days, for enabling horses to do man's work. The spade lifts up the soil in mass, turns it over, and leaves it evenly spread as a loosened, porous bed; but the ploughshare, on the other hand, squeezes down and condenses one part, while it loosens and turns up another. It is simply a compromise of accurate principle, for the sake of insuring the horizontally acting service of the horse. It is a matter of familiar knowledge that spade-husbandry answers very much better than plough-tillage, whenever it can be employed.

Spade-husbandry cannot, however, be much in use in these luxurious days; human labor has now too high a value in the markets of the world for this to be the case. Some agent must therefore be sought that shall combine in itself the skill of the biped and the strength of the quadruped, and that shall also admit of economical application: in other words, the animal drudge must be exchanged for a mechanical one. That potent slave of the wonderful lamp of science, who never fails to accomplish all that the possessor of the radiant spell enjoins, must be summoned to the agriculturist's aid; steam, ever so ready to transform coarse materials into fine, must now be put in commission to grind down the soil, as it has before ground down hosts of stubborn things, in order that nourishing grain may multiply as fast as hungry mouths.

Assuming that steam has once been enlisted in the service of agriculture, the consideration yet remains of how its enormous power may best be employed. Clearly, it must not be harnessed to the obsolete plough, as some have thought; it would be as much out of place, if set to drag, as a horse would be if put to dig. Man works best with an upward lift, the horse with an onward pull; but the genius of steam is rotary. It likes to have the resistance it is to conquer placed at the circumference of a wheel, the spokes of which it is allowed to drive. The steam cultivator must wear the form of a compact locomotive, carrying behind it a revolving cylinder, fully armed with case-hardened claws of steel. As this machine travels onwards, it must cut out its trench as the mole digs its burrow, and it must cast back into this trench the mould that results from its abrading influence, "comminuted, aërated, and inverted," all at one stroke, just as the "worthy pioneer that works i' the ground so fast," flings behind him the earth his restless claws have scraped away.

The author of *Talpa* foretells the speedy approach of the time when the children of the present generation shall be as familiar with the spectacle of locomotives stalking about over the surface of the fields, on agricultural work intent, as we are with the sight of ships of a couple of thousands of tons burden, driving themselves, duck-like, through the water with their invisible web-feet. Already the prophecy begins to be realized; and, on behalf of our bread-feeding, fast-multiplying race, we venture to express a hope that the consummation will speedily arrive. — *Chambers's Journal.*

FAWKES'S STEAM PLOUGH.

During the past year, a new and improved steam plough has been brought before the public by John W. Fawkes, of Lancaster Co., Penn., which is claimed to be superior to any device of the kind heretofore invented. In order to fully understand the merits of this invention, it is expedient to review the results accomplished in this direction by the three principal English inventors, viz., Fowler, Smith and Boydell.

Fowler does his ploughing in this wise: To his engine is attached a drum or drums of iron, over which passes a coil of wire rope. At the other side of the field is a sort of truck, on sharp-edged wheels, which is caused to travel at a snail's pace along, keeping step with a like forward travel of the engine, by the action of gearing worked by the unwinding and winding up of the wire cable on a drum or drums on the truck. This truck, which he calls an "anchor," runs parallel with the engine, and, as the sharp wheels cut deep into the sod, it is not overturned by the strain of the long length of cable across fields. The two ends of the cable are attached to a double frame of ploughs, hung on wheels in the middle; six ploughs face one way, and six the other. The plough-frame is so shaped, that when one set is in the ground at work, the other is hoisted in the air, on the principle of the "see-saw," that every one understands. To this apparatus, cumbersome, troublesome, and expensive as it is, the grand prize of five hundred sovereigns was last year awarded by the Royal Agricultural Society, the judges estimating that a saving could be effected by it of from five to twenty per cent. in the cost of ploughing.

Smith, of Woolston, uses the drum on or about his engine, but not that at the other side of the field; in place of which he substitutes large grooved pulleys, anchored to the ground by stout grapnel-hooks. He has small rollers, a foot or more wide, fixed on bits of plank, on which the wire cable rolls at different places throughout the whole length of the furrow, the better to avoid great friction on the ground. He has also a different attachment to his implements, and in fact he prefers to use different implements; for, whereas Fowler takes only the ordinary plough and attaches it to a frame, Smith uses the grubber, a long-tined sort of machine, with teeth shaped a little like one of our wire-toothed hay-rakes. He has a patent for what he calls a "turning-bow," which is in fact merely a very large clevis arrangement, by the use of which he can turn his implement at the end of the furrow, and not be compelled to travel forward and back, now elevating one end, and now the other, as does Fowler.

Boydell, as a means of moving his plough, applies power to large driving-wheels, to the periphery of which are attached, at equal distances from each other, pieces of track, of such shape that the forward end of one locks in with the rear end of its predecessor, as the revolution of the wheel brings them in turn beneath, and each piece being attached by a bow to the wheel, and free to move on a bolt, the wheel lays its own track, turns on it, picks it up again as it moves along. Here is the sum-total of Boydell's engine, except that it may be steered by a rod working into gears on the truck of two small front wheels, arranged to turn on a transom. All these machines we saw in practical operation last year at the Royal Show at Chester, and while it cannot be denied that Fowler did good ploughing, and did it continuously; and Smith grubbed away zealously, until the whole field looked as if a large drove of land-pike hogs had been turned in there over-night; and

Boydell's "fiery chariot," puffing continuously, as if overworked, and drawing its baby-cultivator, as an omnibus would a boy's sled, did a tolerable share of work; — they all seemed to us either too expensive in construction, too complicated and cumbersome, or too inefficient in performance. Boydell's engine drew a seven-tined grubber to a depth of six inches, and in going up a slight hillock or mound, was completely stopped, and could not proceed until the grubber had been loosened. Smith's grubbing we thought very rough work, certainly not good enough to induce us to purchase one for any farm we might own; and as to Fowler's, the mere fact that he must have a steam-engine to turn a drum, to wind a rope, to drag a plough, to turn up a furrow, to say nothing of the necessary after-use of harrow, roller, clod-crusher, and seed-drill, we thought "we would call again."

The advocates of the Boydell machine say that if steam is to replace horses, it should carry itself and the loads of horses from place to place. The machine should start from its shed, dragging its complement of coals and the implements of tillage, go over the farm roads to the field to be ploughed, take its own position, and move about up and down furrows and across headlands as required. These qualifications were, to a certain degree, combined in the Boydell traction-engine; but it seemed to us that an engine of 30-horse power, costing $1000 or more, should be able to draw a grubber more than six inches deep without being brought up standing; and that some better means of locomotion should be used than the endless succession of pieces of track, like the snow-shoes of a Canadian voyageur, that were to be placed under the wheel for it to turn on, to keep it from sinking in the ground.

The idea of Mr. Fawkes, for a steam travelling engine was, that it should have the power applied to a large drum, bulged on the middle like a barrel; and this plan constitutes the principal feature of his invention. In the machine constructed and exhibited by Mr. Fawkes, during the past year, the engine is a high pressure one, with an upright tubular boiler, containing 228 1¼ inch tubes, a 9-inch cylinder, and 15-inch stroke. It works a direct crank-shaft, which revolves inside the sleeve of a drum-wheel, through spur gearing. The drum has three iron spiders, and a heavy wooden face, which is preferable to an iron face, as the latter, becoming quickly bright, slips on sod ground, and thus, not only traction power is lost, but the ability to move, even, is destroyed. The bed-frame of the engine rests on a two-wheeled truck in front, is supported by a body-bolt, and the front wheels and truck are as free to turn as the front axle of a wagon. They are steered by a rack and screw connected, by a toothed chain, to a steering-wheel.

The weight is so distributed that the water-tank behind the drum or great travelling roller, when full, balances the weight of the boiler, which is placed in front; hence the weight resting upon the small guide-wheels in front is but little, and they are left quite free to turn. To work the machine requires two men, one to steer and attend to the engine, — which he can do, as the cocks, levers, etc., are placed just at his side, — the other to fire and attend to any odds and ends of work on the ground or elsewhere.

The ploughs, of which there are eight employed, are the ordinary Moline plough, fastened to a frame of such shape that the furrows are turned regularly one after the other. Davits extend from the rear of the engine, and on these are grooved pulleys for chains, one end of which is hooked to the plough-frame, and the other is fastened to a windlass. When the engineer wishes to hoist ploughs, he whistles once, and the fireman draws a lever on the platform of the engine. This turns a clutch into gear, which gives motion to the windlass to which the hoisting-chains are attached. The chain is so arranged as to draw the points of the ploughs out of the ground first, and when it has wound to a certain point, it throws itself out of gear, and thus the ploughs, swinging clear of the ground, may be transported anywhere. To lower them, he gives two whistles, and the lever is drawn, which lets the ploughs down to work. Enough slack is given to the chains to suffer the ploughs to turn furrows of even depth in all inequalities of ground.

This engine (30 horse) is estimated to consume 12 bushels of coal per diem, and with plough complete, costs $3500. When not in use for ploughing, the inventor proposes to apply the motive power of the machine to any other purposes deemed desirable, and has arranged the details of the mechanism with that end in view.

To pump water into the boiler, he uses a donkey-pump, and can use it when either stationary or in motion, and with a length of hose can run alongside a ditch, well, or brook, and fill his tank without trouble. — *New York Tribune.*

The following is an abstract of the report of the committee appointed on behalf of the Illinois State Agricultural Society, September 1859, to examine and practically test the invention of Mr. Fawkes. The trials were made on the "Fair Grounds" of the Society, at Freeport, Illinois.

To form a complete conception of this steam plough, let the committee recall the appearance of a small-sized tender of a locomotive engine; let about half the forward portion of the sides and tank be removed. We now have something which resembles the body of Fawkes's machine. In the middle of the forward portion of the platform stands the upright boiler, which is about 6½ feet high, and 4 feet in diameter, the fire-box and ash-pit being of course below the level of the platform, and the fire-door opening forward. The boiler contains 220 8½ inch tubes, which, computed together with the fire-box, gives 375 feet of fire-surface. Steam may be got up in 15 minutes, although twice that time is usually necessary. The fuel may either be bituminous coal or wood. The cylinders are horizontal, 9 inches in diameter, and 15 inch stroke, and are placed one on each side of the boiler. The pistons communicate motion, not to the side-wheels, but to a drum or roller, 6 feet in diameter, and 6 feet long, which, as the sides of the platform overhang its end, is comparatively out of sight. The drum is placed about midway between the front and back of the machine; before it depends the fire-box, and behind it is the tank; so that, when the boiler and tank are full, they nearly counterbalance each other on the axles of the driving-drum.

This drum is composed of two iron heads, or "spiders," and an intermediate one; to these, thick, narrow planks, cut like staves, and fitting closely, are bolted, and form the periphery. The adhesion is, therefore, produced by a surface of wood, six feet long, which never becomes polished, and the bearing of which is always across the grain. There is no slipping; the machine is started and stopped instantly; and, except when propelling itself a considerable distance on turnpike or paved roads, the wear and tear is slight. The substitution of the driving-roller for the ordinary side-wheels, wonderfully increases traction, and prevents sloughing in wet or yielding soil; while moderate irregularities of surface scarcely affect the onward march of the plough. Another great advantage is gained by the gearing of the drum. Instead of being attached directly to a crank on the axle of the drum, each connecting-rod communicates motion to a pinion, which turns easily, but without shake, on the axle just mentioned. The pinion interlocks with a cog-wheel, which, with a pinion on *its* axis, imparts motion to the cog-wheel bolted to the drum; — the whole being so proportioned that six strokes of the piston cause one revolution of the drum.

Increase of power and of control over the movements of the engine are thus secured:

In front of the fire-box is a short, tapering bow of sheet iron, which serves as a seat for the fireman and a receptacle for fuel. The bow is supported by a body-bolt on a truck composed of two iron guide-wheels 3½ feet in diameter and 15 inches broad. The truck moves freely like the front wheels of a chaise, and is controlled by a steering-wheel in charge of the engineer, so that the whole machine is turned as readily and as short as a farm wagon. The engine is of 30-horse power. The entire length of the machine is about 18 feet; its weight, with water and fuel, 10 tons; and cost, including "donkey" engine and pump, about $4000. By this pump, water may be drawn from a well or creek, and the tank filled, or water forced from the tank to the boiler. The tank holds twelve barrels, sufficient for three hours running. The ploughs, eight in number, are attached to one frame, which is suspended by chains passing over grooved pulleys in two beams, projecting from the seat of the engine. These chains communicate to a windlass in charge of the fireman, in front, by which the gang of ploughs may be raised or lowered at pleasure, and the frame of ploughs is drawn by other chains, which are attached to the under side of the frame of the engine.

In answer to the several questions propounded by your Board, touching the capacity and practicability of the engine for farm purposes, we find, upon trial and examination, as follows:

First: The weight is ten tons, as reported by Mr. Fawkes.

Second: The fuel consumed in one hour was 170 pounds, or two bushels and ten pounds of inferior coal, with one-eighth part of a cord of wood, evaporating about 150 gallons of water, and ploughing one acre in twelve minutes (which includes turning).

The wood used was mostly of pine, and considerably decayed, and would have been rejected upon steamboats.

Third: The amount of traction on different grades of land would be a matter difficult to determine, with the facilities in the hands of the Committee. We had the engine run up the various grades of the Fair Grounds, passing into a gulley with the ploughs swung in the rear, which struck on one bank as the main roller was raising the other, which overpowered the engine; but upon detaching the ploughs, the machine moved out without the least difficulty. Upon measurement, the grade was found to be 1 foot vertical to 4 on the horizontal line. Steam, by the indicator, was marked at only 62° — 100° being his ordinary pressure.

Fourth: The friction produced by the pressure against the shoulders of the axles, instead of being fair on the journal (which are of less size), may possibly make a slight waste of power in running across inclined planes. The wear and tear would be the same as with any other steam-engine used for locomotion.

The engine can safely be run across an inclined plane of 30°, because of its great breadth of base (six feet) — the principal part of the boiler, the heavy fire-box, and a great portion of the machinery, being below the centre.

Fifth: We have previously stated that an acre could be ploughed in twelve minutes; but an examination of the following computations will demonstrate its actual performance. A strip of land, 246 yards long and 20 feet wide, was ploughed in four minutes; and the head-lands of 50 feet were crossed, one in 27 seconds, the other in 30 — the ploughs being elevated and lowered to and from the ground in the time.

Sixth: No steam-engine in existence should be intrusted to inexperienced persons.

This one is as simple as any we have ever examined, is strong and substantial. It is a locomotive high-pressure engine in construction, arranged for reversing at will, and was repeatedly advanced and reversed a few inches at a time with perfect ease, and in a few seconds. The skill requisite to manage the machine should be acquired in a month by any intelligent American farmer, and your Committee, in view of the certainty of the employment of steam for farming purposes, would strongly recommend that the farmers of Illinois should give special attention, in the education of their sons, to the principles of mechanics and the practical management of steam-engines.

Seventh: The fuel furnished by the Society to your Committee was of such inferior quality as to hardly enable us to demonstrate fully the steam-generating capability of the boiler; but, by referring to the amount of its fire-surface (375 square feet), it will be seen, by practical men, that, with the advantage of an exhaust to create artificial draught, it is fully competent, with ordinary fuel, to generate continuously abundant steam for its work.

In weight of coal and wood on board, and of passengers, it carried, throughout the experiments, as much as would represent the weight of an entire day's supply of fuel. It would carry water for a three hours' run.

Eighth: As a stationary engine, her power was tested at Power Hall, where, after jacking up her rear end so that the main drum turned clear of the ground, by applying the power direct to the drum or roller, 120 revolutions of it were obtained per minute. By passing the belt of a fifty-foot line of shafting over the drum, the engine propelled one eight-horse thrasher, one corn and cob mill at work at the rate of 25 bushels per hour, two small iron corn-mills grinding six bushels each per hour, one wood-moulding machine, one resawing circular saw of two feet in diameter, and a smut-machine of high speed; all simultaneously, and with only 10 lbs. of steam. From experience with circular saws, we estimate it as capable of running two of the largest size at one time. It is perfectly competent to go into the timber, haul logs where the ordinary log-wagons would be employed, and in one hour be jacked up and furnish power to saw those of large size.

Ninth: The fire-box being within fourteen inches of the ground, the machine would run without injury through water twelve inches deep; it was run by us over ground where, by hand pressure, a lath was forced downward fifteen inches, and on examination we were of the impression that the actual compaction of the surface by the machine was not more than one inch. Horses crossing this slough sank to their fetlocks; but, as with the engine, the actual surface pressing upon the ground is at all times six square feet, the ability to sustain weight is much greater than with the wagon and team, where the weight rests on narrow bases. The four wagon wheels present a surface width of seven inches in all, but the engine, with its drum and guiding wheels, a surface of 102 inches. The weight of the engine is ten tons, that of a wagon-load of grain one and a half tons, or something more than one-sixth as much; but the engine with a drum six feet in diameter, and guide-wheels three and a half feet in diameter, gives a much greater proportional contact with the ground, and its load is proportionably less liable to miring in sloughs.

Tenth: The difference of power between running the engine on plank or hard road, and common prairie, would be great; but that between running on ordinary ground, and ground so soft that the drum would sink four inches, we have no means of knowing. It is evident, however, from the explanations in the preceding answer, that ground in such condition that a drum six feet in diameter and six feet long would move to that depth, would be entirely unfit to plough, and could not be even crossed by horses.

Having thus in detail answered the interrogatories propounded to us by the Executive Committee, we desire to make some general remarks with reference to the practicability of employing steam for ploughing, and other farm purposes. The experiments with Fawkes's steam ploughing engine have demonstrated to our satisfaction that it is practicable that, in a few years, a large portion of the labor now performed by animal power on the farm will be superseded by steam, especially in prairie countries, and on well-improved farms, where but few stones or other obstructions exist.

The engine here exhibited is intended only for large operations, being capable of breaking from 25 to 40 acres per day; but we see no reason why its size may not be reduced very considerably (say to one-fourth), and still successfully compete with animal power.

We estimate the cost of ploughing by it from the following very liberal data:

USED PER DIEM.

One ton of coal,	$5.00
One cord of wood,	3.00
Labor of three men — engineer, fireman, and assistant,	4.00
Oil, etc.,	1.00
Ordinary wear and tear,	2.00
Interest 10 per cent. on $4000,	1.12
Total,	$16.12

With the most liberal allowance for hauling water and coal one mile, for stoppages and turnings, the machine should plough 25 acres per day. At present contract prices of $2.50 per acre for prairie breaking, this would cost $62.50, while by the above estimate it is seen that Fawkes's ploughs for 61½ cents per acre.

Your Committee, in view of the result of their experiments, unanimously recommend that the First Prize of three thousand dollars be awarded to Joseph W. Fawkes, of Christiana, Lancaster Co., Pa., for his Steam Plough.

All of which is respectfully submitted.

Isaac A. Hedges, Cincinnati.
P. W. Gates, Chicago.
A. B. Latta, Cincinnati.

VAN DOREN AND GLOVER'S REAPING AND PLOUGHING MACHINES.

At the Illinois State Agricultural Fair, September, 1859, a combined reaping and ploughing machine was exhibited by Messrs. Van Doren and Glover, the construction of which is thus described by a correspondent of the *New York Tribune*.

A bed-frame of timber, 16 feet in length, is supported on the axle of two wooden iron-faced driving-wheels of 4 feet 2 inches diameter, and 8½ inches face. Between the wheels, the bed is 6 feet wide, and the drivers are inclosed by an extension of the platform, making in all a width from outside to outside of 8 feet. The timbers of the frame meet at a distance of 12 feet from the axle, and at this point rest on a castor-wheel, which is steered by a tiller. The boiler is upright, and contains 72 inch and a quarter tubes, 2 ft. 10 in. long. The fire-box, 20 in. square, is intended for either wood or coal. Above the flues is a steam-reservoir, 3 feet high, with a smoke-flue passing through it. Thus in one tube of boiler iron 8 feet in height, is contained a fire-box, boiler, steam-reservoir, and smoke-flue. In front of the boiler there is a reaper extension, which supports a regular reaping arrangement of cutter bar, dividers, reel, etc., and which may be attached or removed at will. Motion is given to the knives by a long, tilting lever, which is worked directly by an extension of the piston. The reel is turned by a belt passing over a shaft worked by the driving-wheel. To mow grass, the cutter-bar is lowered, or to head grain, is elevated, by a long lever hung on the main axle, and passing back nearly to the steersman, who works the lever by means of a pinion and rack. The cylinder is 5½ inches in diameter, with a 9-inch stroke, and has a link motion to enable it to reverse. The pump is worked by a crank on a shaft, which may be made to gear into the fly-wheel shaft as required; and water is pumped into the boiler when the machine is either in motion or at rest. The drivers are turned by a pinion, which is turned by a bevel-wheel working into a pinion on the crank-shaft. An ordinary barrel of water is carried on the axle alongside the boiler. To plough, the reaping apparatus is removed, and then the machine travels in a contrary direction to what it does in reaping, the ploughing being done behind and the reaping before, as it moves along. A cross-beam, which extends beyond the driving-wheels, is 4 by 6 inches in size. On it are five wheels, gearing into each other, and one driven from the crank-shaft. To the centre of each wheel is bolted an iron bar, ⅝ by 2½ inches, 4 feet long, on each end of which is a small ploughshare without a land side, which cuts 10 inches deep if required. The cut is 3 inches wide; so that each revolution of the arm makes a cut of 6 inches, and the machine travels forward the same distance in the same time. Each plough-point being 2 feet 2 inches from the centre, the two ends make a cut laterally of 19½ inches, and the whole five cutters make a furrow of 8 feet, as near as may be. For ditching, the plough-wheels are removed, and an extra shaft inserted, which is driven direct from the crank-shaft. The shaft turns a wheel to which another form of excavator is attached. The same small plough is at one end of the iron bar, but a spade or scraper replaces that at the other. It throws the dirt to one side, distributing it over 5 to 20 feet of ground, in proportion to the speed of the machine. The fly-wheel may, of course, be used to turn stationary farm machinery of all kinds.

The inventor claims to have ploughed about two acres in all for experiment, and to have mowed about an acre. The whole apparatus, of five-horse power, weighs only 1400 pounds, and is presumed to cost about $600.

WATERS'S STEAM PLOUGH.

A steam plough, exhibited at the Illinois State Agricultural Fair, September 1859, by James Waters, of Detroit, Mich., has the following construction:

It is a locomotive engine, with a horizontal boiler, and four 5¾ inch cylinders, with a 12-inch stroke, making 34 revolutions to one of the driving-wheels.

The drivers are *ten feet* in diameter, made of ½-inch boiler iron, and with a face of 26 inches. They have each two sets of bar-iron spokes, crossing each other so as to brace both ways, like a trotting wagon. There are two steering wheels in front, 5 feet in diameter, 13 inches face, and are turned by a worm and chain by a crank by the engineer, who stands in front, at the right hand of the boiler. The main axle is of 4-inch round iron, and fitted with oil-tight boxes. The boiler is the horizontal tubular one used on locomotives, has 96 2-inch tubes, and a 2 by 3 feet fire-box that may be used for either wood or coal. The boiler is bolted to the axle by clamps, and in front by a light frame which rests upon the axle of the steering-wheels. Motion is given to the drivers by a pinion working into internal gearing which extends all around the inner face of the drivers; the pinion is turned by its wheel gearing into the engine-shaft direct. To prevent slipping of the wheels, pyramidal-shaped ribs of iron are bolted diagonally across the face of the drivers. The inventor claims that the weight of the engine is so placed, that, from the enormous diameter of the drivers, it is thrown upon their forward face, and quite removed from the steering-wheels. The great size is given to the main wheels to prevent miring in soft ground, they being large enough to cross an ordinary slough before they would have time to sink. A tank beneath the boiler holds five barrels of water, which may be pumped into the boiler at will. A tender, or two-wheeled cart carries fifteen barrels more, and on its deck coal and wood enough for a day's work. This tender may be detached, and left at one side of the field, or dragged behind the engine, and in front of the ploughs, as desired. The ploughs are fifteen in number, attached firmly to a triangular frame, which runs on castor-wheels at the corners. They are not separate and independent in attachment, like Fawkes's, so that some of them would miss in passing over basins, and dig deep in going through hillocks, without compromise or evasion of obstacles. There are two gangs, one having eight, the other seven, ploughs. With frames, wheels, and all, the two weigh easily 6000 pounds, while the engine itself is claimed to weigh only seven tons.—*N. Y. Tribune.*

The Committee of the Illinois State Agricultural Society report, concerning this invention, as follows:

Waters's engine has undoubtedly great power, but has some objectionable features as well. There being four cylinders, the machinery is made more complicated, and by so much the less easy of management by farmers. The four cylinders are necessary to a machine like this, which has two large travelling-wheels, to keep each of which in motion at will, a pair of cylinders must be used; for without them it would not be possible to get the wheels off centres under some circumstances. The revolutions of the engine being 24 to each one of the drivers, speed of locomotion is not obtained commensurate with the speed of the engine. The great length of the train of engine, tender, and ploughs, makes it unwieldy to handle, and prevents trimming up corners of lots and banks of sloughs and basins, where much waste of land would be caused. It also is asserted by the inventor that his field is not back furrowed and finished up, but a strip of fifty feet is left in the middle to be finished by horse power. The tractive power of the engine, when at work, seemed ample; but we are not prepared to say that such would be the case throughout a day's work, but suppose it would. The two pairs of cylinders being independent of each other, a serious obstruction to one driver might cause it to slip, while the other held its tractive power; thus there would be a tendency to throwing out of line. The internal gears of the drivers being quite exposed to dust and sand, the wear would be rapid. The raising and lowering of the gangs of ploughs by a quick screw, proved itself bad; for when the points ran down deep, the downward pulling weight caused the screw rapidly to run up, and the ploughs were buried almost to the beams.

RECENT IMPROVEMENTS IN AGRICULTURAL IMPLEMENTS.

Wetherill's Horse-Hoe. — This invention, by Lorin Wetherill, of Worcester, Mass., is designed for hoeing corn, potatoes, cotton, or other field crops that are grown in rows or drills; and is adapted to the condition of the plants in any stages of their growth. It consists principally of a double mould-board plough, having at its rear sides two sets of hoes or paddles, affixed to the ends of arms that rotate in planes perpendicular to the furrow made by the plough. Motion is given to these arms by shafts driven by gearing moved by a wheel running upon the ground just in advance of the plough. The shafts can be raised or lowered at the ends carrying the hoes, in order that a lesser or greater quantity of earth may be thrown by them upon the hills surrounding the roots of the plants. The clods are broken by the hoes into small pieces, which consequently lay more closely about the roots.

It is claimed to be an efficient and labor-saving machine, hoeing as much ground in one day as the draft animals can pass over.

Whitney's Plough-holder. — The invention consists of an iron frame, supported by a wheel, which can be fastened to the left side of the beam of any plough, and which by its weight keeps the plough upright. The machine is simple, costs $5, and is said to work well, even on stony land.

Prairie Draining Plough. — A machine is in use in Illinois, that answers a good purpose in draining the ordinary soil. A strong beam, on four rollers, carries a small cutting-wheel, which divides the sod; this is followed by a sharp coulter, set at an angle backward, to the bottom end of which a piece of iron, shaped something like a pear, is welded, supported by a flat bar, bolted, like the coulter, fast in the beam. To this "mole" is attached a second, of similar shape, a little larger, by a link-joint. Being set into the ground, it opens a hole, which it moulds permanently by side pressure, three feet below the surface, and through this drain the matter runs off as easily and continuously as through tile drains.

New Garden Implement for Transplanting. — A new and useful implement has been invented by John Bargum, of Concord, N. H., designed to facilitate the transplanting of small garden plants or flowers from one bed to another, or from the grounds to pots. Imagine a tapering pint tin pot, with the bottom cut off, and the cup split up and down into two halves, and these halves attached to two handles, like those of a stout pair of shears. By opening the handles, so as to spread the halved cup a little apart, and thrusting it, small end down, into the ground upon each side of the plant, and then pressing the handles together, the dirt is pressed around the roots, and the plant may be lifted out and set in its new place directly from the implement; or any number of them may be laid upon a board or in a box for distant removal.

Raking and Binding Machinery. — A correspondent of the N. Y. *Tribune*, under date of Sept. 8th, 1859, thus describes two devices for raking and binding grain, conjointly, exhibited at the Illinois State Agricultural Fair — one the invention of Allen Sherwood, of Auburn, N. Y., which binds the sheaf with a bit of wire, and the other, that of John P. Manny, of Rockford, Ill.

with an iron hook and a hempen string. On Sherwood's plan, the man who works the apparatus sits behind and lower than the driver, facing the platform. The triangular table of the Manny Reaper is used in this case, although it is claimed that to almost any other machine the patent binder can be applied. At the raker's feet is a half-circle shield of sheet iron to guide the sheaf as raked to within reach of the binder. Behind the shield is an elbow-joint, the short arm perhaps a foot long, and the long one something more, with a handle on its end. Along the upper sides of both parts are eyelets through which a No. 20 wire is guided to the handle, after having passed from a spool fixed between the driving-wheel and platform, along the under side of the platform, and up through it to the eyelets. The binder to commence puts the end of the wire between a pinion and spur-wheel, which hold it firmly, while he pushes the elbow-joint toward the raker, and with the return motion passes his hand along the wire, bending it to the platform and up the off side. He has plenty of slack wire to do this each time, for it unwinds freely from the spool, and, the end being held by the gearing outside, the bending back of the elbow-joint pulls wire up through the platform and through the eyelets, as freely as required. Now, the sheaf is raked directly upon the wire that lies upon the platform. As it comes, the binder reaches out, takes hold of the handle, and pulls the elbow-joint toward him, thus causing the wire to tightly confine the sheaf of grain. He rests the end of the handle so that the end of the wire is caught between the pinion and spur-wheel, when he sets them in motion by turning a crank, and they twist the two ends of the wire together around the sheaf, making, at the same time, a new twist for one end of the next band; a knife cuts the bundle loose, and it falls, all nicely bound, upon the platform.

J. P. Manny's binding apparatus is altogether different. He has only two men, a driver and a binder, the raking being done by the machine. The cut grain is carried sidewise on an endless slatted apron and up an incline, in the usual way. On its passage up, it is confined from blowing away by light slats, and arriving at the summit, it tumbles into a cradle, of which there are three on one shaft, each in succession being brought uppermost by one-third of an entire revolution. One finger of each cradle is of iron, the three made in one casting. The iron finger has a forked end to receive the small cast-iron hook of the sheaf-band. The knotted end of the band, which is nothing but a stout hempen string, about thirty inches long, is put in a notch of a spring-catch, and is then ready in place for the grain, which is suffered to fall into the cradle. When enough has accumulated for a sheaf, the binder trips a lever with his foot, which causes the cradle-shaft to revolve, the hook is brought by the iron finger-end to catch the knotted end of the string, the binding is completed, and the band being freed from the catch, the gavel falls on the ground. The little cast-iron band-hook will weigh perhaps two ounces, but it is a mere shell, and if, by oversight, a half-dozen or more were fed with the grain into the machine, they would be crushed like an egg-shell, and the string be shredded to bits. I saw four of them put into a thrasher, that was being tried by a committee, but no extra noise indicated their passage through; nor could I, after careful search, find the least fragment of iron or string a moment after they must have been ejected.

The sheaves are firmly bound by both machines, — quite as well as good hand binding. You may kick and toss them about, take them up by one side and shake them roughly, and they do not come untied. And both kinds of bands may be loosened in the instant at the threshing-table. The Sherwood motions are too slow, and the endless belt of the Manny machine is like all canvas belts, working sometimes well and sometimes worse. Either can be applied to reapers at a moderate cost, and both have enough to recommend them for use to thus fully bring them to the notice of the public.

IMPROVED SHOE FOR HORSES.

Many attempts have been made to shoe horses without the continual driving of nails into the hoof, by which great injury is sometimes inflicted upon valuable horses, by nails pricking the quick. In order to diminish this evil, Mr. Thomas, of London, has invented a double-bottomed shoe, which is constructed and applied as follows: "He takes an ordinary horse-shoe, and forms a groove in the part which comes in contact with the ground. This groove is about a quarter or three-eighths of an inch deep, and half an inch or more wide, according to the size of the horse and shoe, and within three-quarters of an inch from one extremity of the shoe to the same distance from the other. The groove at the ends and toe of the shoe is cut under. A piece of iron of the same width and shape with the groove, only thicker, and slightly curved upwards, is so fitted at the ends and toe, that, by the tap of a hammer, it is driven into the groove, and hence into the under cutting. The junction forms a complete dovetail, which prevents the removal of the inner shoe, unless by the forcible aid of a chisel. The advantage of this inner shoe is, that it is made to project beyond the ordinary shoe, and, when worn down, can easily be removed and replaced by another, without pulling off the shoe from the horse's hoof. Besides, in frosty weather, the inner shoe needs only to be jagged, and you have the horse frosted." — *Scientific American.*

TRANSPLANTING LARGE TREES.

The following plan for transplanting large trees is adopted in Paris, in the *Champs Elysées:*

A circle is cut around the tree, about three feet from the trunk, and at a depth of about five, through roots and earth. The earth which adheres to the root is covered and bound with brush and ropes, to keep all together; then large chains are passed under the whole, and the ends brought up above the surface of the ground. It now being ready to be removed, two heavy, strong planks are laid down outside of the hole, to receive the wheels of the wagon, which is made of solid iron, and a skeleton body of only two heavy side-pieces, which connect the fore and aft wheels, — the front wheels having an axletree passing from one side to the other, while the rear wheels are hung like those upon many railroad cars, having one open space, and strengthened by a heavy cross-piece of iron, which can be removed at pleasure. Over each wheel is a windlass, to hoist by crank. Now, being ready to take up the tree, the heavy cross-piece behind is removed, and the vehicle is backed upon the planks, and the trunk of the tree now stands up through the middle of the skeleton body; the ends of the chains are made fast to the windlasses, and eight strong men, two at each crank, wind up the chain, and swing the tree, roots and earth, to the wagon, put in the cross-piece behind, attach from four to six horses, and drive off. The tree is lowered into the earth in the same manner that it is taken out.

NEW MODE OF PRESERVING FRESH FRUITS.

Dissolve gutta-percha in sulphuret of carbon. The liquid separates into three layers, the upper of which contains mucilaginous matters, and the lower earthy compounds and other impurities; the middle layer is perfectly limpid, and contains the pure gutta-percha. Separate this from the others by a siphon. Gather the fruits rather before complete ripeness; dry and brush them; dip them in spirits of wine; then two or three times in the gutta-percha liquid; they may then be kept in a box or closet, the temperature of which must not exceed 50° Fahr. When the fruit is to be eaten, the coating may be peeled off, or washed off with a little spirits of wine; and, notwithstanding time and journeys, the fruit will be found to have preserved its taste and perfume, as though it were perfectly fresh.— *Cosmos.*

UNIVERSAL PRINTING-PRESS.

A press adapted to all kinds of printing, has recently been patented by M. Silberman, of Paris, which is thus described in the *British Engineer and Arch. Journal* for December 1858.

Pascal's law is this: "Whatever be the amount of pressure brought to bear upon any point in a contained fluid mass (whether the fluid be a liquid or gas), the pressure is distributed with perfect and entire equality among all parts of the mass, and consequently with perfect equality over all parts of the surface of the vessel which contains the mass;" so that if the vessel, or a portion of it, is pliable and elastic, it will communicate the same pressure it receives to paper, cloth, or any other similar substance, laid upon an unyielding engraved surface. And the invention consists in printing by thus applying the pressure of a fluid to a yielding surface laid against an unyielding engraved surface; and this, whether the surface printed be that of the vessel itself, which thus becomes the press, or whether it be communicated to another interposed yielding surface, from the pliable and elastic side of the vessel, so as to print, on any kind of material, plane, curved, or angular surfaces.

The application of this principle to the peripheric printing of globes, and of vessels of glass and earthenware, is the subject of a separate paper. At present let us consider merely its application to printing upon plane surfaces, as well as the different modifications it admits of, so as to suit the different kinds of printing; and lastly, of its peculiar advantages over other methods.

The following are some of the methods in use for the practical application of the principle:

1. A strong, shallow basin of tough metal is required, with a triple stopcock at bottom, admitting at pleasure the sort of fluid intended to be used, whether it be atmospheric air, steam, or (when great pressure is required) water, with hydraulic pressure. This basin is filled with water, and covered by a tympan formed of a sheet, or of several sheets thick, of caoutchouc, firmly clasped at the edges in an iron frame. A movable plate of iron, strengthened by stays, is attached by strong hinges to one of the edges of the tympan frame. This plate, when shut down upon the surface of the tympan, forms the unyielding portion of the press, and supports the engraved plate against the substance intended to be printed, which receives, by means of the tympan, the pressure produced upon the water at the bottom of the basin.

In order to retain this plate firmly in its place upon the tympan, its edges, as well as those of the basin, should be bevelled in such a manner as to lock the whole way round in a collar with a corresponding groove; this collar opens and closes upon the edges the whole way round, by means of two hinges and wide-threaded, strong screws, or else by means of a cam, or eccentric lever-lock. A very simple contrivance compels regularity in the proceeding, and prevents accidents, by locking the stop-cock, and preventing the admission of pressure into the basin, until after the plate shall have been shut down and firmly locked upon the tympan.

The engraved plate may either be permanently fastened upon the iron plate, or it may be run into its place in a groove, so as to admit of being easily removed and replaced after each impression, as in the case of copperplate printing.

When it is intended to print paper-hangings or cloth with dies, an iron frame, instead of the solid plate above described, is attached to the hinges; a strong iron axle, passing through gudgeons on opposite sides of the frame, carries a panel fitting into the frame, and upon this panel the die is fixed. The panel thus revolving completely on the axle at the same time that the frame is raised upon its hinges to a vertical position, admits of the face of the die being alternately brought in contact with the tub, when it is charged with color, and with the surface of the material intended to be printed.

2. Another form of the press is one in which the tympan is movable upon hinges, and fastens down upon the plate, which in this case is the fixed part of the press, and upon it the die is laid. In lithography or typography, there must, of course, be a hollow in the plate corresponding to the thickness of the stone or type used.

This was the form adopted for the first experiment of the press, its tympan consisted of two sheets of vulcanized caoutchouc fastened to the basin, and secured by strong screws; the tympanum and the plate, instead of being locked together while the pressure was on, by means of the collar above described, were kept together at one end by the hinges, and at the other by a cam, or eccentric lever-lock, working from an iron arch like a common letter-copying machine, and to which two movable claws are attached, which, when the lever is worked, grasp and secure the ends of a strong bar across the centre.

3. It may sometimes be desirable to place the press vertically, notwithstanding the slight, and in fact almost imperceptible difference in the pressure at the top and at the bottom of the basin, and which is produced by the column of water in the basin itself. When air is used, this inequality is absolutely imperceptible; but, on account of the great compressibility of air, a much larger quantity of air must be admitted than when water is used. For instance, if the basin is one metre square and one millimetre deep, and consequently holds one litre, it will require one litre of air to produce a pressure of a single atmosphere, and ten litres to produce a pressure of ten atmospheres.

The vertical position is particularly well suited for very large plates, say five or six feet square; the copperplate can, if necessary, be heated from behind, and the workmen can apply the ink in a standing posture. The press, in this case, would open like a door, and large presses thus arranged would occupy but little space, would be easily worked, would render the application of the ink less fatiguing, and would save rent in office space; for six vertical presses take no more room than two horizontal presses. In this way the printing of very large maps will become not only possible, but cheap.

As to the purposes to which it can be applied: 1. It is equally suitable to all kinds of ordinary printing, whether copperplate, lithography, typography, paper-hangings, or wood engraving; for it fully admits of the depth of shade in certain parts of the engraving being modified according to taste, without altering the engraving by the usual contrivance of folds of paper cut out so as to throw the part into suitable relief. 2. It is peculiarly suitable for polychromic printing, whether typographic, lithographic, or copperplate, and the pressure being only in a vertical direction, the paper or cloth is not liable to be altered in size or form by the pressure, and admits of accurate fitting to the guide-pins as often as the number of colors used may require. 3. It is equally suitable for printing upon all sorts of material, whether paper, cloth, ceramic paste, felt, leather, or caoutchouc. 4. It prints, with a single impression, very much larger plates than it has heretofore been possible to do, and it insures the color being uniform over the whole surface. 5. It admits of being used for stereotype and other casts from ordinary printing type, and does not require that frequent touching with the brush which wears away the characters so quickly.

As to the pressure: 1. The pressure being that of a fluid communicated through a uniformly yielding surface, will be absolutely equal at every point of the surface, consequently there will be no danger of partial pressure on the plate, nor need there be a pressure upon any part of the plate beyond what is necessary, so that the maximum result is thus obtainable with a minimum of pressure. 2. Any amount of pressure required can be easily obtained. 3. The amount of pressure can be ascertained with precision (for instance, by Bourdon's metallic manometer), and diminished or increased to the exact extent which may be required. 4. Perfectly plane surfaces are no longer the only surfaces capable of being printed. 5. Convex or concave surfaces can thus be printed.

As to make, form, and size: 1. The press is extremely simple in its construction; almost all the pieces are cast exactly as they are used, and require very little fitting. 2. It can be made of any strength required. 3. It requires no troublesome alterations when the purpose for which it is used is altered. 4. It fits in a very small space, being only four or five inches wider than the printed sheet, whereas the presses hitherto in use are at least four times wider than the printed sheet. 5. It thus admits of being worked in a small and comparatively inexpensive office. 6. Its size being so small, a printer can have several presses of different sizes in his office, so as to be no longer forced to use his large presses for small sheets. 7. It is easily taken asunder and moved. 8. It is on this last account, and the almost impossibility of breakage, admirably adapted for exportation.

As to its working: 1. It requires hardly any effort, and entirely dispenses with the severe labor which the winches and pedals of the present lithographic press requires, — with the rolling of copper-plate printing, — with the difficulty of charging the blocks with color, as well as with the danger of working the huge lever of the ordinary press in printing paper-hangings; and as it requires less exertion on the part of the workmen, it gives them more time to attend to the quality of the work, and thus tends to elevate their character. 2. A much greater number of impressions can be taken in a given time than was possible heretofore. 3. The manner of using the press can be learned in an hour. 4. No modification of the press, or any of its parts, is necessary when a change is made in the size of the sheet, or otherwise in the nature of the work to be printed. 5. The impression is uniformly even and invariably successful. 6. There is no longer any danger of distorting nor of lengthening, by rolling out the plates in copper-plate printing, nor of breaking the lithographic stones by the uneven pressure of the scraper. 7. The simplicity of the contrivance for locking the press, and for admitting and shutting off the pressure, renders all mistakes impossible. 8. There is no part of the press which is expensive from excessive wear and tear; and even when worn out, both the caoutchouc and the metal have a considerable value as raw material.

As an investment, the great simplicity of the machinery, and the small expense of fitting, will allow the press to be sold extremely cheap.

As to the sort of pressure to be used, steam pressure may be adopted, or the pressure of expanded or condensed air, the hydraulic press, the screw, the cam, or the eccentric or knee lever lock. If steam is used, the waste heat will warm the plates in copper-plate printing, and will thus get rid of the charcoal dust, so injurious to the health of the workmen.

The expenditure of water or steam may be estimated by considering the surface of the caoutchouc as the surface of a piston, and its depression joined to that of the printed surface as the stroke of the piston; consequently, when the basin is one metre square, there is an expenditure of one litre of air or water for each millimetre in the depression of the surface.

Water appears, on the whole, the most desirable agent, on account of its non-compressibility, and of the small quantity required in order to produce very considerable pressure, as also on account of its non-expansibility, which prevents the possibility of an explosion; for if any breakage takes place, the water simply runs out. In experiments which were made with a pressure of from twenty to thirty atmospheres, before perfecting the press, the vessel repeatedly burst, with no greater injury to those engaged than a few splashes on their clothes.

TYPE MAP.

A telegraphic map of Europe, entirely executed in typography, has been issued by the Royal Printing Office of Berlin. The process by which it has been produced is described as follows: The drawing of the map, made on paper, is blackened at the back with a carbon tracing composition, and is placed, blackened side downwards, on a surface composed of quadrats, formed each by sixteen nonpareil squares, and by means of a point, the lines are transferred to them. The quadrats over which these lines are traced are then exchanged for nonpareil type, cast with a face of points, and the coast line is formed by the inner portion of these points being cut away. The telegraphic lines are formed of brass rules, fixed in nonpareil type body, as a sort of legs, which can be inserted into the composition, when needed, by taking out the quadrat — the legs being so adjusted in length that the upper edge of the rule is level with the face of the type. The additional shading of the coast line is effected by the insertion of nonpareil type cast with points on the face. The names of places are inserted by means of type taking the place of the quadrats where required.

The effect produced is peculiarly good. How far this is ever likely to supersede the present methods of producing maps by engraving and transfer to lithographic stone, is questionable; no details as to the cost are given, and it seems very doubtful (however simple the process appears) whether the result can be satisfactorily produced except by a skilled workman, whose labor must be adequately remunerated.

NEW METHOD OF TESTING SUBMARINE TELEGRAPH CABLES.

A plan devised by Messrs. Reed, of England, engineers, for effectually testing submarine telegraph cables previous to their deposition, so that any defect may be made evident, consists in first exhausting the air from a vessel in which the cable to be tested is placed, and then forcing in water, until a pressure of about two hundred pounds per square inch is attained. To perform this operation, they employ a vessel which is so constructed as to be possessed of sufficient strength, so as to resist the pressure of the atmosphere when exhausted, and also, at the same time, the hydrostatic pressure to which the cable is to be subjected. The vessel in which the operation takes place is provided with a cover, so as to admit of a coil of insulated wire being introduced and inclosed therein. One end of the covered wire is conducted from the interior, through a shifting box, to the outside of the vessel; the other end of the wire is coated over as well, and insulated. All being thus arranged, a vacuum is formed, by means of air-pumps, in the vessel which contains the cable. The stop-cock of the air-pumps is now shut off, and the passage for the water is opened, so as to admit of the water entering into the vessel to fill it; or, if desired, a quantity of water may be allowed to enter into the vessel, so as to fill it, or nearly so, before the pneumatic apparatus is put into action. One end of the wire of a galvanometer is connected with the outer end of the wire which has been brought through the vessel, as described above. Pressure is next exerted by pumping water into the vessel, and then, on connecting the two poles of the battery with the galvanometer and the water in the vessel respectively, if the insulation be perfect, no action takes place in regard to the needle of the galvanometer, as no complete electric current has been formed; but, on the contrary, should there exist any defect whatsoever in the coating of the wire, however small it may be, the needle of the galvanometer will at once, by its deflection, indicate the same to the operator, which shows that a circuit has been formed, owing to some of the water in the vessel getting into contact with some part of the wire which is being tested.

OILED PAPER AS A SUBSTITUTE FOR OILED SILK AND GUTTA-PERCHA IN SURGICAL DRESSINGS.

This material was introduced by Dr. James McGhie, of the Glasgow Royal Infirmary, and has been used with success in hospital practice.

The following is the mode of preparing it:

Having secured a paper of good texture, the next desideratum is the fluid or varnish by which it is to be coated and waterproofed. This is made by reboiling boiled linseed oil with litharge, acetate of lead, sulphate of zinc, and burnt umber, an ounce or two of each to a gallon of oil. No artificial heat is employed in drying. A square board is now procured, several inches broader than the size of the sheet to be prepared. Upon this the sheet is spread, and well covered, by means of a broad brush, with the mixture. The first sheet should be brushed on both sides. On this a second sheet is placed, slightly projecting over the first, at one end, in order to facilitate the lifting of the sheets when they are to be hung up to dry. This is also to be coated with the mixture. This process is to be repeated till a mass of sheets, from twenty to fifty in number, is prepared. The board is then to be carried to some unoccupied apartment, across which cords have been stretched, and the sheets are to be lifted *seriatim*, and attached by one end to the cords by means of bent slips of zinc or tinned iron. A very small space is sufficient to hold a hundred sheets or more. After twenty-four hours or more, it is ready to be taken down. As the sheets are found to be liable to stick to one another, they may be dusted with French chalk, which prevents adhesion. The addition of a little wax and turpentine renders the dusting or any other measure unnecessary. There is only one part in the above process where any manipulatory difficulty may at first be encountered, and that is in spreading, evenly and expeditiously, the dry sheet on the oiled one. This is easily overcome by working the brush freely from the centre to the circumference of the sheet.

The following are its most obvious advantages:

1. Its extreme cheapness does away with any inducement which might otherwise exist to employ the same piece more than once. A ream, or 480 sheets, of paper, costs from 7s. 6d. to 10s., and a gallon of the prepared oil about 3s.; so that each sheet costs the fraction of a halfpenny. This does not include the cost of manufacture, which would slightly increase the expense.

2. Its transparency. — When applied over dressings of a stump, or any cut surface, when hemorrhage may be feared, the danger can be seen at once, and obviated.

3. Its lightness. — It adds little to the weight of dressings, and it can cause little or no pressure on a tender surface. It is particularly useful in this respect for covering large burnt surfaces.

4. Its extreme adaptability. — It can be applied with great niceness to any part, so as to give rise to little or no inconvenience. When applied in any particular way, it retains the form impressed upon it.

5. It can be torn easily in any direction. In this respect it contrasts favorably with oiled silk and gutta-percha.

6. It can be made of any required strength by folding it one, two, three, or more times, without becoming inconveniently thick.

7. It possesses a certain amount of adhesiveness, which is increased by the heat of the body, and thereby more effectually prevents evaporation from wet applications.

ANTI-POISONING BOTTLES.

The following is a description of a new form of bottle, introduced in England, to avoid liability to accidental poisoning: In shape they are hexangular, with deep fluting or grooves running lengthwise along the bottle. To the sight and touch they instantaneously present most striking points of difference to any other kind of bottle. Vessels of this description, made of blue glass, are intended to be used for external applications only. For poisonous and powerful medicines, prepared or not from prescriptions, the dose of which is a teaspoonful and under, bottles similarly shaped and fluted, in white glass, are proposed to be employed. The bottles are provided with an entirely new contrivance, the effect of which is to make it impossible to pour out the contents otherwise than very slowly and gradually — almost drop by drop. This is accomplished by a very simple and inexpensive plan of contracting the neck of the bottle at the lower part, by the shoulder, and the mouth being of the usual size, the process of filling is but slightly affected by the contraction. The very deliberate and cautious action thus produced, will, it is believed, deter any one from taking over-doses of medicine; while it is difficult to imagine a case in which a person could pour out and take the whole contents of one of these bottles in mistake for something else. To illustrate the manner in which the new bottle acts, in comparison with ordinary ones, it may be mentioned that not more than a teaspoonful would come out in the same time that an ordinary vial would take to discharge its entire contents. A person being about to take a wrong medicine, say laudanum, contained in this new bottle, on proceeding to pour it out, would be struck by finding that instead of the whole draught having run into the wine-glass, as usual, merely a teaspoonful would have left the bottle; this would naturally lead to an examination of the label, and the consequent discovery of the error. Although to empty even a two-ounce bottle would tire the hand and arm of the holder, yet when only the proposed dose is sought to be withdrawn, the patience is not taxed in the slightest degree. This invention recommends itself to general notice on account of its thoroughly practical character.

INDUSTRIAL APPLICATION OF TALC.

A new application of the natural silicate of magnesia, known as steatite, or talc, has recently been made in France; namely, the manufacture of buttons, and even very handsome cameos, provided that, after its fabrication, the object be exposed during several hours to a white heat. By this strong calcination the steatite acquires sufficient hardness to strike fire with steel, and to resist the hardest file. It can be polished with emery, tripoli, and putty-powder, and may likewise be colored by different organic and mineral substances; thus, chloride of gold dyes it purple, nitrate of silver produces a black. By exposing the object to the deoxidizing blow-pipe flame, the brilliancy of the colors is much heightened.

SUBSTITUTE FOR LINSEED DRYING OIL.

Joseph W. Harmon, of Elizabethtown, N. J., has recently patented the following composition: He takes the residuum of the stills of candle factories as the important basis of his compound, which consists of certain products from palm-oil, lard, tallow, or other greasy matters remaining after the stearic acid has been taken off. To one gallon of this residuum is added one gallon, more or less, of rosin-oil, and these are melted together into one homogeneous mass; then three-quarters of a pound of litharge is added, and one pound and a half of umber, together with three pounds fresh slaked lime, and three pounds of oil-cake. The whole mass must be carefully mixed and boiled properly, and, after cooling, it is brought to a proper consistency by spirits of turpentine, when a good substitute for linseed drying oil is produced — the proportions varying, of course, according to circumstances.

SULPHURIZED OIL PAINT.

A sulphurized oil paint has recently been brought to the notice of the Society of British Architects. It is prepared by subjecting eight parts of linseed-oil and one part of sulphur to a temperature of 278°, in an iron vessel. This paint, when applied to the surface of a building of stone or brick, or to wood-work, with a brush, effectually keeps out the air and moisture, and prevents the deposits of soot and dirt. It is said that it improves the color of stone and brick, as well as preserves them.

EXPERIMENTS ON LUBRICATION.

A careful experiment, made on the Michigan Central Railroad, in regard to the comparative value of whale and metallic oils, resulted in showing a great difference in favor of whale-oil. Running a single train 103 days, one-half of the journals were lubricated with whale-oil, consuming 28½ gallons, costing 60 cents per gallon; the other half with metallic oil, consuming 27 gallons, costing $1.34 per gallon. — *Railroad Register.*

IMPROVED METHOD OF TANNING.

The *Scientific American*, translates from the Bavarian *Journal of Arts and Trades* the following account of a new method of tanning, recently introduced into Bavaria, by M. Knoderer.

It is well known that, by keeping the hides and the tanning substance from coming in contact with the air, the tanning process is materially facilitated. In order to effect this practically, the only way is to carry on the tanning in vacuo.

The vessel in which the tanning substance is kept has to be made air-tight, and, at the same time, no metal can be used except the very expensive one, copper. Iron, as well as zinc, is affected by the tanning substance; wood can only be used if its pores have been stopped by some varnish, which effectually prevents the air from entering the vessel after it has been pumped out.

M. Knoderer employs a cylinder, or barrel, rendered air-tight, and fitted with man-holes, air-pumps, etc., and an apparatus by which a rotation can be imparted to it. The operation of tanning is then carried on as follows: When the hides are taken from the wash, all the water contained in them is expelled by a powerful press. This done, they are placed into a barrel, together with the necessary amount of bark, or other tanning substance. A sufficient quantity of water is added to keep the contents of the barrel moist. The man-hole is now closed, and the air pumped out as clear as possible. As the rarefication of the air in the barrel proceeds, the pores of the hides are opened and prepared to receive the tanning substance. When the air has been rarefied as much as possible, a suitable quantity of tanning solution is admitted by means of a pipe, which passes through one of the trunnions on which the barrel is suspended. The barrel is then rotated half an hour, according to the quantity of hides in the same. After two or three hours' rest, the rotation is continued for a longer time; and so on, diminishing the time of rest and prolonging the time of rotation, until at last the rotation is continued to the end of the operation.

By thus combining three actions — the rarefication of the air, whereby the pores of the hides are opened, and the formation of gallic acid is prevented; the rotary motion, which facilitates the extraction of the bark, and which produces a continuous fulling of the hides; and the increased temperature which is produced by the motion, and whereby the combination of the gelatinous matter contained in the cellular texture of the hides with the tanning substance is greatly facilitated; — by this combined action, the tanning of the hides is effected to perfection, and with a saving of time, which is fully established by the following table, based on actual experiments:

	Time for tanning in vacuo without motion.	Time for tanning in barrel, when rotated.
Calf-skins, from	6 to 11 days.	4 to 7 days
Horse-hides,	35 to 40 "	14 to 18 "
Light cow-hides,	30 to 35 "	12 to 16 "
Cow-hides, middling,	40 to 45 "	18 to 20 "
Heavy cow-hides,	50 to 60 "	22 to 30 "
Ox-hides, light and middling,	50 to 60 "	20 to 30 "
Ox-hides, first quality,	70 to 90 "	35 to 40 "

At the same time, 75 per cent. of bark is saved by using the rotary barrel.

PREPARATION OF FRICTION MATCHES.

Wagner has published the following results of his investigations respecting the preparation of friction matches.

The ingredients used are phosphorus, a metallic oxide, nitre, and a cementing substance. One of the most important points in the preparation of the paste is the proportion of phosphorus. This should not be more than one-tenth or one-twelfth, when the phosphorus is melted in solution of gelatine, after the usual method. A much smaller amount of phosphorus is sufficient for the preparation of a good paste when the mode of preparation is altered. A greater effect is produced with a given quantity of phosphorus when it is very finely divided, on account of its greater inflammability in this state. A solution of phosphorus in bisulphide of carbon, leaves the phosphorus so finely divided on evaporation, that it ignites by contact with the air. However, when this finely divided phosphorus is mixed with solution of gelatine, the dry mass does not ignite when exposed to the air, although it is very inflammable. Apart from greater expense of a large amount of phosphorus, it is otherwise disadvantageous, owing to the production of a film of phosphoric acid, which renders the ignition of the wood or stearine more difficult.

Wagner recommends the following mode of preparation:

Eight parts phosphorus dissolved in bisulphide of carbon; 21 parts gelatine; 24 parts peroxide of lead, and 24 parts nitre.

He considers that the binoxide of manganese would be the best adapted to the preparation of the paste, since it contains a larger amount of oxygen than red lead or peroxide of lead, and as the metallic oxide serves only to maintain the combustion by yielding oxygen.

The nitre also is supposed to be serviceable only as a source of oxygen, and might therefore be replaced by some other nitrate; for instance, nitrate baryta, which, like the potash salt, is anhydrous. The amorphous phosphorus does not seem to be nearly so good for the preparation of matches as ordinary phosphorus, most likely in consequence of the necessity for the conversion of amorphous phosphorus into ordinary phosphorus before ignition takes place.

M. Canouil, of Paris, has patented the following mixtures without phosphorus for the manufacture of matches:

1.	Dextrine (British gum),	10 parts.
	Chlorate of potassa,	75 "
	Brown oxide of lead,	35 "
	Iron-pyrites,	35 "
	Water, q. s.,	

The chlorate, binoxide of lead, and pyrites are powdered separately, and then made into a paste with the solution of British gum. The latter may be replaced by gum or glue.

2. Matches with a Prepared Friction Surface. — The mass consists of

Chlorate of potassa,	7 parts.
Sugar of lead,	2 "
Bichromate of potassa,	2 "
Flowers of sulphur,	1 "
Gum,	6 "
Water,	18 "

They are mixed in the same manner as No. 1.

The friction cover is made from

Blacksmith's scales,	1 part.
Emory,	1 "
Chlorate of potassa,	6 "
Red glue,	1 "
Glue, q. s.,	

These are mixed, and painted on sheets of paper, wood, or metals.

3. Chlorate of potassa,	5 parts.
Powdered glass or flint,	3 "
Bichromate of potassa,	2 "
Gum, or British gum,	2 "
Water, q. s.,	

Prepared and mixed as under No. 1.

Matches dipped into the above mixtures are not ignited by concussion, nor by a temperature as high as 350° F.

PRICE'S PATENT CANDLE WORKS, LONDON.

The process of manufacturing candles, as carried on at the works of Price's Patent Candle Company, which we propose briefly to describe, is one of the most interesting sights in London. The two establishments are known as Belmont, at Vauxhall, and Sherwood, at Battersea. At Sherwood, the works cover over twelve acres of ground, six of which are under cover; and to this establishment we wish to carry our reader. The raw materials principally used in this manufactory are palm oil, cocoa-nut oil, and petroleum; the first, however, is used in by far the largest quantities, and to its preparation for the manufacture of candles we shall first draw attention. Palm oil, as imported, is of a deep orange color, of the consistency of butter at midsummer; hence it will not flow out of the cask like the more fluent oils; and to assist this costive tendency — the first care of the manufacturer — the following plan is pursued: the casks of oil, as they arrive from the docks, are transferred to a large shed, the floor of which is traversed, from end to end, with an opening about a foot wide, which is in communication with an under-ground tank. Over this opening the bung-hole of each successive cask is brought, and the persuasive action of a jet of steam thrown into the mass speedily liquefies and transfers it to the under-ground tank. Herefrom the oil is pumped by steam-power to what may be called the high service of the establishment, gravitation being sufficient to make it carry itself to the distilling-rooms. Palm oil and all animal oils are made up of three elements,

—a very hard body, called stearic acid, a liquid termed oleic acid, and a white, sirupy body, which acts as a base to the other two. Now these three companions agree admirably in nature, but the moment art attempts to convert them to her own purposes, in the formation of candles, a little difficulty arises; the glycerine turns out to be the slow man of the party; like many good men and true, its illuminating power is found to be greatly deficient to that of the company it is in, and hence its ejection is voted by the scientific candle-maker. Not long since, this was performed by the process termed lime saponification. By this method, cream of lime was intimately mixed with the fatty matter to be acted upon, and the principle of chemical affinities coming into play, the different ingredients, like the dancers in a certain coquettish waltz, forsook each other for new comers; thus the stearic and the oleic acids waltzed off with the lime, leaving the glycerine by itself. No sooner, however, was this arrangement completed, than it was broken up by the introduction of strong sulphuric acid, which in its turn waltzed away with the lime, leaving the fat acids free. This was an expensive process, however, inasmuch as, independently of the cost of the lime and sulphuric acid, the stearic acid obtained was comparatively small in quantity, and the whole of the glycerine was wasted. The next step in the process is known as the sulphuric acid saponification, the fat acids being exposed to sulphuric acid, at a temperature of 350° Fahrenheit. By this process, the glycerine is decomposed, the fats are changed into a dark, hard, pitchy mass, the result of the charring of the glycerine and coloring matters, its final purification being effected in a still, from which the air is excluded by the pressure of superheated steam. In 1854, this process was brought to its present perfect state, by passing this superheated steam directly into the neutral fat, by which means it was resolved into glycerine and fat acids, the glycerine distilling over in company, but no longer combined with them. This was an immense step gained, inasmuch as the glycerine, thus for the first time obtained pure, and in lagre quantities, was raised from being a mere refuse product which the candle-maker made every effort to destroy, into a most important body, of great use in medicine and the arts; indeed, like gutta-percha, or vulcanized India-rubber, it is no doubt destined to play a great part in the affairs of the world, and is far more valuable than its companion bodies, the stearic and oleic acids. We may here mention that it is the presence of this very glycerine in the old mould-candle, and in the still existing "dip," which produces the insufferable smell of the candle-snuff. A candle, when blown out, exposes the smouldering wick to the action of the atmosphere, and the glycerine distills away in the smoke. Yet here we see as much as six tons distilling at one time, in one room, without the slightest smell, in consequence of the process taking place in a vacuum. Imagine, good reader, what would be your sensations sniffing at six tons of the concentrated essence of candle-snuff!

The two acids, the hard stearic and the fluent oleic, have still to be separated, as it is only the former which is, from its high melting point, calculated to form the true candle material. The cooled fats, forming a thick, lard-like substance, having been cut in appropriate slices by means of a revolving cutter, are then, by an ingenious labor-saving apparatus, spread upon the surfaces of cocoa-nut mats, which are taken away in trucks to the press-room. In the press-room these piles are subjected to hydraulic pressure, which slowly squeezes out the oleic acid, leaving the stearic acid behind, in the form of thin, hard, white cakes. These are remelted. The arrangement by which the melting process is carried on is novel in the extreme.

Into each vat a long coil of pipe depends, which admits into the fatty mass a hissing tongue of steam, which quickly liquefies it.

The stearic oil, or candle-making material, of the cocoa-nut, is extracted simply by pressure, no distillation or acidification being required. The well-known "composite candles" of this form are made from a combination of this oil at low melting point and the hard stearic acid of the palm oil, their relative proportions varying according to the varying condition of the price of each in the market. We have yet to speak of the production of candle material from the novel substance petroleum, a natural product of the kingdom of Burmah, where it wells up from the ground, like naphtha, to which it bears a very striking resemblance. It is a mineral substance, composed of a number of hydro-carbons, varying in specific gravity and boiling points. The preparation of this dark-orange-colored liquid is conducted simply by distillation; a number of very different products coming over at different temperatures, ranging from 160° to 620° Fahrenheit. The first product to distil is the extraordinary liquid termed sherwoodole, a detergent very similar to benzine collas, the well-known glove-cleaner, removing grease-stains like that liquid, but without leaving any smell behind. A very beautiful lamp-oil, termed Belmontine oil, is the next product. This oil burns with a brilliant light, and, as it contains no acidifying principle, it never corrodes, like other oils, the metal work of the lamps. The two next products are light and heavy lubricating oils, used for lubricating spindles, at a much cheaper rate than the ordinary oils now in use. The last product to distil is termed Belmontine, a new, solid substance, of a most beautiful translucent white, somewhat resembling spermaceti, and forming a candle of a most elegant appearance, very similar to the paraffine lately distilled from peat.

The candle-making material being now fit for moulding, let us introduce the reader to this department of the manufactory. A room, 127 by 101 feet, is fitted up, throughout its entire extent, with parallel benches, running from one end of the department to the other. In these benches, ranged close together in a perpendicular direction, are the candle-moulds, which, viewed from above, their open mouths present the appearance of a vast honeycomb, commensurate with the size of the room itself. Along the top of each bench, 101 feet in length, there runs a railway, and working on this railway is what may be termed a candle locomotive, — a large car, running on wheels, containing hot candle material. The wicks having been adjusted truly in the long axis of the mould, the locomotive now advances, and deposits in each line of moulds exactly enough material to fill them, proceeding regularly from one end of the bench to the other, setting down at different stations its complement of passengers. After a sufficient time has elapsed to allow them to cool, preparations are made to withdraw them from their moulds. This is done in the most ingenious manner: in an apartment close at hand, an iron boiler of great thickness is filled with highly compressed air, by means of a pump worked by a steam-engine; pipes from this powerful motive communicate with every distinct candle-mould, and convey to it a pressure of air equal to 45 pounds to the square inch, about the surface of the diameter of a candle. These candle-moulds and the air-pump constitute an immense air-gun, containing thousands of barrels, each barrel loaded with a candle. The turning of a cock, by boys in attendance, lets off these guns, and ejects the candles with a slight hissing noise. This fusillade is going on all over the room throughout the entire day, and in the course of that time no less than 188 160 candle projectiles, weighing upwards of fourteen tons, have been shot forth.

The wicks of these candles are made very fine, the high illuminating power of the stearic acid enabling a fine wick to give far more light than the coarse wick of the common "dip." Again, the particular twist given to the wick when it is plaited, and the wire with which it is bound, causes it to project from the flame when burning. Palmer's candle-wicks are twisted upon each other, the relaxation of the twist as it burns answering the same end, — the projection of the burning cotton through the flame and into the air, which immediately oxidizes it, or causes it to crumble away, thus obviating the necessity of snuffing. Here we see an extraordinary example of the manner in which a very simple improvement will sometimes interfere with a very large trade, — the simple plaiting of a wick doing away with one of the most extensive branches of hardware in Birmingham and Sheffield.

The candles are sent forth into the market in pound packets, packed in highly ornamental boxes. The manufacture of these boxes is not the least interesting part of the manufactory. In consequence of the duty on paper, it was necessary to look about for some cheap substitute, and deal was finally adopted. A plank 1 foot wide by 4 long, is planed into no less than 140 shavings of that size; these are pasted on one side with a very thin straw paper, so as to form the hinges for the sides. They are cut out by a machine to the required sizes, and rapidly made up afterwards by hand, the cost being truly insignificant. For the manufacture of the night-light cases, the shavings are rolled into a cylinder, pasted, and then cut off to the required lengths in a hand-lathe. — *Once a Week.*

CUTTING FILES BY MACHINERY.

At a recent meeting of the Institution of Mechanical Engineers, London, a machine for cutting files, the invention of M. Bernot, of Paris, was exhibited and described by Mr. Greenwood, of Leeds.

He said the chisels could cut five times as many files as by hand, without being resharpened. The teeth cut on the files were raised with perfect regularity, and were fully better than those made on hand-made files. Twelve of such machines are now in operation at Douai, France, one in Brussels, Belgium; and the relative cost for cutting files by them was eight cents per dozen; by hand, sixty-four cents. Mr. Greaves, who was present, said he had been engaged in file-cutting for twenty-five years, and he could state that this machine could cut as good files as those made by hand, if it were well attended. It was also stated that various such machines had been tried both in America and England, none of which had been so successful as the one of M. Bernot. In most of the machines heretofore made, the idea eliminated in them was an iron hand holding a chisel, and an iron hammer striking blows on it. The vibration of the chisel, by this mode, caused irregularity in the teeth. In the new machine, the blow is given by the pressure of a flat steel spring pressing upon the top of a vertical slide, at the lower end of which the chisel is firmly fixed. This slide is actuated by a cam, which makes about a thousand revolutions per minute, and obviates all irregular vibrations.

BEAUCHÉ'S MACHINE FOR MANUFACTURING CIGARS.

The principle of this machine, the invention of Louis Beauché, of Paris, France, consists in rolling the pieces of tobacco-leaf between two elastic endless bands, which run in opposite directions. Two pairs of these endless bands are prepared, one for rolling together the filling of the cigar, and the other for winding the wrapper. The frame of the upper band is hung on hinges at one side, so that it may be turned open. The operator gathers a bundle of pieces of tobacco-leaf, previously cut of the proper length, and places them upon the lower band, with a smooth piece of leaf loosely around them. He then presses down the frame of the upper band, bringing it into gear with the lower band, where it is held by a latch. He then throws the two bands into gear with the driving machinery, and the bundle of tobacco is rapidly rolled by the two bands between which it is pressed, which run in opposite directions. The effect of this operation is to press the bundle together and sufficiently tighten the inner wrapper about it. The apparatus for winding the wrappers is provided at one end with a hollow metallic cone, partly formed with a revolving roller, for finishing the pointed end of the cigars, and giving a twist to the wrapper which prevents it from unwinding. The upper band of this apparatus being turned open, the wrapper, previously cut of the proper reniform shape, is placed with one end upon the lower band near its end, and the filling, prepared as before described, is then laid upon it, and the apparatus is closed and thrown into gear with the driving machinery. The two endless bands, running in opposite directions, roll the cigar between them, and as the wrapper is held at an angle by the operator, it is drawn in and wrapped around the filling, forming the cigar. The rotary motion is continued until the pointed end of the cigar is rubbed smooth, and handsomely finished by its revolutions in the metallic cone. The upper band now being turned open, the cigar is taken out and the square end cut off, when it is ready for market. — *Scientific American.*

THE WESTMINSTER CLOCK.

The clock recently constructed by Mr. Dent, of London, for the new House of Parliament, Westminster, London, is one of the most complete and accurate pieces of workmanship ever put together. When in its place, the clock will report itself to Greenwich every day by a galvanic action at the striking of some given hour, and when once fairly going and regulated, it will not require altering to the extent of a second per week. It has been erroneously stated that the dial-faces of this clock are the largest in the world. This is not the case, as they are considerably less than one which exists at Mechlin, in Belgium. But then the Westminster has four dial-plates, and in this respect it stands at the head of all other clocks; for no other one in existence has to work four dials, 22½ feet wide, for eight and a half days. The hands of the Westminster clock weigh each about 2 cwt., and at thirty seconds, or half minute, the ponderous minute-hand moves 7 inches on the circumference of the dials; but the movement will be gradual, instead of a sudden jerk, the momentum being checked by what is known as the "gravity escapement." The frame of the check is 15½ feet long, 4 feet 7 inches wide, and 19 deep. The whole of the mechanism of the clock weighs nearly 4 tons; but motion is given to the whole by the action of a small spring, weighing one-sixth of an ounce. The pendulum weighs 6 cwt.; but, so accurate are all the adjustments, that when it is required to regulate the clock, the addition or removal of a piece of metal weighing one ounce will accelerate or retard it at the rate of a second per day. The winding up of this clock is a matter of no small importance, inasmuch as the weight to be lifted will not be less, including friction, than from three to four tons; and the time required for the operation will be at least five hours. The expense, therefore, if done by hand, will be a considerable item. The use of a small steam-engine has been suggested.

GLAZED WATERPROOF CLOTH.

A patent has lately been taken out in England for making waterproof glazed cloth, to imitate leather, by the following process: About three ounces each of litharge, brown umber and hydro-protoxide of manganese, are subjected slowly to a boiling action in one gallon of linseed oil, for about three hours. It is now spread over the surface of twilled cotton cloth laid on a table, with a sponge, and then hung up in a warm room to dry. After this, it is subjected to a second coat of the same oil varnish, rendered black with lampblack. A small scraper is employed to put on the second coat, as it is a little thicker than the first. If the varnish is desired to dry quick, it is thinned with turpentine. When the second coat is dry, the cloth is polished with pumice stone and water, to render its surface smooth and close. Several coats of this varnish are put on in a similar manner, each being dried before the other is applied. The finishing, or top varnish, is made of linseed oil boiled with umber, litharge and Prussian blue, thinned with turpentine. The finishing operation is running the cloth between two engraved metal rollers.

IMPROVEMENT IN MUSICAL INSTRUMENTS.

A patent has lately been taken out in England, by J. Robertson, for an invention which relates to a most simple method of increasing the volume and richness of tone of musical instruments. As applied to violins or similar stringed instruments, the sounding-board is made somewhat thicker than those in common use, and the inside is deeply grooved, longitudinally, in parallel lines. The grooving operation removes the white fibreless wood, leaving the more fibrous portion standing. The back of the instrument may also be grooved; but the sounding-board is the most essential feature of the improvement. The sounding-boards, and their supports, of piano-fortes may be grooved in a similar manner, and with good results. The grooves leave the spaces of wood between them in such relative positions, that an increased resonant vibratory action is thereby caused, which thus greatly improves the tone of the instrument. — *Scientific American.*

ENGRAVING OF ROLLERS FOR CALICO-PRINTING.

A Providence correspondent of the *Boston Journal* states that a mechanical arrangement has been invented by Mr. Milton Whipple, and improved by Mr. Thomas Hope, of Providence, by which the engraving of rollers used in printing calicos and delaines can be accomplished " in one-quarter the time formerly employed, and a great reduction of labor and expense. The surface of the copper rollers are covered with three coats of asphaltum paint before being placed on the machine. The mechanism is so arranged that upon tracing an index figure, which only requires one person to attend upon the sketch or pattern to be engraved, it forms a connection with several diamond points placed above the roller, and causes them to move in the same manner with the index. They thus scratch the lines of the pattern through the thin covering of asphalt upon the copper surface. When completed, the rollers are placed in dilute acid, which etches into the copper where the paint has been removed, and thus accomplishes the engraving."

NOVEL COAL SIFTER.

A novel sifter, only requiring the refuse from the grate or stove to be poured into a hopper, when it does its own sifting by gravity, is constructed with an inverted cone at the bottom, and a direct one over it, both being made of woven wire, and forming the screen. These are surmounted with a hopper, into which the coal and ashes are poured, when they fall upon the apex of the cone, slide down its periphery, discharge round the inside base of the inverted cone, and so on, the ashes falling through an orifice at its lowest point. The screens are so arranged as to be easily removed and cleared, should they become clogged. It might be applied by farmers to assorting such seeds, fruits, potatoes, etc., as are round enough to roll over the cones. For coals it must be of great value, should it not choke too often by filling the meshes with irregular pieces. — *N. Y. Tribune.*

IMPROVEMENT IN THE MANUFACTURE OF STARCH FROM CORN.

M. Watt, of London, has obtained a patent for making starch from Indian corn in the following manner: He steeps the corn in water ranging in temperature from 70° to 140° Fah., for about a week — changing the water at least once in every twenty-four hours. A certain amount of acid fermentation is thus produced, causing the starch and refuse of the corn to be easily separated afterwards. The swollen corn is ground in a current of clean soft water, and the pulp passed through sieves, with the water, into vats. In these the starch gradually settles to the bottom; the clear water is then run off by a tap, and the starch gathered and dried in a proper apartment for the purpose.

FLEXIBLE IVORY.

According to the process of Geisler, in Switzerland, articles of ivory are placed in a solution of phosphoric acid of 1·130 specific gravity, and left there until they assume a transparent aspect. After this, they are taken from the acid, washed off in water, and dried with soft linen cloth. The articles are now as soft as thick leather; they become hard in the open air, and when placed in warm water they assume their former softness.

The application of such ivory for nipples of nursing-bottles, or for covers of sore breasts, and for similar articles, is of importance. The change evidently consists in a solution of a portion of the lime, producing a composition containing a smaller percentage of lime than ivory.

ON THE OXIDATION OF IRON.

At a late meeting of the Manchester Philosophical Society, H. M. Ormerod produced two specimens of iron used in buildings, which have become so oxidized as to injure the structures in which they had been used. An iron cramp, taken from a buttress of the Manchester Parish Church, had become treble its own thickness by rust, and had thus split the building in the centre, and lifted about twelve feet of the wall. It was inserted about ninety years ago. The other piece of iron was a small wedge, taken from the steeple of St. Mary's Church; it was three-eighths of an inch thick originally, but had increased to seven-eighths of an inch with the rust. There were several wedges used, and these had lifted the stones which they were meant to keep in their places, and some of them had even been split by the slow but certain force of rust expansion. The steeple was erected in 1756, and the upper part had become so ruinous by these wedges, that it had to be taken down by the city surveyor.

Destructive Action of Oxides of Iron on Wood. — M. Kuhlmann, at a recent meeting of the French Academy, drew attention to the decay of the wood of ships in the places adjoining iron nails and bolts; while no such decay took place where wooden or copper bolts were employed. His observations were made on ships at Dunkirk. For the purpose of explaining these facts, he had instituted numerous experiments on the action of sesqui-oxide of iron on various vegetable products, the results of which appear to prove that the sesqui-oxide brings the oxygen of the atmosphere into contact with the organic matter of the wood, and thus hastens its destruction. The oxide becomes, in some degree, a kind of reservoir of oxygen, filling itself at the expense of the air, and emptying itself to support the combustion of combustible bodies. To avoid this injury to the wood of ships, the nails etc. should either be coated with zinc, or made of copper.

ON THE STRENGTH OF IRON AND STEEL.

At the meeting of the British Association for 1859, Prof. Macquorn gave an abstract of a set of experiments conducted by Robert Napier and Son, (the eminent engineers) of Glasgow, to test the strength of iron and steel bars and plates. The following are the most important results arrived at, arranged in a tabular form, — the weights in each case being applied gradually.

TABLE A — IRON BARS.

Districts.	Tenacity in lbs. per sq. in.
Yorkshire, strongest,	62,886
" weakest,	60,075
" forged,	66,392
Staffordshire, strongest,	62,231
" weakest,	56,715
West of Scotland, strongest,	64,795
" weakest,	65,655
Sweden, strongest,	48,232
" weakest,	47,855
Russia, strongest,	56,805
" weakest,	49,564

TABLE B — IRON PLATES.

Yorkshire, strongest lenghthwise,	56,005
" weakest,	52,000

TABLE B — IRON PLATES.

Districts.	Tenacity in lbs. per sq. in.
Yorkshire, strongest crosswise,	50,515
" weakest, "	46,221

TABLE C — STEEL BARS.

Steel for tools, rivets, etc.,	
" strongest,	132,909
" weakest,	101,151
Steel for other purposes,	
" strongest,	92,015
" weakest,	71,486

TABLE D — STEEL PLATES.

Strongest lengthwise,	94,289
Weakest lengthwise,	75,594
Strongest crosswise,	96,3[illegible]8
Weakest crosswise,	69,082

NOTE. — The strongest lengthwise is the weakest crosswise, and *vice versa.*

ON THE USE OF PINE AS AN ORNAMENTAL WOOD.

In the royal palace at Potsdam there is a suite of apartments, the whole wood-work of which, as well as the standing furniture, consists of yellow deal, not painted, but polished, and exhibiting the natural color and grain of the wood. In England some progress has been made towards the introduction of this system in lieu of the coarse imitative efforts of the painter and grainer. London furniture dealers manufacture bedroom furniture in yellow pine, French polished, for which they find a ready sale, the preference it receives being due to its beauty only, and not its cheapness; for the necessity of using in it only the choicest timber, free from knots and blemishes of all kinds, makes the price nearly as high as that of mahogany.

RECOVERING WOOL FROM WORN FABRICS.

A patent has been taken out in England, by R. Bell, for recovering wool from old worn-out clothes, composed of cotton and wool, such as delaines. The patentee takes muriate of manganese, such as is ordinarily obtained as a residuum in the manufacture of bleaching-powder; the rags to be treated are then steeped in a solution of this, which entirely decomposes the vegetable or cotton portions, and leaves the woollen fibres uninjured. The liquor is then strained through a sieve that retains the wool, which is afterwards washed, dried, and may be used for shoddy or other purposes in making new goods out of old materials, just as new paper is made out of old rags.

NATURAL PHILOSOPHY.

ATMOSPHERIC ELECTRICITY. — BY JAMES P. ESPY.

It has not yet been ascertained by electricians, so far as I know, what is the cause of atmospheric electricity; those, however, who have studied my theory of storms, and agree with me that there is an upmoving current of air in the centre of all storms, kept up by constant evolution of latent caloric, as the vapor condenses by the cold of diminished pressure as the air ascends with its vapor in it, will agree with me that it follows as a corollary from the following experiments, that electricity must be generated simply by the up-moving current of air from the surface of the earth, especially if it be violent enough, as it frequently is, to carry up drops of rain with it to a great height.

It is well known that all bodies, as Dr. Alex. Palagi, of Bologne, says, in their natural state, give signs of positive electricity, when separating from the soil, and of negative, when approaching it. In the twenty-third volume of *Geneva Archives of Science*, pp. 283 and 382, it is stated that Volpicelli caused a ball of metal to revolve on a horizontal axis of glass, at a distance from that axis one metre and a half, and connected by means of a copper ribbon with a Volta's condenser, — during a demi-revolution ascending, detaching it when descending, — and in four demi-revolutions he collected positive electricity enough to make the straws diverge so as to touch the interior sides of the electrometer.

When the connection was made with the ball descending, negative electricity was obtained.

Now, in all storms, especially where floods of rain descend, there are at the sides and under those parts of the cloud where floods of rain descend, down-moving currents of air; and this will account for the sudden change of electricity, from positive to negative, so well known to all observers. Moreover, as there are thousands of up-moving currents of air every day, nearly all over the earth, this theory will account for the upper air being almost always positively electrified; for a body cannot be removed upwards from the surface of the earth without becoming positively electrified; and, *vice versa*, a body cannot descend towards the surface without becoming negatively electrified. It would be well to examine the electric state of the air in the belts of high barometer, where the air must in general be descending, and also in the *annulus* of storms, where the barometer stands above the mean (and of course the air must be descending there), to see if the electricity is not sometimes negative; and if so, electricity may become a means of predicting storms. — *Jour. Franklin Institute.*

ON THE FORMATION OF FULGURITES.

In June 1859, a violent thunder-storm occurred at Oldenburg, Germany. On the Haute River, four workmen were on board a dredging-boat, occupied in deepening the new bed for the river, when all at once the lightning struck the shore close to them; they appeared at the same instant to be struck violently on the head with a soft body. Having recovered from the shock, they perceived smoke rising from a point of the shore; they ran to the place, and in the burnt grass they discovered, about seven yards from the water, two holes near one another, and their edges surrounded with a whitish sand. They dug carefully, and found in each hole a tube, that they were unable to extract entire, on account of its fragility; but they followed them as far as the marshy soil situated under the sand. These were two fulgurites, having the ordinary appearance, being round and as thin as sheets of paper, perfectly enamelled on the inside, but garnished on the exterior with grains of sand; there were also, here and there on the outside, spots of green oxide of iron, of the color of bottle-glass. The soil was formed of about three inches of vegetable earth on the surface, then came twenty inches of white sand, and lastly the boggy earth. The fulgurite began and ended at the superior and inferior surfaces of the bed of sand. The principal fragments have been placed in the museum of Oldenburg.

NEW ELECTRIC LIGHT.

Galignani's *Messenger* thus describes a new apparatus for producing an electric light, recently exhibited in Paris: "The principle on which it is constructed is electro-magnetism; that is, the property which electricity has, under certain circumstances, of producing magnetism inversely and conversely. Suppose a wire, many yards in length, and covered with silk, to be coiled round a hollow cylinder, and let a magnetic bar of steel fit like a core in the hollow; then, each time the core is introduced into the cylinder, an electric current passes through the wire; and though of short duration, its intensity is proportional to the length of the coil. Again, each time the core is taken out, another electric current is produced in an inverse direction; so that by constantly inserting and drawing out the core, an indefinite number of electric currents may be obtained. If the core, instead of being a magnetic steel bar, consists of a bar of unmagnetized iron, and an electric current be made to pass through the coil of wire, then an equally singular effect is obtained; the iron core becomes so highly magnetized, that it will raise heavy bars of iron, and the attraction is so great that it requires a strong man to wrench the bar from the magnetized core. The effect, however, ceases as soon as the electric current is interrupted. It is clear, from this, that it is much easier to obtain a permanent effect by magnetizing and unmagnetizing in this way, than by alternately inserting and withdrawing out a steel magnet, as in the former method. And the only difficulty that remains is to give the apparatus a convenient mechanical arrangement. This is done as follows: suppose a hexagonal frame placed horizontally on legs, like a table. At each of the angles let there be one of the electro-magnets, or cylinders of induction, with wire coiled round, as above described, and supported by an inner frame, so that the whole may have the appearance of a horizontal wheel, with electro-magnets for spokes; only the nave is supplied by a hollow frame. In this hollow there fits a drum, revolving on a vertical axis, and carrying on its circumference eight bars of soft iron, which, in going round, come very nearly in contact with the electro-magnets. Now, from what has been said, it is easy to understand, that whenever one of these bars approaches an electro-magnet, it is attracted laterally until it comes in front of it, when the action of the electro-magnet ceases; but at that instant the attractive power of the next electro-magnet commences, and so on. Now, as each of the bars thus receive six impulses in one revolution, and as there are eight bars, the number of impulses received in all by the revolving drum is forty-eight, which impulses occurring in a few seconds, produce, in point of fact, a continuous motion. Now, if the place of the spokes be occupied, not by cylinders of induction, but by magnetized iron bars, the cylinders being fixed on the revolving drum, and their hollows filled with cores of unmagnetized soft iron; then each time a cylinder comes in front of a magnet, the soft iron becomes magnetized, and generates a current in the coil, which ceases as soon as the cylinder changes its place. Now, as the motion is continuous, and the revolution rapid, each ceasing current is replaced by another, and so on, *ad infinitum*. These currents are concentrated into a common conductor, and by this means an amount of electricity is obtained which will melt an iron wire three yards long and one-fourth of a line in diameter. An apparatus, consisting of thirty-two cylinders and twenty-seven magnets, and made to revolve two hundred and thirty-eight times in a minute, produced a permanent and regular light, equal to that of two hundred and thirty tapers. Such, indeed, was the intensity of the light produced, that a lighted candle being held against a white wall, not only the shadow of the candle, but the shadow of the flame, was projected on the wall by the electric light. The cost at which a light of this intensity is produced, is stated not to exceed fifteen centimes per hour, for each apparatus."

CURIOUS ACTION OF ATMOSPHERIC ELECTRICITY.

In front of the Bibliothèque Impériale, at Paris, there exists an open space upon which the Opera-house formerly stood. The place is ornamented with a bronze fountain, which has been coated with copper by the electrotype process. The operation was carried on in a workshop built for the purpose, at the neighboring village of Auteuil. While the upper basin, from which the water flows, through sixteen tigers' mouths was in the bath of sulphate of copper, a violent thunder storm burst over Paris, and the lightning fell close to the workshop in question. Immediately after the storm had subsided, M. Oudry had the copper solution poured off, in order to examine the vase, and to assure himself that the electric fluid had not deranged the deposit: he was extremely surprised to discover that the copper had been deposited on the tigers' heads in streaks or lines about the twenty-fifth of an inch in height, separated by equal intervals, and so happily arranged that they form a veritable tiger's skin, covered with hair, in as perfect a manner as if they had been produced by the hands of a skilful engraver. This curious effect of the electric fluid has accordingly been allowed to remain, and the result is a great addition to the expressive character of the work.

EFFECT OF PRESSURE ON ELECTRIC CONDUCTIVITY.

Prof. Wartmann, of Geneva, Switzerland, has recently made a series of highly interesting experiments on the effect of pressure on the electric conductibility in metallic wires. The method which he adopted in his experiments is that known as the electrical bridge. The current of a Bunsen's battery of six large cells was divided between the wire to be tested (a very soft copper wire, 0·05 of an inch in diameter, covered with gutta-percha) and another conductor, both being covered with a delicate Ruhmkorff's galvanometer, so that the needle remained on the zero point. All contacts were made invariable by solderings. No sensible effect being determined by the pressure of nine atmospheres in a picrometer, a press was used to produce compressions superior to four hundred atmospheres, consequently greater than that experienced by an electric wire immersed in the ocean at a depth of 12,420 feet. The wire, besides its ordinary coating, was further protected by two coverings of thick gutta-percha placed between the steel plates which held it. The experiments have shown: 1. That a pressure of thirty atmospheres diminishes the electrical conducting power of a copper wire. 2. That the effect increases with the pressure. 3. That the diminution is the same for each compression, as long as the latter is constant. 4. That the primitive conducting power is exactly restored when the pressure vanishes altogether.

ON THE CHEMICAL EFFECTS OF ELECTRIC DISCHARGES.

Plücker has published, in successive parts, the results of an elaborate and very interesting investigation of electric discharges in tubes containing rarefied gases. For the details we must refer to the original papers, which do not admit of condensation, and content ourselves with giving, in the author's own words, the results, which are most interesting to chemists.

1. Certain gases (oxygen, chlorine, bromine and vapor of iodine) combine more or less slowly with the platinum of the negative electrode, and the resulting compounds are deposited upon the surrounding sides of the glass tube. When the gases are pure, we approximate in this manner to a perfect vacuum.

2. Gases which are composed of two simple gases (vapor of water, ammonia, protoxide of nitrogen, deutoxide of nitrogen, nitrous acid), are immediately separated into their components, and then remain unchanged, if they do not (as ammonia) unite with the platinum. If one of the gases be oxygen (as in steam and the different oxides of nitrogen), this gradually disappears, and only the other gas remains.

3. When the gases are composed of oxygen and a solid simple substance, complete decomposition by the current takes place but slowly, the oxygen going to the platinum of the negative electrode (sulphurous acid, carbonic acid). Carbonic acid at first splits instantly into the lower gaseous oxide and into free oxygen, which combines gradually with the platinum. Carbonic oxide gas is then slowly decomposed by the combination of its oxygen with the negative electrode. The results above mentioned were obtained by means of the so-called Geissler's tubes, which are simply glass tubes of various forms, containing rarefied gases, and provided with platinum wires fused into the glass. The electric currents were partly derived from the electric machine, and partly from Ruhmkorff's apparatus. Finally, the results themselves are directly deduced from the prismatic analysis of the light of the simple and compound gases, the spectrum obtained being simple, or composed of two distinct and superposed spectra, according as the discharge passes through a simple gas or a mixture of two. — *Pogg. Ann.*, cv. 67. — *Silliman's Journal.*

ON THE DISCHARGE OF ATMOSPHERIC ELECTRICITY THROUGH GAS-PIPES AND MAINS.

In a paper on the above subject read before the American Association, at Springfield, 1859, by Prof. B. Silliman, Jr., the author stated that, in June 1858, a thunder-bolt fell on the spire (227 feet high) of a church in New Haven, and was conducted by a rod to a point less than 25 feet from the ground. Here, owing to an imperfect arrangement of the rod, it passed through a brick wall 20 inches thick, to a gas-pipe on the wall opposite. By the new channel thus forcibly gained, the discharge was conducted to the main pipes of distribution, and no further immediate effects were seen. Soon afterwards, however, the escape of gas on the street in front of the church was noticed, as well by the odor as by the death or the sickly condition of the shade-trees lining the street. Upon opening the ground, it was found to be saturated with gas, and every joint in the whole length of the street, some forty in number, was discovered to be leaking profusely. The inference seemed unavoidable that the leakage was occasioned by the electrical discharge.

During the last week of July 1859, another very energetic discharge fell upon a house in George Street, New Haven, which was supplied with gas, and while but little injury was done to the dwelling, and none at all to its inhabitants, the gas mains in the whole street, to the number of over sixty joints, were found to be leaking profusely. In June of this year, the new church spire struck in 1858, was again the subject of a second accident of this sort; the wall of brick was again perforated near the same place, and in the same manner as last year, with the additional circumstance that the gas-pipe in the church was fused or burnt off at the point of contact of the escaping discharge, and the gas being thus set on fire, in its turn set fire to the wall casing behind which it ran. But either because the violence of the discharge was less than last year, or because a portion of it found a lateral escape, there was no effect produced in disturbing the joints of the street mains.

This effect Prof. Silliman thought was plainly to be referred to the sudden expansion of the gas in the main, at the point of electrical discharge. Notwithstanding the enormous extent of the metallic circuit, — over 20 miles of pipe from 3 to 12 inches in diameter — all buried in moist earth, the restoration of electrical equilibrium could not be so accomplished without this hitherto unobserved effect of expansion on the gas in the mains.

Prof. Henry remarked, that the introduction of gas-pipes into our houses brought a new source of danger to human life from electrical discharges. The rod should not merely terminate in the earth, but he had been in the habit of recommending that it be placed in connection with the water or gas-pipes.

DAMAGE BY LIGHTNING AT SEA.

Sir W. Snow Harris, under the direction of the House of Commons, has published a list of the ships of the Royal Navy damaged by lightning between the years 1790 and 1840. The list, although not complete, embraces no less than 280 cases, the particulars of which are full and reliable. These cases include 106 ships of the line, 70 frigates, 89 sloops and brigs, 2 schooners, 7 cutters, 5 hulks, 5 ships in ordinary, 5 steamers, two of which were iron; so that every variety of vessel has been subjected to lightning. In these 280 cases, there were damaged or destroyed, at least 185 lower masts, of which 135, or nearly three-fourths, were lower masts of line-of-battle frigates. Not less than 100 were completely ruined as masts; 180 top-masts were ruined or damaged; more than two-thirds thereof belonging to ships of the line and frigates, and about 150 top-gallant masts were destroyed. In addition to this amount of damage, large quantities of rigging, sails, and other stores, were either damaged or destroyed. In about one-eighth of the 280 cases, the ships were set on fire by the lightning, either in the masts, or in the sails or rigging; and in some instances the ships were severely damaged in the hull. The total loss on these 280 cases, in material alone, has been estimated at about $700,000.

ON THE ELECTRIC-CONDUCTING POWER OF THE METALS.— BY M. MATTHIESSEN.

The following values for the conducting power of the metals were determined in the Physical Laboratory at Heidelberg, under the direction of Professor Kirchhoff, by the same method as is described in the *Philosophical Magazine*, February 1857:

	Conducting Power	at Temp. in Centigrade degrees.
Silver,	100	0
Copper, No. 3,	77·43	18·8
Copper, No. 2,	72·06	22·6
Gold,	55·19	21·8
Sodium,	37·43	21·7
Aluminum,	33·76	19·6
Copper, No. 1,	30·63	24·2
Zinc,	27·39	17·6
Magnesium,	25·47	17·0
Calcium,	22·14	16.8
Cadmium,	22·10	18·8
Potassium,	20·85	20·4
Lithium,	19·00	20·0
Iron,	14·44	20·4
Palladium,	12·64	17·2
Tin,	11·45	21·0
Platinum,	10·53	20·7
Lead,	7·77	17·3
Argentine,	7·67	18·7
Strontium,	6·71	20·0
Antimony,	4·29	18·7
Mercury,	1·63	22·8
Bismuth,	1·19	13·8
Alloy of Bismuth 32 parts, Antimony 1 part,	0·884	24·0
Alloy of Bismuth 12 parts, Tin 1 part,	0·519	22·0
Alloy of Antimony 2 parts, Zinc 1 part,	0·413	25·0
Graphite, No. 1,	0·0693	22·0
Graphite, No. 2,	0·0436	22·0
Gas-coke,	0·0386	25·0
Graphite, No. 3,	0·00395	22·0
Bunsen's Battery-coke,	0·00246	26·2
Tellurium,	0.000777	19·6
Red Phosphorus,	0.00000123	24·0

All the metals were the same as those used for my thermo-electric experiments, with the exception of cadmium, which was purified. The alloys of bismuth-antimony, bismuth-tin, antimony and zinc, were determined in order to ascertain whether, as they give with other metals such strong thermo-electric currents, they might be more advantageously employed for thermo-electric batteries than those constructed of bismuth and antimony. Coppers Nos. 1, 2, 3, were wires of commerce. No. 1 contained small quantities of lead, tin, zinc, and nickel. The low conducting power of No. 1 is owing, as Prof. Bunsen thinks, to a small quantity of suboxide being dissolved up in it. Graphite No. 1 is the so-called pure Ceylon; No. 3 purified German, and No. 2 a mixture of both. The specimens were purified by Brodie's patent, and pressed by Mr. Cartmell, to whom I am indebted for the above. The conducting power for gas-coke, graphite, and Bunsen's battery-coke increases by heat from 0° to 140° C.; it increases for each degree 0·00245, *i. e.*, at 0° C. the conducting power = 100, and between the common temperature and a light-red heat about twelve per cent. The following metals were chemically pure: Silver, gold, zinc, cadmium, tin, lead, antimony, quicksilver, bismuth, tellurium. Those pressed were sodium, zinc, magnesium, calcium, cadmium, potassium, tin, lead, strontium, antimony, bismuth, tellurium, and the alloys of bismuth-antimony and bismuth-tin. The way in which these wires were made is described in the *Philosophic Magazine* for February 1857. — *Phil. Mag. Vol. XVI., p.* 219.

ON THE ELECTRICAL DISCHARGE, AND ITS STRATIFIED APPEARANCE IN RAREFIED MEDIA.

The following is a report of an important paper recently read before the Royal Institution, by Mr. W. R. Grove, F. R. S.: The best mode of examining and attempting to explain the electrical discharge, is to compare it with its nearest analogue flame, to which one form of the discharge, viz., the voltaic arc, has much seeming resemblance. The flame of a common candle results, as is well known, from the chemical combination of carbon and hydrogen with the oxygen of the air; and the combustion is most brilliant where the heated gases and particles are in proximity to the oxygen. It forms a hollow cone, as the oxygen of the air, being consumed or combined into water and carbonic acid at the exterior portion, cannot reach the interior; the course of the currents of heated air, and the particular form of this hollow cone of flame, are beautifully shown by the refraction it produces on a more brilliant light, such as that of the electric lamp; the flame issues from a single nucleus, the wick; and the amount of heat produced is definite for a definite amount of chemical combination.

In the voltaic arc there are two points or *foci;* the polar terminals there undergo a change, but not a consumption equivalent, or nearly so, to the heat and light produced; but if the consumption of the zinc, or the quantity of it combined with oxygen in the cells of the battery, be compared with the amount of heat generated in the arc, plus that in the cells of the battery and conducting wires, the same amount of total heat will be found to be developed as if the same quantity of zinc were simply burned in oxygen.

By subdividing more and more the plates of the voltaic battery, and proportionally increasing their number, we gradually increase the length and diminish the volume of the arc, until at length we arrive, as in the voltaic columns of De Luc and Zamboni, at the electric spark.

The spark from a Ruhmkorff coil was projected on a screen by the electric lamp, and the impression contrasted with that of the flame of a candle; in the former, two cones are seen to issue from the terminals, instead of the single one of the latter, one being more powerful, and overcoming or beating back the other; and this effect is reversed as the direction of the current is reversed.

In all cases hitherto observed, there is a dispersion or projection of a portion of the terminals; this takes place in all forms of electric disruptive discharge, whatever be the materials of which the terminals are composed. In the voltaic arc there is a transmission of matter, principally from the positive, which is the more intensely heated, to the negative terminal; in the spark from the Ruhmkorff coil the dispersion is principally, and in some cases appears to be entirely, from the negative terminal, while this is now the more intensely heated.

In addition to this, there is generally, but not always, a change produced in the medium across which the discharge passes; compound liquids, vapors, and gases are decomposed, and even elementary gases are allotropically changed. There is also a polar condition of the electrical discharge, which produces the converse chemical effects at each pole — effects described by Mr. Grove in a paper in the *Philosophical Transactions* for 1852.

Gases offer a powerful resistance to the passage of the discharge, but this resistance is diminished as the gases are rarefied; and a discharge which would not pass across a space of half an inch in air of the ordinary density, will pass through several feet in highly attenuated air.

In experimenting on the passage of the discharge through the vapor of phosphorus in 1852, Mr. Grove observed, for the first time, that the discharge was traversed by a number of dark bands, or striæ. At first he was disposed to attribute this phenomenon to some peculiarity of the medium; but on trying good *vacua* of other vapors and gases, he found the striæ were in all cases visible, and seemed to depend on the degree of rarefaction of the gas. Many subsequent experiments have been made by himself and others on the subject, and more particularly by Mr. Gassiot; and the extent of knowledge we have acquired upon this still mysterious phenomena was now discussed and illustrated.

In the vapor of phosphorus, the striæ generally exhibit themselves like narrow ruled lines, about 0.05 inch diameter, transverse to the line of discharge; but with certain precautions they become wider, and assume a conical form, somewhat resembling the whalebone snakes made as a toy for children. Mr. Gassiot has used most carefully prepared Torricellian *vacua*, and has also, in conjunction with Dr. Frankland, obtained excellent *vacua*, by filling tubes containing sticks of caustic potass with carbonic acid, exhausting them by the air-pump, and allowing the residual gas to be absorbed by the carbonic acid.

The following is a summary of the effects produced by the electric discharge through these *vacua:* If the vacuum be equal to that generally obtained by an ordinary air-pump, no stratifications are perceptible; a diffused lambent light fills the tube; in a tube in which the rarefaction is carried a step further, narrow striæ are perceptible, like those first described in the phosphorus vapor experiment. A step further in rarefaction increases the breadth of the bands; next we get the conical, or cup-shaped form; and then, the rarefaction being still higher, we get a series of luminous cylinders of an inch or so in depth, with narrow divisions between them. Lastly, with the best vacua which have been obtained, there is neither discharge, light, nor conduction.* The fact of non-conduction by a very good Torricellian vacuum was first noticed by Walsh, subsequently carefully experimented on by Morgan (Philosophical Transactions, 1785), and subsequently by Davy (1822); the latter did not obtain an entire non-conduction, but a considerable diminution both of light and conducting power.

From these repeated experiments it may fairly be considered as proved, that, *in vacuo*, or in media rarefied beyond a certain point, electricity will not be conducted, or, more correctly speaking, transmitted, — an extremely important result in its bearing on the theories of electricity.

The gradual widening of the strata, as the rarefaction proceeds, is in favor of the phenomena of stratification being due to mechanical impulses of the attenuated medium, and appears to support the following rationale of the phenomenon given by Mr. Grove, who does not advance it as conclusive, but only as an approximation to a theory to be sifted by further experiments. When the battery contact is broken, there is generated the well-known induced current in the secondary wire, in the same direction as the original battery current, to which secondary current the brilliant effects of the Ruhmkorff coil are due; but, in addition to this current in the secondary wire, there is also a secondary current in the primary wire, flowing in the same direction, the induction spark, at the moment following the disruption of contact, completing the circuit of the primary, and thus allowing the secondary current to pass. This secondary current in the primary wire produces in its turn another secondary, or what may be termed a tertiary, current in the secondary wire, in an opposite direction to the secondary current. There are thus, almost synchronously, two currents in opposite directions in the secondary wire; these, by causing a conflict, or irregular action on the rarefied medium, would give rise to waves or pulsations, and might well account for the stratified appearance. The experimental evidence in favor of this view is as follows: When a single break of battery contact is made, by drawing a stout copper wire over another wire, the striæ do not invariably appear in the rarefied medium through which the current of the secondary wire passes. This would be accounted for, on the above theory, by supposing that in some cases of disruption the induced spark passes across immediately on disruption, and thus completes the circuit for the secondary current in the primary wire; while in other cases, either from want of sufficient intensity, or from the mode or velocity with which contact is broken, or from the oxidation of the points where contact is broken, there is no induced spark by which the current can pass. In the former case there would be a tertiary current in the secondary wire, and therefore striæ; in the latter there would be none.

But the following experiment is more strongly in favor of the theory. It is obvious that the secondary must be more powerful than the tertiary current. Now, supposing an obstacle or resistance placed in the secondary circuit, which the secondary current can overcome but the tertiary cannot,

*The production of vacua by carbonic acid, and the increasing breadth of the stratifications with increased rarefaction, was communicated by Mr. Gassiot in a paper, read to the Royal Society, January 13, 1859. I incline to think that oxy-hydrogen gas, with potash, might give a better vacuum than carbonic acid, as the last residual portions of the gas would be slowly combined by the discharge, and the water so formed absorbed by the potash. — W. R. G.

we ought, by the theory, to get no striæ. If an interruption be made in the secondary current, in addition to that formed by the rarefied medium, and this interruption be made of the full extent which the spark will pass, there are, as a general rule, no striæ in the rarefied medium, while the same vacuum tube shows the striæ well if there be no such break or interruption. The experiment was shown by a large vacuum cylinder (16 inches by 4) of Mr. Gassiot, and his micrometer-electrometer; this tube showed numerous broad and perfectly distinct bands when the points of the micrometer were in contact; but when they were separated to the fullest extent that would allow sparks to pass, not the slightest symptom of bands or striæ was perceptible; the whole cylinder was filled with a uniform lambent flame. With a spark from the prime conductor of the electrical machine, the striæ do not appear in tubes which show them well with the Ruhmkorff coil; occasionally, and in rare instances, striæ may be seen with sparks from the electrical machine, but not as far, as Mr. Grove has observed, when the spark is unquestionably single. All this is in favor of the theory given above; but without regarding that as conclusive, or as proved *rationale*, it is clearly demonstrated by the above experiments that the identical vacuum tubes which show the striæ with certain modes of producing the discharge, do not show them with other modes, and that therefore the striæ are not a necessary condition of the discharge itself in highly attenuated media, but depend on the mode of its production.

The study of the electrical discharge *in vacuo* is of the utmost importance in reference to the theories of electricity, and probably will assist much towards the proper conception of other modes of force, or, as they are termed, *imponderables*, heat, light, etc.

The experiments of Walsh and Morgan, corroborated as they now are by that of Mr. Gassiot, show that, although the transmission of electricity across gaseous media is aided by refraction of the medium up to a certain degree, yet that a degree of attenuation may be reached at which the transmission ceases, at all events for a given distance between the terminals and given intensity of electrical charge. Whether, having reached this point, a reduction of the space to be traversed, or an increase of intensity in electricity, or both, would again enable the electricity to pass, is not quite clear, though there is reason to believe that it would, and the increased intensity of electricity would probably be again stopped by a further improvement in the vacuum, and so on. But the experiments go far to prove that ordinary matter is requisite for the transmission of electricity, and that if space could exist void of matter, then there would be no electricity; thus supporting the views advocated by Mr. Grove and some others, that electricity is an affection or mode of motion of ordinary matter.

The non-transmission of electricity, by very highly attenuated gas, may also afford much assistance to the theory of the aurora borealis, a phenomenon, the appearance of which, the regions where it is seen, its effect on the magnet, and other considerations, have led to the universal belief that it is electrical.

The experimental result that a certain degree of attenuation of air forms a good conductor, or easy path for the electrical force, while either a greater or less degree of density offers more resistance, and this increasing towards either extremity of density or rarefaction, shows, that if there be currents of electricity circulating to or from the polar regions of the earth, the return of which, as is generally believed, gives rise to the beautiful phenomena of the aurora borealis, or australis, the height where this transit of electricity takes place would be just that at which the density of the air is such as to render it the best conductor. By careful measurement of the degree of attenuation requisite to enable the electrical discharge to pass with the greatest facility in our laboratory experiments, we may approximatively estimate the degree of rarefaction of the atmosphere at the height where the aurora borealis exists. By these means we get a mode of estimating the height of the aurora, by ascertaining, from the decrement of density in the atmosphere in proportion to its distance from the earth, at what elevation the best conducting state, or that similar to our best conducting vacuum tubes, would be found, or conversely, by ascertaining the height of the aurora, by parallactic measurements, we may ascertain the ratio of decrement in the density of the atmosphere. Thus, by our cabinet experiments, light may be thrown on the grand phenomena of the universe, and the great questions of the divisibility of matter, whether there is a limit to its expansibility, whether there is a fourth state of attenuation beyond the recognized states of solid, liquid, and gaseous, as Newton seemed to suspect (thirtieth query to the Optics), and whether the imponderables are specific affections of matter in a peculiar state, or of highly attenuated gaseous matter, may be elucidated. Though the entire solution of such questions be beyond the power of man, we may ever hope to gain approximative knowledge. The manageable character of the electrical discharge, and the various phenomena it exhibits when matter is subjected to its influence in all those varied states to which we are enabled, by experiment, to reduce it, can hardly fail to afford new and valuable information on these abstruse and most interesting inquiries.

STATIC INDUCTION.

The following is an abstract of a lecture recently delivered by Professor Faraday, before the Royal Institution, on "Static Induction":

After referring to the simple case of evolution of electricity by the friction of flannel and shellac, and tracing the effect upon their separation into ordinary cases of induction, and after calling attention to induction as action at a distance, and through the intervening matter, Professor Faraday proceeded to examine closely the means by which the state of the intervening matter could be ascertained, choosing sulphur as the body, because of its admirable nonconducting conditions, and its high specific inducting capacity. It is almost impossible to take a block of sulphur out of paper, or from off the table, without finding it electric; if, however, a small spirit-lamp flame be moved for a moment before its surface, at about an inch distance, it will discharge it perfectly. Being then laid on the cap of the electrometer, it will probably not cause divergence of the gold leaves; but the proof that it is in no way excited is not quite secure until a piece of uninsulated tinfoil or metal has been laid loosely on the upper surface. If there be any induction across the sulphur, due to the feeble excitement of the surfaces by opposite electricities, such a process will reveal it; a second application of the flame will remove it entirely. When a plate of sulphur is excited on one side only, its application to the electrometer does not tell at once which is the excited side. With either face upon the cap, the charge will be of the same kind; but with the excited side downwards, the divergence will be much, and the application of the uninsulated tinfoil to the top surface will cause a moderate diminution, which will return as the tinfoil is removed; whereas, with the excited side upwards, the first divergence of the leaves will be less, and the application of the tinfoil on the top will cause considerable diminution. The approximation of the flame towards the excited side will discharge it entirely. The application near the unexcited side will also seem partly to discharge it, for the effect on the electrometer will be greatly lessened; but the fact is, that the flame will have charged the second surface with the contrary electricity. When, therefore, the originally excited surface is laid down upon the cap of the electrometer, a diminished divergence will be obtained, and it is only by the after application of uninsulated tinfoil upon the uppper surface, that the full divergence due to the lower surface is obtained.

Being aware of these points, which are necessary to safe manipulation, and proceeding to work with a plate of sulphur in the field of induction before described, the following results are obtained: A piece of uncharged sulphur being placed in the induction field, perpendicular to the lines of inductive fire, and retained there, even for several minutes, provided all be free from dust and small particles, when taken out and examined by the electrometer, either without or with the application of the superposed tinfoil, is found without any charge. A gilt plate-carrier, if introduced in the same position, and then withdrawn, is found entirely free of charge. If the sulphur-plate be in place, and then the carrier be introduced and made to touch the face of the sulphur, then separated a small space from it, and brought away and examined, it is found without any charge; and that, whether applied to either one side or the other of the block of sulphur. So that any of these bodies, which may have been thrown into a polarized or peculiar position whilst under induction, must have lost that state entirely when removed from the induction, and have resumed their natural condition.

Assuming, however, that the sulphur had become electrically polarized in the direction of the lines of induction, and that therefore whilst in the field one face was positive and the other negative, the mere touching of two or three points by the gold-leaf carrier would be utterly inefficient in bringing any sensible portion of this charge or state away; for though metal can come into conduction contact with the surface particles of a mass of insulating matter, and can take up the state of that surface, it is only by real contact that this can be done. Therefore the two sides of a block of sulphur were gilt by the application of gold-leaf on a thin layer of varnish; and when the varnish was quite dry and hard, this block was experimented with. Being introduced into the induction field for a time, and then brought away, it was found free from charge on both its surfaces; being again introduced, and the carrier placed near to it, but not touching, the carrier, when brought away, showed no trace of electricity. The carrier being again introduced at the side, where the charged or inductric body (made negative) is placed, made to touch the gilt surface of the sulphur on that side, separated a little way, and then brought out to be examined, gave a positive charge to the electrometer; when it was taken to the other side of the sulphur, and applied in the same manner, it brought away a negative charge; thus showing, that whilst the sulphur was under induction, the side of it towards the negative inductric was in the positive state, and the outer side in the negative state.

Thus the di-electric sulphur, whilst under induction, is in a constrained polar electrical state, from which it instantly falls into an indifferent or natural condition the moment the induction ceases. That this return action is due to an electrical tension within the mass, sustained while the act of induction continues, is evident by this, that if the carrier be applied two or three times alternately to the two faces, so as to discharge in part the electricity they show under the induction, then, on removing the sulphur from the induction field, it returns, not merely to neutrality or indifference, but the surfaces assume the opposite states to what they had before, — a necessary consequence of the return of the mass of inner particles to or towards their original condition. The same result may be obtained, though not so perfectly, without the use of any coatings. Having the uncoated sulphur in its place, put the small spirit-lamp on the side way from the negative inductric; bring the latter up to its place, remove the spirit-lamp flame, and then the inductric body, and finally, examine the sulphur; the surface towards the flame, and that only, will be charged. Its state will be found to be positive, just like the same side of the gilt sulphur, which had been touched two or three times by the carrier. During the induction, the mass of the sulphur had been polarized; the anterior face had become positive, the posterior had become negative; the flame had discharged the negative state of the latter; and then, on relieving the sulphur from the induction, the return of the polarity to the normal condition had also returned the anterior face to its proper and unchanged state, but had caused the other, which had been discharged of its temporary negative state whilst under induction, now to assume the positive condition. It would be of no use trying the flame on the other side of the sulphur-plate, as then its action would be to discharge the dominant body, and destroy the induction altogether. When several plates were placed in the inductive field, apart from each other, subject to one common act of induction, and examined in the same manner, each was found to have the same state as the single plate described. It is well known that if several metallic plates were hung up in like manner, the same results would be obtained.

From these and such experiments, the speaker took occasion to support that view of induction which he put forth twenty years ago (*Phil. Trans.*, 1837), which consists in viewing insulators as aggregates of particles, each of which conducts within itself, but does not conduct to its neighbors, and induction as the polarization of all those parties concerned in the electric relation of the inductric and inducteous surfaces, and stated that, as yet, he had not found any facts opposed to that view. He referred to specific inductive capacity, now so singularly confirmed by researches into the action of submarine electro-telegraphic cables, as confirming these views; and also to the analogy of the tourmaline, while rising and falling in temperature, to a bar of solid insulating matter, passing in and out of the inductive state.

To the above report Prof. Faraday has since made the following addition:

The inquiries made by some who wish to understand the real force of the test experiments relating to static induction, and their consequences in relation to the theory of induction, make me aware that it is necessary to mention certain precautions which I concluded would occur to all interested in the matter; I hope the notice I propose to give here will be sufficient. When metallic coatings or carriers are employed for the purpose of obtaining a knowledge of the state of a layer of insulating particles, as those forming the surface of a plate of sulphur, it is very necessary that they should exist in a plane perpendicular to the lines of the inductive force, and in a field of action where the lines of force are sensibly equal. Hence the importance of adhering to certain fixed dimensions in the construction of the apparatus, —

the dimensions of the inductive surfaces, in the apparatus referred to, being nine inches in diameter, and nine inches apart. The inductive surface mentioned is also a plane. A ball cannot properly be used for this purpose; for the lines of inductive force originating at it cannot then be perpendicular to the layer of gold-leaf forming the coating of the sulphur. The consequence would be, that this layer of gold, being virtually extended along the lines of inductive force, — *i. e.*, having parts nearer to, and parts more distant from the inductric, — will be polarized according to well-known electrical actions, will have opposite states at those parts, will show these states by a carrier, and will give results not belonging merely to insulating particles in a section across the lines, but chiefly to united conducting particles in a section oblique to or along the lines. The carrier itself must be perfectly insulated the whole time, or else a case of induction, not including the sulphur, and entirely different to that set out with, is established. It must not even extend by elongation into parts of the field of induction where the force differs in degree, or else errors of the same kind as those described with the ball inductric will occur. It should also be so used as to receive no charge by convection. When introduced between the inductric and the sulphur, it is very apt, if the charge be high, or if particles adhere to the inductric, to receive a charge. This is easily tested by introducing the carrier into its place, abstaining from touching the gold-leaf, withdrawing the carrier, and examining it; it is not until this can be done without bringing away any charge, that the carrier should be employed to touch the gold-leaf surface, and bring away the indication of its electrical state. As before said, if, when the state of matters is perfect, and no convection interferes, the gilt sulphur be put into its place, left there for a short time, and brought away again, it will be found without any charge either of the gold-leaf coating or the sulphur. If it be put into place, the coating next the inductric be uninsulated for a moment only, and the plate brought away, that coating will then appear positive. If it be put into place, and the further gold-leaf be uninsulated for a moment, that coating, when the plate is brought away, will be found negative. These are all well-known results, and will always appear, if convection and other sources of error be avoided.

ELECTRIC APPARATUS AND EMBRYOLOGY OF THE SKATE.

At a recent meeting of the Boston Society of Natural History, Dr. Jeffries Wyman stated that he had recently examined the electric apparatus in the tail of one of our common skates (*Raia lævis*). The electric organs have been noticed by several anatomists, but have been fully described in *Raia batis* and other species, by Robin. In the species dissected by Dr. Wyman, the organs were more largely developed, extended further up into the base of the tail, and were more uncovered by the muscles, posteriorly, than in the ones examined by Robin. Thus far, no positive proof has been adduced to show that the organs in question really constitute an electric apparatus. Structurally they resemble those of the Torpedo and Gymnotus, but have not been observed to evolve electricity, though it has been stated that if a living skate is held by the tail, an electric shock is felt.

Dr. Wyman also stated that he had seen the horny shell of the egg of the skate in the process of formation. He had found one in each oviduct, surrounded by the glandular enlargement which is visible near its middle. That portion of the duct was very much thickened, and mainly consisted of long tubular follicles, opening into its cavity. Although the shells were partially formed, the yolks had not yet descended into the duct; many of them were nearly mature. If this be a normal state of things, then we have, thus far, an unobserved example of the shell being formed previous to the descent of the ovum. The shell forms a pocket, open at the upper extremity, and through this opening, which is never wholly closed, the egg probably descends into its cavity.

NEW OBSERVATIONS ON ANIMAL ELECTRICITY.

The structure of the eggs of birds offers a certain resemblance to some forms of the galvanic battery, inasmuch as it consists of a fluid inclosed in a porous diaphragm, and in contact with another fluid of a different chemical composition. This circumstance attracting the notice of Dr. John Davy, he made it the subject of experiment, in order to ascertain whether any galvanic action was exerted by the different constituents of which the egg is composed. The result fully answered his expectations; and there can be little doubt that electro-chemical action plays an important part in the changes which the egg undergoes during the process of incubation. Using a delicate galvanometer and a suitable apparatus, on plunging one wire into the white, and the other, insulated except at the point of contact, into the yolk, the needle was deflected to the extent of 5°; and on changing the wires, the course of the needle was reversed. When the white and yolk were taken out of the shell, and the yolk immersed in the white, the effects, on trial, were similar, but not so when the two were well mixed; then no distinct effect was perceptible. Indications also of chemical action were obtained, on substituting for the galvanometer a mixture consisting of water, a little gelatinous starch, and a small quantity of iodide of potassium, especially when rendered very sensitive of change by the addition of a few drops of muriatic acid. In the instance of newly-laid eggs, the iodine liberated appeared at the pole connected with the white; on the contrary, in that of eggs which had been kept some time, it appeared at the pole connected with the yolk, answering in both to the copper in a single voltaic combination formed of copper and zinc.

POLARIZED CONDITION OF MUSCULAR AND NERVE FIBRE.

Mr. H. F. Baxter, in a paper in a recent number of the *Edinburgh New Philosophical Journal,* having arrived at the conclusion that the muscular and nervous tissues are during life in a peculiar state or condition, which has been termed polarized, puts the following question: "Can this state, dependent as it evidently is upon nutrition, be increased by any artificial means?" That it may be diminished, or easily destroyed, is to be inferred from the fact that, whatever interferes with the proper nutrition of a muscle or nerve, or disorganizes their structure, whether by mechanical or chemical agencies, destroys also the conditions upon which the existence of the muscular or nerve currents depend; and it is, it may be observed, from the manifestation of these currents that the existence of this polarized condition is inferred. It is reasonable, therefore, to suppose, that it might be by the employment of the electric force (or current) that we should perhaps obtain some evidence to assist in solving this problem.

We have not space for the details. The only conclusion (says the author) that can be deduced from the foregoing investigations, contained in the former as well as present papers, are the following:

1st. That we have no evidence of being able to increase the polarized condition of the nervous and of the muscular tissue by artificial means, such as the electric current; but it is highly probable.

2d. That an increase of this polarized condition may arise from an increased action of those changes which take place in the living animal, such as nutrition, being the same means by which it is produced and maintained in the living animal.

Before acceding to these conclusions, it may be reasonably asked, have we not other evidence besides that afforded by means of the galvanometer, to indicate an increase in the polarized condition of the nerve? Do not the tetanic contractions which are observed in a limb whose nerve has been subjected to the action of an electric current (inverse), indicate an increased action of the nerve? Previous to discussing this question, which will be considered in the concluding remarks, the following experiment was performed:

A current from six of Grove's cells was passed through the limb of a galvanoscopic frog in the inverse direction, and as soon as the tetanic contractions were produced, the nerve was divided at the junction of the nerve with the muscles of the limb; the tetanic contractions ceased. The two ends of the divided nerve were now placed in apposition, but no tetanic contractions ensued. This inverse current was again allowed to pass for some time through the nerve thus united, but no tetanic contractions occurred upon the breaking of the circuit. Great care, however, is required in this experiment to divide the nerve at the exact point where it emerges from the muscles, as pointed out by Matteucci, otherwise the tetanic contractions take place.

The results of this experiment only tend to confirm what has been already satisfactorily proved by others, that the continuity of the nerve fibre, in the nerve leading to the muscle, is necessary for the conduction of the impression excited at the distal end of the nerve in order to arouse muscular contraction. It need scarcely be added, that the muscular and nerve currents may, however, be obtained under these circumstances between the separated portions.

POCKET ELECTRO-MEDICAL APPARATUS.

M. Despretz has recently submitted to the Paris Academy a new Electro-Medical apparatus, invented or combined by Ruhmkorff, and reduced to its simplest condition. A small box, in size about four cubic inches, contains: 1. An induction coil; 2. A small Bunsen's pile of zinc and charcoal, in which nitric acid is replaced by Marié-Davy's sulphate of mercury; 3. Some handles, a brush, and some needles for distribution of the direct currents, or of the extra current to the surface of the patient. The manipulation of the apparatus is as simple as its construction. No vapors are disengaged. This apparatus will maintain its activity during a day. Its price is said to be moderate.

APPLICATION OF THERMO-ELECTRICITY TO SURGERY.

Thermo-electric currents are now extensively employed by Middledorp, of Breslau, in surgery. With wires and blades of platina of various dimensions, brought to a white electric heat, he undertakes many operations commonly performed with cutting instruments. The heating agent is a Grove's battery; and, properly employed in an operation, there is no hemorrhage of the small vessels; the action is energetic and limited, can be sustained or cut off at pleasure, and applied through narrow passages, and to depths never attempted in ordinary cauterization. Mr. Middeldorp says: "This intelligent fire — let me be pardoned the expression — admits of cutting, splitting, of cutting away, of cauterization on a single point or in rays, or over large surfaces, of stopping hemorrhage, of provoking inflammation of certain tissues, of coagulation of the blood, of suppuration, and the development of proper granulations. In short, being introduced cold, the galvano-caustic instruments inspire no fear in the patient, but once in place, a touch of the finger suffices to raise them to a glowing heat," and the wished-for effect is speedily produced. Of four hundred operations performed by Mr. Middledorp with the "intelligent fire," not one has been followed by ill results.

THERAPEUTIC USES OF ELECTRICITY.

From an article in the *British and Foreign Medico-Chirurgical Review*, "On the Therapeutic uses of Electricity," we derive the following extracts, which are illustrative of the mechanical philosophy of this agent, and its physiological effects when applied to vital animal tissue. In speaking of electric currents, the writer says:

"The degree of tension, or intensity of the electric current is, however, more influential than its quantity in determining physiological results; and it is to variations in this quality that we ordinarily apply the terms 'strong' and 'weak.' There are several currents in common use for physiological experiment and therapeutical exhibition; and as this quality of tension or intensity is predicated of all of them, it is necessary that we should describe separately the conditions upon which its variations depend. But before doing so, inasmuch as some confusion has crept into the language of modern electricians, we will state as concisely as possible what these several currents are, what are their proper names, and in what way they have been erroneously designated.

"In the wire which unites the two poles of a voltaic arrangement — whether this consists of one pair of plates, or of one hundred pairs — there is, when the wire is unbroken, a current of electricity, termed the '*initial current.*' This passes in the direction from the copper or negative metal, through the wire to the zinc or positive plate. If this wire is broken, and the two ends of it are grasped by the hands, the individual so doing becomes, in that part of his body which intervenes between those two ends, a part of the voltaic apparatus; and the initial current passes through him in the direction described. If this wire, if any part of its course be broken, there is at the moment of division, and existing at that moment only, another current setting in the opposite direction to that taken by the initial current. This has received various names: Duchenne has termed it an 'induced current of the first order,' but its proper designation is the '*extra current.*'

"Another wire placed near and parallel to the conducting wire — viz., that through which the initial current passes — has its polar condition so affected that an '*induced current*' is propagated through it in an opposite direction to the initial current. Several of such wires may be employed, at different degrees of proximity to the conducting wire, and in all of them there is an induced current; that which is nearest to the conducting wire being called the '*induced current of the first order*,' and the next of '*the second order*,' and so on.

"The currents employed by M. Duchenne, and about the different properties of which so much has been said and written, are the 'extra current' in the conducting wire, and an 'induced current of the first order' in a parallel wire; and M. Becquerel states, that for Duchenne to designate them induced currents of the first and second order respectively: 'c'est créer . . . . . un langage tout à fait different de celui qui est employé par tous les physicians' (p. 89).

"The most striking differences between these various currents are to be referred to their degree of intensity, and this is determined by different conditions, of which the following are the most important. The 'initial current' is intense in proportion to the number of the active cells in the battery, the nature of the electrolytes employed, and the integrity of conducting materials throughout the whole circuit. The force of the 'extra-current' is determined by the same circumstances; but that of the 'induced currents' depends partly upon these, and also upon other conditions — viz., the size of the wire, the length of it which is brought into proximity with the conducting wire, and the presence and degree of additional magneto-electric induction. *Cæteris paribus*, the finer the wire and the greater its length, the more intense is the induction.

"In order to obtain great, and at the same time convenient, length of the wires, they are twisted into the form of a hollow spiral, or helix, the latter becoming, in itself, endowed with magnetic properties, one end of the helix being a north and the other a south pole. If into the hollow of this spiral or helix, there are introduced bars of soft iron or steel, these bars become magnetic by induction; and thus the electrical force, developed in the battery cells by chemical action, becomes resolved into the correlated force of magnetism. But precisely the reverse order of induction may take place in another apparatus, and the 'lifter' of a permanent magnet, around which a copper wire is twisted spirally, at the instant that it becomes a magnet by induction, from contact with the poles of the permanent magnet, develops chemico-polarity, or electricity in the copper wire. The former arrangement is termed 'electro-magnetic;' the latter, 'magneto-electric.' In the one, electricity is developed from chemical decomposition; in the other, from magnetism: but in the former — inasmuch as magnetism is induced by the initial current — there is, in addition to the 'primary induced current,' that order of induction which exists alone in the latter, and the addition of this is one mode of augmenting the intensity of the current.

"Thus, then, the initial current develops magnetism in the bars of soft iron which are inserted into the hollow of its helix, and the presence of magnetism in these bars, at the moment of its induction, develops an electrical current in the copper wires; the intensity of the latter induced current being, *cæteris paribus*, in proportion to the size of the temporary magnet, and determined or regulated by the length to which these soft bars are inserted in the helix. The tension, therefore, of the induced current depends upon that of the initial current, upon the size of the wire, upon its length — *i. e.*, upon the number of turns in the spiral — and upon the force of magnetism temporarily developed in the bars of soft iron.

"Whatever form or current is employed, the nature and degree of its physiologic effects — *i. e.*, of its power to occasion vital phenomena, as distinct from chemical and thermal — are determined mainly by differences in this quality of tension. Generally speaking, a weak current produces feeble contractions of the muscles, and slight effects upon the organs of sensation; whereas a powerful current produces strong contractions and violent sensations. Both sensory and motive phenomena may be occasioned by the application of any one of these currents, but their variations in intensity render some more useful for one class of effects, and others for a second class. Thus, Duchenne has drawn considerable attention to the fact, that the 'extra current' acts very readily on the muscles, and that the 'induced current' affects more powerfully than the extra current, the skin, nerves, and retina. This difference of action he refers to a special elective power on the part of the two currents respectively; but Becquerel has proved that, in reality, it is merely dependent upon the difference of their intensity, the induced current having much greater tension than the extra current. M. Becquerel has shown, by a simple experiment, in which he modifies the arrangement of the wires, that the effects which Duchenne attributes to the one current may be obtained from the other, and *vice versâ.*

"In proportion to the intensity of the current employed, electricity has the power of evoking the ordinary physiologic action of a nerve or muscle; of occasioning excessive and perverted action; of exhausting the functional activity for a time, or of destroying it altogether. In the first degree there is sensation or motion, each of these being within the limits of physiologic function; thus luminous appearances, gentle sounds, gustatory effects, etc., on the one hand, and slight muscular contraction on the other, — contraction so slight as merely to exhibit the persistence of muscular contractility, and not to test its power, — are the results of applying an electric current of low intensity. If a stronger current is employed, the impressions upon the sensory organs become excessive in degree and painful in character; while, in the place of gentle muscular contraction, there is distressing cramp or arrested (inhibited) action in certain organs. A still more violent current exhausts both nerve and muscle; and here sensation and contraction, though for a time withdrawn, are capable of being restored by repose, or by the inverted current; whereas the electricity may be so powerful as at once to put an end to the vitality of the tissues — *i. e.*, to kill the nerve, limb, or individual through which it passes.

"It is owing to these different effects of variations in intensity that electricity may be employed both physiologically and therapeutically for so many different purposes. As a test of irritability, or a gentle stimulus of weakened sensibility and contractility, the current of low intensity may be employed. For the sake of displaying the inhibiting influences of the vagi and the splanchnic nerves, or for awakening the torpid nervous centres of an individual poisoned by opium or alcohol, a more powerful current is required. Whereas, for the relief of excessive muscular contraction, or of neuralgia, a still more intense current, one that shall temporarily exhaust the nervous function, may be employed.

"Besides the quantity and tension of a current, the mode of its transmission exerts a notable influence upon its physiologic effects. Under this head we place the different actions of the continuous and interrupted currents; and with regard to the former, the changes produced by altering their direction; and with regard to the latter, their convection by means of moist or dry conductors, the rapidity or slowness of their interruption, and the degree of pressure with which the conductors are applied.

"The most general differences between the effects of the continuous and interrupted current, are displayed very simply by an arrangement of M. Claude Bernard's, in which there are introduced into the same current, from a small Cruickshank's battery, first, the nerve of a frog's leg, and second, a delicate voltameter; the apparatus being so constructed that the current may be either continuous or intermittent. By this arrangement, says M. Bernard, it is shown that—

"'So long as the current is continuous, chemical effects are produced, and the physiological effects are 'nuls,' or at all events inappreciable. The facts are that the water in the voltameter is decomposed by the current, whilst the limb of the frog remains perfectly motionless. But immediately that, by means of the interrupter, the current is rendered intermittent, everything is changed; the decomposition of water ceases in the voltameter, and the frog's limb becomes violently convulsed.' *

"But this experiment, although it illustrates very aptly the broadly marked difference between the effects of the continuous and intermittent current, by no means exhausts the subject of that difference, nor does it accurately represent all the facts. For the continuous current is not devoid of physiologic action, nor is the interrupted, under all the circumstances, incapable of acting chemically. True, there is no visible contraction of the frog's leg; but under certain conditions the irritability of the nerve is exhausted, and under others it becomes increased. True, there is no sign of sensation in an amputated frog's leg, but the continuous current can produce sensory effects; for the proof of which let any one pass a continuous current through his tongue or eyeballs; or, as Purkinje did, through the ears.† And further, it is quite easy to produce permanent, *i. e.*, tonic, contraction of a muscle or group of muscles, as we have often done by a current of this kind; and there is evidence to show that not only persistent contraction of muscles may be relaxed by such influence,‡ but that hyperæsthesia may be reduced.§

"Here, then, we have evidence of four kinds of physiologic action due to the continuous current, namely, the production of sensory effects, and also of motor, as well as the relaxation of spasm, and the reduction of hyperæsthesia,—the different manner in which the current acts being mainly due to its intensity.

"Other circumstances, however, influence the quality and degree of action exerted, namely, the direction of the current. Generally speaking, the transmission of a continuous current through a nerve, in the direction from the centre to the periphery, exhausts the vital property of the nerve; whereas a current passed in the opposite direction, *i. e.*, from the periphery towards the centre, increases the vital property. The former is termed 'direct,' the latter 'inverse.' Again, the direct current acts more energetically than the inverse in producing muscular contractions. This we have often witnessed, when employing, for the purpose of experiment or therapeutic application, an ordinary Cruickshank's battery, and so making use of the initial current that its intensity could be regulated and measured by varying the number of plates employed. Not only is the muscular contraction produced by transmitting a current from twenty plates, much stronger when

* Leçons sur la Physologie et la Pathologie du Système Nerveux, 1858, tome i. p. 151.

† Rust's Magazin, bd. xxiii. p. 297.

‡ Remak, Medical Times and Gazette, May 8, 1858.

§ Becquerel, p. 97.

this current is direct than when it is inverse; but a current of such low intensity as to cause no appreciable contraction when transmitted in the latter direction (inverse), will occasion very evident action when passed in the former (direct). Thus the difference between these currents must be remembered in testing irritability, as well as in testing power. It is sometimes a source of fallacy in physiologic experiments; as, for example, in examining the irritability of muscles in a paralyzed limb, by passing the current from one arm to the other. In this case, it is, of course, direct in one arm, and inverse in the other; and we have frequently seen the difference between the irritability of the muscles on the paralyzed and non-paralyzed sides so slight as merely to equal, or even fall below that which exists between the action of the inverse and direct current respectively. When such is the case, the irritability appears greater in that limb through which the direct current passes, whereas it may be really less."

NEW AND CHEAP FORMS OF GALVANIC BATTERY.

The following description of a new, cheap, and effective arrangement of a galvanic battery, devised by Dr. John O'C. Barclay, U. S. N., is contained in a note addressed to the editor by Dr. B., March 1859: "Having in the years 1847-8 been engaged in some investigations touching the amount of work done by constant batteries, and the comparative cost of running them, I was led, in consequence of the well-known passive state enjoyed by cast iron in contact with concentrated nitric acid, to construct a cheap form of battery, in which both elements are of cast iron. The battery is powerful (perhaps in this point rather inferior to Grove's), and is very constant. The following is the form I adopted: In a vessel of convenient material is placed a hollow cylinder of cast iron, the metal being the black variety, or such as is used for gun metal. The side of the cylinder should be split or cut through from top to bottom by a slot one-fourth inch wide, or more. Within this cylinder, and in moderately close approximation, is a porous jar, which contains a solid, or, at option, a hollow rod or cylinder, of the same kind of cast iron. To charge this battery, I make a saturated solution of chloride of sodium, which I pour into the outer vessel, and in contact with the larger iron cylinder. Into the porous jar I put a mixture of equal parts of concentrated nitric and sulphuric acids, and the battery is now ready for use. Theoretically, the acids should not be equal in quantity; but the difference is so small that, practically, it may be neglected. As some of your readers may wish to know the changes undergone by the solids and fluids during the flow of the electrical current, I will, in a line or two, state them. On uniting the poles, water is decomposed, its oxygen uniting with the sodium of the chloride of sodium, while its hydrogen combines with the fifth atom of the nitric acid in the porous jar. The chlorine attacks the iron of the outer cylinder, forming the very soluble chloride of that metal, and leaving the surface of the iron always clean. The sulphuric acid in the porous jar unites with the oxide of sodium to form sulphate of soda, thus completing the process. As I before said, this form of battery is cheap, powerful, and constant, and is by no means troublesome; and I offer it to your readers as a new and useful instrument, particularly to those of them to whom the difference of cost between iron and amalgamated zinc is worthy of consideration, or to those who find the use of mercury injurious or troublesome. The black cast iron should be used, this being passive in concentrated nitric and sulphuric acids.

I have experimented with no other. It would perhaps be proper to cleanse the iron of its skin and grit before using. I, however, used no such precaution. A fair trial of this battery will not fail, we think, to establish for it a place among the best of those now in use."

Avery's Improvements in the Galvanic Battery. — Mr. T. C. Avery, for many years electrician at West Point, has invented and patented several important improvements upon the Grove Battery used in the working of telegraph lines. The new instrument has been in use upon the lines of the American Telegraph Company for several months. Mr. Avery's improvement consists: 1. In insulating the outside of the zines, thereby reducing the surface of metal brought in contact with the sulphuric acid, and preventing the local action, which interferes seriously, at times, with the successful working of the telegraph. 2. The use of double the surface of platinum — this increases the positive current, and equalizes it with the negative, thus preventing, to a great extent, as he alleges, the escape of the current in damp or stormy weather. 3. The insulation, at the top and bottom of the porous cups, preventing the nitric acid from destroying the zines, and creating local action on the inside, which is equally as injurious as the action of the sulphuric acid on the outside.

Mr. Avery claims, in point of economy, the saving of at least two-thirds of the zine, one-half of the sulphuric acid, one-eighth of the nitric acid, and three-quarters of the mercury or quicksilver, now used.

ON THE ELECTROLYSIS OF SULPHURIC ACID. — BY DR. NORTON GENTHER.

The following experiments were undertaken for the purpose of deciding the question, whether an electrolyte of different constitution than the simple binary relation of atom for atom of each element, is capable of decomposition by the current. Previous experiments with chromic acid, chloride of iron, and chromate of potash, had well-nigh decided the question in the affirmative; but the attempt to decompose sulphuric acid, made with eight cells of Bunsen's battery, by Magnus, failed to confirm this view of it. This failure Dr. Genther attributed to the limited force of the current, and accordingly renewed the experiment, with fourteen of Bunsen's cells. The anhydrous acid still resisted, and even when the platina poles were approached so close as to insure the direct transmission of the current, it only gave signs of a rapid bubbling movement. The anhydrous acid was next mixed with different quantities of acid of the constitution $SO_3 + HO$, and the mixture exposed to the action of the same battery in a U-form tube. The proportions first tried were four of the anhydrous to one part of the other acid. This mixture yields a solution crystallizing at 68° Fah. It is therefore necessary to apply a higher temperature, which is invariably obtained by the continued action of the current. The conducting power of this solution is so low as only to allow a very small distance to intervene between the poles. Soon after the action commences, oxygen is liberated at the positive pole, while not a gas-bubble appears at the negative. The solution, however, being of a brownish-yellow cast, becomes colorless in the arm of the tube containing the positive electrode, the color being entirely confined to the other arm. The action being allowed to continue, blue streaks slowly make their appearance at the surface of the liquid at the negative pôle, which, although multiplied by the duration of the current, are yet very sparingly developed.

In the second mixture, the proportions were three parts of the anhydrous acid to one of the acid $SO^3 + HO$. This gives a solution of better conducting power. As in the former experiment, oxygen appears at the positive pole, but much more copiously; and at the negative pole a slight escape of gas-bubbles is perceptible, whilst the blue streaks present themselves in greater quantity, coloring the liquid contained in the negative arm of the tube. The odor of sulphurous acid is also distinctly perceptible. With the continuance of the action the temperature rapidly rises, the escape of gas at the negative pole is more abundant, and sulphurous acid is formed; but the blue streaks, however, diminish when the tube is immersed in water gradually heated, and disappear altogether at 140° Fah., while a more copious formation of sulphurous acid sets in. As the tube containing the electrolyte gradually cools, the color reäppears.

This whole process is effected much more rapidly when the mixture is in the proportion of two parts of the anhydrous to one of $SO_3 + HO$, or of equal parts of both, the temperature being kept at 32° Fah. The blue color at the negative pole clearly proves that sulphur is liberated there, the solution resembling that obtained by dissolving sulphur in anhydrous sulphuric acid. Of this fact, the temperature at which decomposition takes place, and the formation of SO_2, furnish sufficient testimony independent of the color produced.

The development of sulphurous acid seems to be occasioned by the rise of temperature produced in the solution by the action of the current. Nor is it confined to the negative arm of the tube; circumstances which indicate that it is a secondary product.

In regard to the sulphur which has been observed at the negative pole, there are only two ways of accounting for its presence. It is either the result of direct decomposition by the current, or of the reducing action of the liberated hydrogen.

The combination SO_3 with HO, according to Faraday, is decomposed into sulphur and hydrogen at one electrode, and oxygen at the other. The same combination subjected to the action of the battery by Genther, gave at first only H and O at their proper poles; sulphur was liberated only when the temperature of the electrolyte was considerably raised by the action of the current. When the tube was placed in water kept at 32° Fah., the liberation of oxygen and hydrogen was of longer duration before free sulphur appeared. The temperature of the electrolyte was found to rise almost instantaneously with the removal of the tube from the water. This would seem to indicate that by keeping the electrolyte at 32°, the liberation of sulphur would be prevented, which shows the great influence temperature has on the product of the decomposition. It was further observed that the odor of sulphurous acid accompanied the liberation of sulphur, owing probably to the action of S on the warm sulphuric acid. If we assume that in this process the liberation of the sulphur is due to the reducing action of H, then it consistently follows that the H, endowed with so strong an affinity, must unite with the sulphur it meets at the moment of separation, and form sulphuretted hydrogen. Not a trace of this gas has however been yet detected. Furthermore, if the hydrogen could exert this reducing action, it would at most be but the reducing of SO_3 to SO_2. With such proofs drawn from experiment, we must assume the direct decomposition by the current of sulphuric acid into S, which appears at the negative pole, and oxygen at the positive pole. It depends on the concentration of the acid whether the extra decomposition of water accompanies the foregoing products.

That an electrolyte differing from the simply binary constitution is capable of direct decomposition by the current, is thus shown in the case of SO_3, and even with less room for doubt, in the case of anhydrous chromic acid, and chromate of potash, as the researches of Prof. Magnus prove. — *Liebig and Kopp's Annual*, 1857.

ELECTRO-ZINC DEPOSITS ON ENGRAVED COPPER PLATES.

Bradbury's (of London) process for surfacing engraved copper plates with a coating of pure zinc, by electro-metallurgical means, for the purpose of protecting such plates from wear while printing, is described by the inventor as follows:

To obtain a deposit of pure zinc, capable of printing from fifteen hundred to two thousand impressions or more, before requiring to be removed and renewed, I have recourse to a combined solution of chloride and cyanide of zinc, prepared as follows:

Chloride of Zinc Solution. — In a suitable vessel, dissolve one part chloride of ammonium in eight parts water; place in this a porous cell containing the same solution and a copper plate, which attach to the zinc of a Smee's battery, and in the outer cell place a plate of spelter, which attach to the silver of the above battery for forty-eight hours.

Cyanide of Zinc Solution. — Dissolve one-half pound of cyanide of potassum in twelve parts of water; then add as much chloride of zinc as the solution will take up.

Mix these solutions together in equal parts; use a zinc positive pole and one of Smee's compound batteries, intensity arrangement, charged with one part of sulphuric acid to twelve of water. In from forty-five minutes to an hour, a deposit of the most beautiful lustre will be obtained, capable of yielding from fifteen hundred to two thousand impressions, and even more, according to the experience of the manipulator.

Mr. Bradbury, however, states in addition, that the durability of engraved copper plates is best increased by covering them with a thin electro-deposit of nickel. "This metal," he says, "gives a surface kinder, for printing purposes, than either steel, copper, or any of the known metals; the reason being simply that, in addition to hardness, it possesses the smoothest, firmest, and brightest surface to be obtained from electro-deposition. An engraved copper plate may be covered and recovered *ad infinitum*, thereby preserving the integrity of the original work to an illimitable number of impressions.

"Again, if colored inks made from metals be used, such inks do not in the least degree act upon nickel, as they are known to do upon steel and copper. Nickel may be deposited at the same nominal cost as platinum and palladium, namely, from a penny to twopence per square inch.

"The purity and extreme fitness of nickel deposit, — its non-oxidation, the facility of throwing it down, its yielding five thousand impressions and upward from the coating, — place the electro-nickel facing immeasurably above electro-iron facing, as it has hitherto been done."

COPYING DRAWINGS BY GALVANISM.

Marshal Vaillant has described to the Academy of Sciences, of Paris, a mode of copying drawings devised by M. Defrance, and perfected by Col. Leveret. The process is as follows:

The drawing is made on transparent paper, and is laid, face downward, upon a board, and fixed by tacks. Coats of gelatine are then applied with a brush to the back of the drawing, so as to obtain a sheet of gelatine from $\frac{1}{100}$ to $\frac{1}{50}$ inch thick. Upon this gelatine the drawing is traced with a simple point. A solution of gutta-percha in sulphuret of carbon is then applied with a pencil, and the coatings repeated until it has also assumed a thickness of about $\frac{1}{100}$ of an inch. This will require at least thirty coats. When the gutta-percha is sufficiently dry, a plate of copper is laid on it to give it stiffness. The whole is then turned up, and the original drawing exposed. This is easily removed, and then by delicate touches of a sponge dipped in water, the gelatine is separated from the gutta-percha, which is metalized by black lead. The plate is then electrotyped as usual.

The Marshal declares that by applying this process to the six-sheet map of Kabilie, they have obtained an economy of seven-eighths of the time, and of six-sevenths of the expense. — *Academy of Sciences of Paris, Nov. 19, 1858.*

DETERMINATION OF THE VARIATION OF THE COMPASS.

We have before us a simple but very useful contrivance, the invention of Captain Toovey, of the mercantile marine, for determining the true variation of the compass. It is a simple dial, inscribed with an inner and an outer circle, having the quadrants and eight points of the compass worked off on each. In the centre is fixed a gnomon, to the foot of which is attached a movable hand that travels round the dial. This hand, in using the instrument, is made to indicate the direction of the ship's head, and her course. The dial is then placed in a horizontal position on the capstan-head, the ship's side, the poop-rail, or any other convenient place. The bearings of the sun are then ascertained, and the shadow cast by the gnomon indicates with accuracy the angle of variation of the compass, which is read off on the inner or outer circle with perfect ease. The dial is fitted with a movable sight for ascertaining the bearings of any object in the heavens or on the horizon. — *London Engineer.*

CAST-IRON MAGNETS.

M. Florimond, Professor at Louvain, has succeeded in making very good magnets of cast iron, very highly tempered. The quality of the cast iron for this purpose must be neither too fine nor too coarse, and the plates should be at least three times thicker than the plates of steel usually employed.

ON INCREASING THE POWER OF LOCOMOTIVES BY MAGNETIZATION.

The following paper was read before the American Scientific Association, by Mr. E. W. Serrell:

The importance of increasing the power of locomotive engines without adding to their weight, which is so destructive to the superstructure of railways, led me to attempt to magnetize the driving-wheels, to obtain additional adhesion. Before doing so, however, I carefully inquired of those most likely to be informed, both in this country and in Europe, if previously ascertained facts indicated the probability of success, and I was almost discouraged by the unanimous answer, "No." But I persevered, and the result is more than was anticipated. An additional adhesion of over seventy-five per cent. has been obtained, and this by a very simple method.

The lower segment of the wheel is surrounded by a helix of copper wire, through which the wheel revolves; and, contrary to the generally received opinions, it was found that, upon curving the helix into a segment, the radius of which is equal to the diameter of the wheel, the point of greatest magnetic effect coincided with the contact of the wheel and rail. One wheel had south polarity, and its corresponding opposite wheel north polarity. The wheels magnetized in the experimental trial were 4½ feet in diameter, and weighed about 1100 lbs. each. On a very slippery rail, 19 lbs. of steam per inch slipped the wheels without magnetism; under the same condition, 35 lbs. were required to slip them when magnetized. On a very clean rail, and everything being favorable, 50 lbs. were required without any magnetic effect, and 88 lbs. when magnetized. The helix was made of No. 8 copper wire, in one strand, 2700 feet in length, and laid in 288 turns, insulated with cotton and marine glue, and covered with India-rubber. I have not been able to discover any increased or diminished effect by the wheels being in motion or at rest, and they were tested up to 300 revolutions per minute. The battery used was a modification of Grove's, so contrived as not to stop, and consisted of sixteen cups each, having about 300 inches of zinc surface, and they were connected for the quantity of eight cups.

I have since adopted a modification of Smee's and Chester's battery, being more permanent. It should be noticed, that when the helices produced the greatest effect, they were raised about 2½ inches above the rail, measuring from their under sides.

TELEGRAPH APPLIED TO MILITARY PURPOSES.

At the battle of Solferino, a high degree of precision in evolution was attained by the French army, by means of the telegraph.

From each corps, once in position, a horseman rode off to the next division, unrolling on his rapid course a light wire, which no time was lost in adapting to a field apparatus; and the process was repeated all along the French line of twelve miles. Hence the movement of the whole army was known and regulated like clock-work, on that decisive day. This arrangement had been planned in Paris, and a supply of gutta-percha covered metal thread forwarded with secrecy and dispatch.

MAGNETIC ACTION OF THE SUN.

The following abstract of a lecture delivered before the Royal Institution (London), by Mr. Brayley, exhibits in brief the present state of our knowledge respecting the magnetic action of the Sun, and its connection with the spots on its surface, the earth's magnetism, and the polar lights, or the result of those observations by which, as it has been said, we are "landed in a system of cosmical relations, in which both the sun and the earth, and probably the whole planetary system, are implicated." In the opinion of the Joint Magnetic Committee of the British Association for the Advancement of Science, and the Royal Society, expressed in their report, that discussion has not merely brought into view, but fully established, the existence of a very extraordinary periodicity in the extent of fluctuation of all the magnetic elements, which connects them directly with the physical constitution of the Sun, and with the periodical greater or less prevalence of spots on its surface, — the maxima of the amount of fluctuation corresponding with the maxima of the spots, and these again with those of the exhibitions of the Aurora Borealis, which thus appears also to be subject to the same law of periodicity. The discovery made by General Sabine of a decennial period in all those magnetic influences at the surface of the globe, which, by their dependence on the hours of solar time, led him to recognize the Sun as their primary cause — operating, however, in some other manner than by its heat — was explained by reference to the observations of Arago on the diurnal variation of the declination, which were purposely selected by the lecturer, as giving independent evidence on the subject, having been made before the establishment of the British Magnetic Observatories, and because that philosopher was evidently unaware of the existence of the periodicity they demonstrate, in common with the later and different observations in which the decennial period was first recognized by Sabine. A general view was then taken of the phenomena of the Solar Spots, and of the analogy between them and the revolving storms of our own atmosphere first inferred by Sir John Herschel, and since remarkably confirmed, it was stated, by the observations of the Rev. R. Dawes on the rotation of the spots about their own centres, and those of Mr. Carrington on the currents in which they appear to drift across the Sun; and the discovery of a decennial period in their amount and frequency by Schwabe of Dessau, in the observations which he has carried on for the third part of a century, was described by reference to tables comparing the periods of the maxima and the minima of the spots with those of the magnetic fluctuations as made known by Sabine, which were thus shown to be, when complete, corresponding periods of ten years. The enormous activity in certain regions of the Sun indicated by the magnitude of the spots, and the rapidity of their motions and changes, it was suggested, was adequate to any conceivable exertion of force upon the Earth. In proceeding to the third subject of this law of periodicity, the Polar Lights, after a brief description of their characteristic phenomena, Mr. Brayley stated that, in his opinion, the only suggestion of their cause, hitherto enunciated, in the nature of a *vera causa*, had been made by Professor Faraday, and had been amply verified by facts subsequently observed, — a statement now made for the first time. In the Bakerian Lecture, read before the Royal Society in 1832, relating his discovery of terrestrial magneto-electric induction, Mr. Faraday showed that effects similar to those he had obtained by instrumental means, but infinitely greater in force, might be produced by the action of the globe, as a magnet, upon its own mass, in consequence of its diurnal rotation; and, in the sequel, he asked whether the Aurora Borealis and Australis might not be the discharge of electricity, thus urged towards the poles, and endeavoring to return, above the earth, to the equatorial region; citing, as in accordance with an affirmative reply, the effect of an aurora upon the magnetic needle recorded by Mr. R. W. Fox. He did not pursue the subject; but the hypothesis has been abundantly verified, with respect to the production of terrestrial currents of electricity, in the manner inferred, by the earth's rotation, and the other natural motions of conductors cutting the magnetic curves, by facts which the electric telegraph, land and submarine, has disclosed, and some of which were recited; while all the phenomena of the Polar Lights themselves, especially those which are susceptible of precise measurement and instrumental observation, conspire to verify Faraday's suggestion as to their immediate nature and cause. That they are truly electrical in their nature, an inference rendered so probable by their obvious phenomena, Mr. Brayley considered to be proved by their (electro-magnetic inductive) effects on the magnetic elements; nothing hitherto known having the power of producing such effects but magnetism itself, and electricity, while no phenomena of the former are luminous, — there is no magnetic light; — and the absence of atmospheric electricity during the display of the aurora, paradoxical as it may seem, is a necessary consequence, the electricity being absorbed, as it were, by its conversion into the correlate magnetism; or, in other words, ceasing to be statically manifested while being dynamically exerted. Some experimental illustrations of the electrical nature of the Polar Lights were then exhibited, in which the luminous disruptive discharge was taken in exhausted tubes, that is, in excessively rare media resembling in their attenuation the atmosphere itself at the elevations where the Aurora occurs; one of the tubes, prepared by M. Gassiot, showing the stratified discharge (originally obtained by Mr. Grove), recently cited by Humboldt in evidence that the dark space in the Aurora may be real, and not merely the effect of contrast. The source of the electricity in these experiments being the apparatus termed the Ruhmkorff coil, the close accordance between them and the natural phenomenon was pointed out, in the fact that the electricity was obtained by a process of magneto-electric induction, exactly analogous, on the small scale, to the natural process to which, operating in the globe itself, Faraday has referred the electricity manifested in the Polar Lights. The actual influence of the Aurora on the magnetic elements was exemplified by three photographs from the self-registering apparatus at the Kew Observatory, on which the vertical, the horizontal, and the total-force magnetometers, respectively, had recorded the disturbances produced in them by the Aurora of December 3, 1858. The facts establishing the participation of the Polar Light in the great law of solar periodicity which it had been the object of the lecturer thus generally to explain, were then briefly stated; and the conclusion was deduced, that the relation of the periodicity to the electrical causation of the Polar Light is simply this, — that the magnetic action of the Sun periodically affects the terrestrial magnetism, which being converted into electricity by the earth's rotation and moving conductors, agreeably to the theory maintained, exhibits the period in the polar discharges of that electricity.

MAGNETIC DECLINATION.

From a table published by Encke, in the *Memoirs of the Berlin Academy*, it appears that, in the fifteen years between 1839 and 1854, the magnetic "declination," or the westerly deviation of the magnetic north from the true north, has diminished 1° 49½′; the "variation" has, therefore, been at the mean rate of 7¼ minutes per annum; but it has been a little greater in the second half of the term than the first. The declination at Berlin in 1854 was 14° 56′ 52″.

At a meeting of the Royal Belgian Academy, a letter was read from Hansteen to the secretary, M. Quetelet, stating that with one of Gambey's needles, aided by careful manipulation, he is able to take the precise dip within at least half a minute. From observations made in four summer months with a dipping-needle and unifilar and bifilar horizontal needles, he has come to the conclusion that the diurnal variation, observable in magnetic phenomena, is produced by a feeble perturbative force which turns round the horizon from east to west in twenty-four hours. "When this force proceeds to the south, the horizontal intensity diminishes, the inclination augments, and the declination has its mean value (about ten hours before midday); when it proceeds to the north, the horizontal intensity increases, the inclination diminishes, and the declination assumes its mean value, which takes place about an hour before sunset; when it proceeds towards the west or the east, the respective declination augments or diminishes (one hour after midday, eight hours before midday or midnight"). The inclination or dip, which is now decreasing, will reach its minimum, Hansteen thinks, in Western Europe, in 1878, and has already reached it in Siberia. Its maximum was in 1678, indicating a period of two hundred years.

ON A NEW METHOD OF RENDERING VISIBLE TO THE EYE SOME OF THE MORE ABSTRUSE PROBLEMS OF CRYSTALLOGRAPHY, HITHERTO CONSIDERED ONLY AS MATHEMATICAL ABSTRACTIONS.

There are some propositions of crystallography which require some mechanical means beyond that of the use of solid models, to make them appeal to the eye for clearer perception. The most perfectly symmetrical solid forms of the crystallographer belong to the cubical or tessular system. There are seven different kinds or orders of forms belonging to this system, perfectly symmetrical, four of which admit of an infinite variety of species. These forms are associated in nature, as well as in their mathematical relations to each other. They are found in crystals of the same substance, either in their simple forms, or else associated in combination with each other, in the different faces of a compound crystal; thus the cube, the octahedron, and the rhombic dodecahedron, are found as simple crystals of the diamond; or faces parallel to all three or two of them, may be discovered on a more complex natural crystal. The three forms we have just enumerated, — the cube, the regular octahedron, and the rhombic dodecahedron, — may be considered as the permanent or limiting forms of the cubical system; they admit of no varieties; their angles, whether those of the inclination, of adjacent faces, or of the planes constituting their faces, are invariable; they are also limiting forms. Between the octahedron and the rhombic dodecahedron, we may conceive an infinite number of varieties of the three-faced octahedron, passing from the form of the octahedron to that of the rhombic dodecahedron; similarly, the octahedron and the cube are limiting forms of an infinite series of twenty-four-faced trapezohedrons, and the cube and rhombic dodecahedron of a series of four-faced cubes. The forty-eight-faced scalenohedron, or the six-faced octahedron, is a form varying within the limits of all the others. To represent to the eye the passage of all the varieties of these forms between their respective limits, is the object of the mechanical contrivance which is the subject of this paper. A skeleton or armillary sphere is constructed of iron wire, so as to mark out the principal zones of the sphere of projection of the forms of the cubical system; three circles are united at right angles to each other, so as to represent eight equilateral spherical triangles, each of whose sides are arcs of 90°. The six points where the arcs cross each other are the poles of the six faces of the cube; the lines joining each pair of opposite poles represent the cubical axes, each axis being perpendicular to two faces of the cube which can be inscribed in the sphere. Each arc is now bisected. These twelve points of bisection are the poles of the rhombic dodecahedron; the lines joining the opposite pairs of these poles are the rhombic axes, each of these axes being perpendicular to two faces of the rhombic dodecahedron inscribed in the spheres, or inscribed in the cube inscribed within the sphere. Let each of the eight equilateral spherical triangles be divided into six equal and similar spherical triangles by arcs, joining the angle of each triangle with the centre of its opposite side. The armillary portion of the sphere is now completed. The point within each of the eight equilateral spherical triangles, formed by the intersection of the three arcs by which it is divided, is the octahedral pole. There are, of course, eight of these; the lines joining the opposite pairs of these poles are the octahedral axes, each one being perpendicular to two opposite faces of the regular octahedron inscribed in the sphere, or in the cube inscribed within the sphere. If we now join each pole of the octahedron with the three poles of the octahedron in the three adjacent equilateral spherical triangles by straight wires, and do this symmetrically for the eight poles, we shall then have the edges of the cube inscribed within our armillary sphere, — the octahedral axes joining the opposite solid angles of this cube, and the rhombic axes passing through the centres of each opposite edge. Within this skeleton cube we now inscribe a regular octahedron, using elastic strings for its edges, by uniting the point where each cubical axis passes through the face of the cube, with the similar points on the two adjacent faces. Each face of the octahedron is therefore represented by an equilateral triangle of elastic cord. We now suppose each side of the eight equilateral triangles to be bisected. Every angle of the eight equilateral triangles is joined to the bisection of its opposite edge by another series of elastic cords. We have now an octahedron inscribed in the cube inscribed within our armillary sphere, — every face of the octahedron having marked upon it the traces formed by an imaginary plane passing through the zones of its sphere and its centre. It will now be seen that the cubical axes join the opposite solid angles of the octahedron; the rhombic axes the bisections of its opposite edges; while the octahedral axes pass through the intersections of the elastic cords, which join each solid angle of the octahedron with the centres of the edges opposite to it. The points where the elastic cords meet, and the octahedral axes pass through the faces of the octahedron, are now fastened to cords. These cords are made to run round pulleys, and are united together, so that by pulling them simultaneously, the points uniting, every one of the three elastic cords which are described on the face of the inscribed octahedron, can be made to travel uniformly and symmetrically along each of the octahedral axes, from the face of the octahedron to the solid angle of the circumscribing tube. Another series of cords are united to each of the four elastic cords, which meet at the point bisecting each of the edges of the inscribed octahedron. These, by a similar contrivance, are made to draw these points along the rhombic axes. The instrument is now completed. By simply pulling the eight cords united together, which cause the elastic cords to ascend the octahedral axes, the inscribed octahedron passes through every form of the three-faced octahedron, till it reaches the limiting form of the rhombic dodecahedron, — each three-faced octahedron being inscribed within the cube inscribed within the sphere. In a similar manner, by pulling the cords running along the rhombic axes in combination with those running along the octahedral axes, all the other forms are shown as passing within their prescribed limits. As soon as the cords are loosened, the elastic bands immediately resume the form of the inscribed octahedron. In addition to these forms the instrument also can be made to demonstrate the passage of all the hemihedral forms of the cubical system, with inclined faces within their limits. In this manner, it was demonstrated that this instrument can make visible to the eye all the changes and varieties of an interesting series of forms and their mutual relations, which could otherwise only be conceived by a considerable power of mathematical abstraction. This armillary sphere, by some other small additions, can be make use of for tracing out some of the most beautiful portions of the zone-theory of the poles of crystals. — *Rev. Walter Mitchell, M. A., Proc. Royal Institution, London, March* 18, 1859.

OBSERVATIONS ON PHOSPHORESCENCE.

At a late meeting of the American Photographic Society, New York, the subject of phosphorescence being under discussion, the President, Professor W. H. Draper, made the following remarks: "I will mention a fact or two which may be found to have some bearing on the question of stored-up light. If the powder of sulphide of calcium be spread on some convenient surface, as a sheet of tin, and upon this a key be laid, and the whole be exposed for a few minutes to the sunlight, on bringing it in a dark room and removing the key, the whole surface will shine, except where the key left its shadow. The image of the key will appear black on a white ground. The phosphorescent light, however, gradually diminishes, till the image of the key cannot be distinguished. If now a ring be laid on the powder, and the surface be again exposed to sunlight, in the dark the image of the ring will appear and disappear. The experiment may be continued with other objects, and with precisely similar results. So far you find nothing that you did not know or might easily anticipate. But now heat the plate in the dark, and the images of the key and ring, and other objects, will reäppear. These images were impressed, for a considerable time were latent, and again they are developed. A phosphorescent which has lost its power to shine in the dark, recovers this power when a spark of electricity is sent through it. The light now given out passes readily through quartz, while glass is opaque to it. I have examined a great many diamonds in the study of phosphorescence. I have observed that yellow diamonds are invariably phosphorescent, and shine with brighter light than others. If, after the diamond has ceased to shine in the dark, it be warmed in the hand, it glows again, but only for a short time; this property may be restored successively at increasing temperatures."

ON PHOSPHORESCENCE, FLUORESCENCE, ETC.

The following is a report of a lecture on the above subject, given by Professor Faraday, before the Royal Institution, June 17th, 1859: The agent understood by the word "light," presents phenomena so varied in kind, and is excited to sensible action by such different causes, acting apparently by methods differing greatly in their physical nature, that it excites the hopes of the philosopher much in relation to the connection which exists between all the physical forces, and the expectation that that connection may be greatly developed by its means. This consideration, with the great advance in the experimental part of the subject which has recently been made by E. Becquerel, were the determining causes of the production of this subject before the Members of the Royal Institution on the present occasion. The well-known effect of light in radiating from a centre, and rendering bodies visible which are not so of themselves, as long as the emission of rays was continual — the general nature of the undulatory view, and the fact that the mathematical theory of these assumed undulations was the same with that of the undulation of sound, and of any undulations occurring in elastic bodies, were referred to as a starting position. Limited to this effect of light, it was observed that the illuminated body was luminous only whilst receiving the rays or undulations. But superadded occasionally to this effect is one known as phosphorescence, which is especially evident when the sun is employed as the source of light. Thus, if a calcined oyster-shell, a piece of white paper, or even the hand, be exposed to the sun's rays, and then instantly placed before the eyes in a perfectly dark room, they are seen to be visible after the light has ceased to fall on them. There is a further philosophical difference, which may thus be stated: if a piece of white oyster-shell be placed in the spectrum rays issuing from a prism, the parts will, as to illumination, appear red, or green, or blue, as they come under the red, green, or blue rays; whereas, if the phosphorescent effect be observed, *i. e.*, that effect remaining after the illuminating rays are gone, the light will either be white, or of a tint not depending upon the color of the ray producing it, but upon the nature of the substance itself, and the same for all the rays. The ray which comes to the eye in an ordinary case of visibility, may be considered as that which, emanating from the luminous body, has impinged upon the substance seen, and has been deflected into a new course, namely, towards the eye; it may be considered as the same ray, both before and after it has met with the visible body. But the light of phosphorescence cannot be so considered, inasmuch as *time* is introduced; for the body is visible for a time sensibly after it has been illuminated, which time in some cases rises up to minutes, and perhaps hours. This condition connects these phosphorescent bodies with those which phosphoresce by heat, as apatite and fluor-spar; for when these are made to glow intensely by a heat far below redness, it is evident that they have acquired a state which has enabled them for a time to become original sources of light, just as the other phosphorescent bodies have by exposure to light acquired a like state. And then again, there is this further fact, that as the fluor-spar, which has been heated, does not phosphoresce a second time when reheated, still it may be restored to its first state by passing the repeated discharge of the electric spark over it, as Pearsall has shown. Then follows on (in the addition of effect to effect) the phenomena of fluorescence, and the fine contributions to our knowledge of this part of light by Stokes. If a fluorescent body, as uranium glass, or a solution of sulphate of quinine, or decoction of horse-chestnut bark, are exposed to diffuse daylight, they are illuminated, not merely abundantly but peculiarly, for they appear to have a glow of their own; and this glow does not extend to all parts of the bodies, but is limited to the parts where the rays first enter the substances. Some feeble flames, as that of hydrogen, can produce this glow to a considerable degree. If a deep-blue glass be held between the body and the rays of the sun, or of the electric lamp, it seems even to increase the effect; not that it does so in reality, but that it stops very many of the luminous rays, yet let the rays producing this effect pass through. By using the solar or electric spectrum, we learn that the most effectual rays are in most cases not the luminous ones, but are in the dark part of the spectrum; and so the fluorescence appears to be a luminous condition of the substance, produced by dark rays which are stopped or consumed in the act of rendering the fluorescent body luminous; so they produce this effect only at the first or entry surface, the passing ray, though the light goes onward, being unable to produce the effect again; and this effect exists only whilst the competent ray is falling on to the body, for it disappears the instant the fluorescent substance is taken out of the light, or the light shut off from it. When E. Becquerel attacked this subject, he enlarged it in every direction. First of all, he prepared most powerful phosphori, these being chiefly sulphurets of the alkaline earths, strontia, baryta, lime. By treatment and selection, he obtained them so that they would emit a special color; thus, seven different tubes might contain preparations which, exposed to the sun, or diffused daylight, or the electric light, should yield the seven rays of the spectrum. The light emitted generally possessed a lower degree of refrangibility than the ray causing the phosphorescence; but in some instances he was able to raise the refrangible character of the ray emitted to that of the exciting ray. By taking a given preparation, and raising it to different temperatures, he caused it to give out different colored rays by the single action of one common ray; this variation in power returning to a common degree as the temperatures of the phosphori became the same in all. He showed that *time* was occupied in the elevation of the phosphorescent state by the ray, and also that time was concerned in various degrees during the emission of the phosphorescent ray; that this time, which in many cases was long, might be affected, being shortened by the action of heat, and then the brilliancy of the phosphorescence for the shortened time was increased. He showed the special relation of the different phosphori to the different rays of the spectrum, pointing out where the maximum effect occurred; also that there were the equivalents of dark bands, *i. e.*, bands in the spectrum, where little or no phosphorescence was produced. These phosphori were many of them highly fluorescent. Thus, if one of them was exposed to the strong voltaic light, and then placed in the dark, it was seen to be brilliantly luminous, gradually sinking in brightness, and ultimately fading away altogether; but if it were held in the rays beyond the violet end of the spectrum (the more luminous rays being shut off), it was again seen to be beautifully luminous, but that state disappeared the instant it was removed from the ray. Now this is fluorescence, and the same body seemed to be both phosphorescent and fluorescent. Considering this matter, and all the circumstances regarding time, Becquerel was led to believe that these two luminous conditions differed essentially only in the time during which the state excited by the exposure to light continued; that a body being really phosphorescent, but whose state fell instantly, was fluorescent, giving out its light while the exciting ray continued to fall on it, and during that time only; and that a phosphorescent was only a more sluggish body, which continued to shine after the exciting ray was withdrawn. To investigate this point, he invented the *phosphoroscope*, an apparatus which may vary in its particular construction, but in which disks or other surfaces, illuminated by the sun or an electric lamp might, by revolution, be rapidly placed before the eye in a dark chamber, and so be regarded in the shortest possible space of time after their illumination. By such an apparatus Becquerel showed that all the fluorescent bodies were really phosphorescent, but that the emission of light endured only for a short time. An extensive series of experimental illustrations upon the foregoing points was made with fine specimens of phosphori, for which the speaker was indebted to M. Becquerel himself. The phosphoroscope employed consisted of a cylinder of wood, one inch in diameter and seven inches long, placed in the angle of a black box with the electric lamp inside, so that three-fourths of the cylinder were external, and in the dark chamber where the audience sat, and one-fourth was within the box, and in the full power of the voltaic light. By proper mechanical arrangements this cylinder could be revolved, and the part which was at one instant within, rapidly brought to the outside, and observed by the audience. As the cylinder could be made to revolve 300 times in a second, and as the twentieth part of a revolution was enough to bring a sufficient portion of the cylinder to the outside, it is evident that a phosphorescent effect which would last only the $\frac{1}{3000}$ or even the $\frac{1}{6000}$ of a second might be made apparent. All escape of light between the moving cylinder and the box was prevented by the use of properly attached black velvet. The cylinder was first supplied with a surface of Becquerel's phosphori. The effect here was, that when by rotation the part illuminated was brought outside the box, it was found phosphorescent. If the cylinder continued to rotate, it appeared equally luminous all over, and when the rotation ceased, or the lamp was extinguished, the light gradually sank as the phosphorescence fell. Then a cylinder having a surface of quinine or æsculin, was put into the apparatus. Whilst the cylinder was still, it was dark outside; but when revolving with moderate velocity it became luminous outside, ceasing to be so the moment the revolution stopped. Here the fluorescence was evidently shown to occupy time, — indeed, the full time of a revolution, — and taking advantage of that, the self-shining of the body was separated from its illumination within, and the fluorescence made to assume the character of phosphorescence. Another cylinder was covered with crystals of nitrate of uranium, a hot saturated solution having been applied over it with a fine brush. The result was beautiful. A moderate degree of revolution brought no light out of the box, but with increased motion it began to appear at the edge. As the rapidity became greater, the light spread over the cylinder, but it could not be carried over the whole of its surface. It issued as a band of light where the moving cylinder left the edge of the box, diminishing in intensity as it went on, and looking like a bright flame, wrapping round half the cylinder. When the direction of revolution was reversed, this flame issued from the other side, and when the motion of the cylinder was stopped, all the phenomena of fluorescence or phosphorescence disappeared at once. The wonderfully rapid manner in which the nitrate of uranium received the action of the light within the box, and threw off its phosphorescence outside, was beautifully shown. The electric light, even when the discharge is in rarefied media, or as a feeble brush, emits a great abundance of those rays, which produce the phenomena of fluorescence; but then if these rays have to pass through common glass, they are cut off, being absorbed and destroyed, even when they are not expended in producing fluorescence or phosphorescence. Arrangements can, however, be made, in which the advantageous circumstances can be turned to good account with such bodies as Becquerel's phosphori, or uranium glass. If these be inclosed within glass tubes having platinum wires at the extremities, and which are also exhausted of air and hermetically sealed, then the discharges of a Ruhmkorff coil can be continually sent over the phosphori, and the effects, both fluorescent and phosphorescent, be beautifully shown. The first or immediate light of the body is often of one color; whilst on the cessation of the discharge, the second or deferred light is of another, and many variations of the effects can be produced. In connection with rarefied media it may be remarked, that some of the tubes by Geissler and others have been observed to have their rarefied atmospheres phosphorescent, glowing with light for a moment or two after the discharge through them was suspended. Since then, Becquerel has observed that oxygen is rendered phosphorescent, *i. e.*, that it presents a persistent effect of light, when electric discharges are passed through it. I have several times had occasion to observe that a flash of lightning, when seen as a linear discharge, left the luminous trace of its form on the clouds, enduring for a sensible time after the lightning was gone. I strictly verified this fact in June 1857, recording it in the *Philosophical Magazine*, and referred it to the phosphorescence of the cloud. I have no doubt that that is the true explanation. Other phenomena, having relation to fluorescence and phosphorescence, as the difference in the light of oxygen and hydrogen exploded in glass globes, or in the air, were referred to, with the expression of strong hopes that Becquerel's additions to that branch of science would greatly explain.

ON INTERMITTING FLUORESCENCE.

J. Müller has observed in platinocyanid of barium a peculiar phenomenon, to which he has giving the name of intermitting fluorescence. When a strip of paper is washed with a solution of the salt in such a manner that on evaporation the surface appears covered with a layer of delicate green crystals, and then exposed in a dark room to the spectrum produced by a flint glass prism, aided by a lens of long focal distance, almost the whole portion on which the blue rays fall appears blue. In this blue portion, however, three isolated green fluorescent bands appear. The middle of one of these bands corresponds to Frauenhofer's line G; the two others lie between G and F. The centres of these bands correspond to the wave-lengths 0·000462^{mm}, 0·000446^{mm}, 0·00430^{mm}. From this it appears that rays of these wave-lengths produce fluorescence, while those of intermediate wave-lengths produce none. An uninterrupted green fluorescence begins at that portion of the spectrum which corresponds to a wave-length of about 0·000410^{mm}. No similar phenomenon has hitherto been observed. —*Pogg. Ann.*, civ., 649.

NOTE ON THE POLARIZATION OF THE LIGHT OF COMETS.

The following note, communicated by Sir David Brewster to the French Academy, is published in the *L. E. and D. Philosophical Magazine*, for April 1859, p. 311. Although there can be no doubt as to the accuracy of the observations of M. Arago, on the indications of polarization discovered by him in the light of the comets from 1819 to 1835, there is nevertheless nothing impossible in the supposition that the light may have been polarized after arriving in the terrestrial atmosphere. In fact, when we consider that light is polarized by refraction in passing through the coats of the eye, that it is polarized by refraction at the four or six surfaces of the object-glasses of an astronomical telescope, and also in passing through the surfaces of its eyepiece, and lastly, that the light of celestial bodies undergoes a slight polarization by the refraction of the atmosphere, we are compelled to admit that the problem of the existence of polarized light in the light of comets is not solved.

I am not aware that those who have observed traces of polarization in the light of comets, have noticed the direction of the plane in which it has been polarized; nevertheless, without some observation we cannot discover its cause. If the light be polarized in a plane passing through the sun, the comet and the eye, we must infer that it is polarized by the reflection of the light coming from the sun; if it be polarized in an opposite plane, the polarization may be due to the refraction of the atmosphere. If it be polarized *qua qua versus*, this may be due to these causes, viz., to refraction by the surfaces of the object-glasses and eye-piece, to the imperfection in the annealing of the glass of which the lenses are formed, or to the fact of one or more of the lenses being pinched in their cell. Supposing it to be an effect of the first of these causes, the opening of the object-glasses and eye-piece should be reduced to a central band, which would eliminate the light polarized in an opposite plane, and leave that which is polarized in a plane perpendicular to the direction. By turning the telescope on the lenses, the direction of the polarization would be changed.

If the polarization be produced by a defect in the annealing of the glass of which the lenses are made, the existence of this imperfection will be rendered evident by exposing the lenses to polarized light.

If the polarization observed be due to the reflection of the rays of the sun by the comet, or its envelope, small stars will be seen more distinctly when the polarized light is extinguished by the application of a Nicol's prism.

Objects rendered visible in a fog. — Whilst I was studying the polarization of the atmosphere, I observed this remarkable fact, that when distant objects are rendered indistinct by the interposition of a light fog, a part of their definiteness may be restored by looking at them through a Nicol-prism, which stops all the light which the fog has polarized in a plane passing through the sun, the object, and the eye of the observer. The objects thus made more distinct and visible, were seen through that portion of the fog in which the polarization of the reflected light was at a maximum. This method of rendering visible, objects rendered indistinct by fogs, may, it appears to me, receive important applications in military and naval operations.

ON THE FORM OF THE EYEBALL, AND THE RELATIVE POSITION OF THE ENTRANCE OF THE OPTIC NERVE INTO IT IN DIFFERENT ANIMALS.

In a paper on the above subject presented to the British Association, 1858, by Mr. T. Nunneley, the author observed that the orbits of the eyes are much larger than the eyeballs, and that their axes diverge considerably in an outward direction, while those of the two eyes are perfectly parallel. The eyeballs lie in the fore-part of the orbits, and according as they are more or less prominent, and more or less covered with the lids, do they appear to be larger or smaller. The eye of the infant is larger, in proportion to the size of the body, than that of the adult; but it is by no means certain that the eye of the male is larger proportionately to the size of the body than the eye of the female. By some anatomists the human eye was described as a spheroid, the diameter of which, from before to behind, is greater than in any other direction. He had measured a great number of eyes, of the human subject as well as of animals, and he found that wherever there was a departure from the spherical figure, it was in the direction contrary to that which had been commonly stated. In some instances the difference between the two diameters was scarcely perceptible; in all, where a distinction was observed, the transverse was the greatest. He had prepared a set of tables (which were printed), containing the result of the measurement of two hundred eyes of various creatures. In conclusion, Mr. Nunneley said: The measurements, I think, clearly prove that whatever part the fibres of the optic nerve play in the phenomena of vision, — and they, in all probability, only convey to the sensorium the impression received by the true retinal elements, — the greatest number of them are distributed on that part of the eyeball where there is the greatest range of vision, and that the largest expanse of retina is on that part of the ball opposite to where objects are placed, and consequently it is where the visual images of them must fall. Thus the extent of vision is always in conformity with the space of retina on that side of the optic nerve, and as the rods and cellules appear always to correspond in abundance with the fibres, that side of the retina which receives the greatest number of images is most exercised, or where the range of vision is the greatest, is always the largest. That this is a fact, I think a careful comparison of the position of the eyes in the head, the size of the eyeball, and the exact position of the entrance of the nerve into it, with the mode of life and habits of various creatures, will render more obvious than a casual glance would do. To mention only a few instances as illustrations: Man, from the erect position of his body, the horizontal placing of his eyes, and his habits, has a more panoptic range than any other creature (of course in this consideration all motion of the head, neck, and body of the animal, must be excluded, and those of the eyeballs alone admitted). In him the optic nerve enters the ball not far from the centre; leaving, however, a somewhat shorter space on the inner and lower parts of the retina than on the upper and outer. Now, while man enjoys a free range of vision *above* the horizontal line, there are far more occasions for him to look at objects below than above this line, and thus mere visual images are projected to the upper and outer sides of the entrance of the optic nerve oftener than to the inner and lower sides of this spot. In the pig, who sees at no great range before him, and who seeks his food with the snout almost always in the ground, whose head and eyes are consequently for the most part downward and near the ground, the nerve enters the ball more outwardly and much lower than it does in man. The pig wants not to see far before him, but he does require, while grubbing, to look behind him, from whence danger comes. So with the timid herbivorous animals. Look at the entrance of the nerve in the bullock and sheep, who pass so much time with the head in a dependent position near to the ground with the eye directed upon the surface, in open plains, where danger usually comes from behind; in them the upper and the inner sides of the retina are much larger than the lower and outer portions; while in the deer, who live in more wooded places, where danger is also from the front, but who, like the bullock, has the head downward in feeding, though the inner or anterior side of the retina is still larger than the posterior, it is so to a much less extent than it is in the bullock, while the upper portion still continues as proportionately large as it is in sheep and bullocks. On the contrary, in the horse, who is not so preyed upon, who carries the head erect, and observes all around, the nerve enters the eye more nearly in the axis. In birds, with few exceptions, the upper portion of the retina is much more considerable than the lower parts, but the anterior and posterior portions vary much in different genera. Those whose locomotion is performed principally by the feet, and whose range of habitation is very small, as the common fowl and turkey, have the inner or anterior portion very considerably greater than the outer or posterior. Those birds whose range is greater, and who use the wings for progression, but do not wander very far, as the grouse and partridge, have much less difference in the two portions of the retina; while in those birds whose flight is far and prolonged, as the crow, rook, swan, goose, and duck, the entrance of the nerve is very nearly to the centre of the ball. So in reptiles. In the turtle, who only requires to see immediately before and under him, the outer and upper portions of the retina are very much the larger. In the more active alligator, frog, toad, and chameleon, while the upper portion maintains its size, the outer and inner parts are more nearly equal. In those creatures whose habitation is for the most part under ground, as the shrew and the mole, the eyes are so small as to have led Magendie to assert that the mole is without the organs altogether, which is not the fact, for I have found all the essentials of an eye, even true retinal elements, optic nerve, and a well-developed choroid. Yet the organ is so minute, and concealed by the skin and hair, as probably only enables the creature to discern the light, which is all that it requires; for, living underground, where it seeks its prey, it obviously must depend upon the acuteness of other senses than of sight for its living. Though in the individual there is usually some proportion between the size of the eye and the body, taking different classes and genera, the size of the animal is very little guide to that of the eye, the proportions between the two being determined by other considerations than that of the bulk alone of the creature; for though, as a whole, the eye in fish bears a larger proportion to the whole body than it does in other divisions of the animal kingdom, and the eyes of birds are, as a class, much larger than those of mammalia or reptiles, yet amongst the different genera of all these classes there are very great differences, determined, apparently, by the following considerations, amongst others not so obvious. When the creature lives in feeble light, yet moves actively about, and is guided in its locomotion by the sense of sight, as in nocturnal birds and animals and fish, the eye is very large, apparently to take in a large quantity of the feeble light; on the contrary, where the creature is guided in its movements by other senses, then the eye is very small, as in the bat, the mole, the shrew, and the eel. Where vision penetrates to a long distance, and where the eye enjoys great power of overcoming the aberration of parallax, the eye is large, as in rapacious birds. When the brain and intellect are more developed, the size of the eye diminishes, and the two eyes become more parallel, as in man and the higher mammalia. Where animals are feeble, timid, have but little defensive power, and are preyed upon, the eye is usually very large, as in the hare, the conies, the whole deer tribe, and many of the other ruminants. Where the animal is not predacious, and the size and strength are such as to protect it from being preyed upon, the eyes are commonly small, as in the whale and the elephant: in the latter the eye is even smaller than it is in the horse, and scarcely larger than in the eagle.

KALEIDOSCOPE TOP.

Under the above name a beautiful philosophical toy has lately been exhibited to the London Society of Arts. It is a top, with a flat disk of wood, and a spindle in its centre, by which it is set in motion with a string. On the upper surface of the disk cards of various colors and shapes are placed, and held by pins, and the top is set in motion. This produces pleasing effects, as a blue and yellow card exhibits a green color, a red and blue card a purple, and a red and yellow card an orange color. By taking a black card pierced with holes, and held steady above the rotating colored cards, the eye sees through the openings a most beautiful play of colors. They dance and waver in the outline of the perforated black card in a manner that appears magical. These effects are due to the fact that the eye retains for a certain period the impressions of color which it receives, and one impression has not time to be effaced before another succeeds it. The inventor is J. Gorham, who has thus succeeded in making a toy exhibit all the effects of the well-known prismatic wheel.

OCCASIONAL LUMINOUSNESS OF THE ATMOSPHERE AT NIGHT, AS OBSERVED ON THE ANDES.

In a communication on the above subject, presented to the American Association for the Promotion of Science, 1859, by the Rev. George Jones, U. S. N., the author first referred to the case mentioned by Humboldt, in his Cosmos, which occurred in Germany about the year 1833, when the atmosphere was so luminous that people could see to read fine print. While at Quito, in 1856–7, he (Mr. Jones) noticed a singular luminousness, — not constant, but occasional, — and made records of the phenomenon. About that time, and before he had spoken to any one about it, an Irish gentleman, Col. Lanegan, who had taken part in the revolutionary struggle in Ecuador, mentioned a similar case which he had observed at Macheche, about three days' journey from Quito, when the night was so bright that his servant called him up, and they started on a journey, supposing it to be day, but after a while it became so dark that they could not see at all. Col. Lanegan attributed it to the zodiacal light, but he was wrong as to the cause.

The Colonel's statement led Mr. Jones to make some inquiries on the subject, of Col. Stacy, at Quito, who told him that, in his night-marches on the mountains, the air was often so bright that they could see everything distinctly, and again it was so dark that they went stumbling over every stone that came in their way.

Mr. Jones said his own observations were made on cloudy nights, when he could get no light from the stars, and the luminousness of the atmosphere was such, at times, that he could read the headings of newspapers, — the New York *Herald*, and New York *Journal of Commerce*, for instance. The next night would perhaps be so dark that he could not see his hand twelve inches from his face. He could not account for this phenomenon, unless on the supposition that all space was filled with luminous matter, that vibratory matter is self-luminous, and that it is sometimes swept by us in dense waves. This explanation, he admitted, was far-fetched, but he could think of no other.

MOTHER-OF-PEARL.

A peculiar phenomenon is noticed when wax, stearine, or similar substances, especially if colored black by lampblack or graphite, has been poured on a sheet of mother-of-pearl. It is that the inner surface of the congealed substance, in a certain position to the eye, appears with the same bright iridescence as the plate itself. This goes to prove that those colors are not owing to a particularity of the substance of mother-of-pearl, but solely to the condition of its surface, which consists of fine striæ that bend the rays of reflected light, and resolve them into the various colors. Its being reflected light, is proved by the complete disappearance of the variegated colors when the surface is exposed to homogeneous light, such as that from a lamp fed with alcohol containing chloride of sodium. Liquid wax or stearine poured on the surface will receive an impression of even the finest unevenness, only discernible with the glass, and therefore also striæ causing the iridescense. That the surface of mother-of-pearl gives this opalescence, in a number of positions, to the eye, and that obtained on wax only when held in a certain direction, is caused by the many laminæ underlying each other in the original, as remarked by Breithaupt. Seen through a Nicol's prism (of course with homogeneous light), in case the undulating plane of the prism falls vertically upon that of the reflected rays, the surface of the wax impression appears dark, while that of the original will still be bright; for although the plane of the prism be vertical to that of the rays proceeding from the surface, it intersects those from the underlying laminæ under a different angle. —*Archiv. der Pharmacie*, 1859.

NEW PHOTOMETER.

The following is a description of a new photometer, recently introduced for the testing of coal-gas.

It consists simply of a disk of paper, one portion of which is oiled and rendered translucent, while the remainder is left unoiled and opaque. The disk slides on a long graduated bar, which has the standard spermaceti candle (burning one hundred grains an hour) at one end, and the standard gas-burner (a five-feet Argand burner, fifteen holes, one-twenty-third of an inch in diameter, seven-inch chimney) at the other. If the paper is placed very near the candle, on looking at the side next the candle, we see the opaque portion of the disk much brighter than the oiled portion, the quantity of light from the candle which is reflected being greater than the quantity from the gas which is transmitted. On looking at the other side of the paper, the oiled portion presents the brighter appearance. The paper is slipped along until the distinction between the oiled and opaque parts disappears, and all portions of the disk present a uniform brightness, when seen on both sides. The comparative distances between the paper and the candle, and the gas and paper, being measured by the graduated bar on which the paper slides, a simple calculation gives the quantity of light emitted by the gas as compared with the candle.

ON THE MEASUREMENT OF THE CHEMICAL ACTION OF LIGHT.

M. Niepce St. Victor has devised the following plan for measuring the chemical action of light. He fills a flask with a solution composed of oxalic acid and nitrate of uranium, which produces, under the action of even diffused light, a disengagement of carbonic acid gas with effervescence. In order to assure himself that heat has nothing to do with this phenomenon, the vessel containing the solution was placed in a bath, and heated to the boiling-point, but no disengagement of gas took place.

There is in this fact the principle of an apparatus for measuring, comparatively, the action of light. A graduated tube, passing across the stopper of the flask, receives the liquid, which, under the pressure of the gas disengaged, rises more or less, according to the power of the luminous rays, during a given space of time.

ATMOSPHERIC REFRACTION.

Notwithstanding the great importance of solar eclipses in astronomical calculations, their value has been hitherto much diminished by a certain want of agreement of the phenomena observed with the calculations of the most competent astronomers. The moment when the eclipse becomes total, as well as the places over which the shadow passes, and the duration of obscurity, all commonly differ, in a most provoking manner, from what theory would seem to indicate. On this subject, M. Liais has written a letter to the Astronomer Royal, of Great Britain, in which he points out a source of error which had hitherto escaped the researches of the most distinguished *savans*. The law by which a ray of light, passing obliquely from a rare into a denser medium, is deflected from its path so as to enter the dense body less obliquely than it could have done by pursuing a straight course, is well known to hold good with respect to atmospheric strata of different density. This refraction causes the heavenly bodies to appear higher up in the sky than they really are; and the denser the atmosphere, and the nearer the luminary is to the horizon, the more will this effect be apparent. This refraction M. Liais calls the regular refraction; but, besides this, there exists an abnormal refraction, which takes place only on occasions of eclipses of the sun. It will be readily understood that the sun's rays being cut off from a portion of the earth by the interposition of the moon, the temperature decreases, and the strata of the atmosphere becomes denser over the place where the moon's shadow falls; thus a cone of comparatively dense air, surrounded by that which is expanded by the sun's heat, is created, which will cause a variation in the refraction of the solar rays. The tendency of this refraction will evidently be to diminish the extent of ground covered as well by the umbra as the penumbra, and to make the eclipse at any given point to commence later and end sooner, in other words, to be shorter, than previous calculation would indicate, if this abnormal refraction had not been taken into account. The amount of these refractions, depending as they do on the height of the sun and on variations in the atmospheric density, from a variety of causes, can never be calculated beforehand, but the necessary data can easily be obtained as the moment of eclipse approaches, by which to make the necessary corrections. Besides alterations in the apparent position and duration of the eclipse, these refractions produce several remarkable phenomena, which are only to be observed during a total solar eclipse; of these the peculiar blood-red color of the moon may be mentioned, as well as the apparent projection of the red flames, of which we know so little, upon the moon's disk during the eclipse of 1842. Again, slight irregularities in the refraction of different portions of the sun's edge may tend towards the production of what are known as Baily's beads, which have been frequently observed in cases where it is difficult to suppose the existence of lunar mountains to have caused them. M. Liais proposes, with a view to correcting errors in the determination of longitudes by eclipses, that the different phases of the phenomenon, as well before as after the moment of total obscurity, be photographed, and the least distance of the centres at the place of observation calculated from the variation of the angle of position of the cusps. The intersection of the line between the centres to be determined by calculation, together with the latitude of the place of observation, will give the longitude independently of these abnormal refractions.

EXPERIMENT IN BINOCULAR VISION, ELUCIDATING THE PRINCIPLES OF THE STEREOSCOPE.

A correspondent of the *Journal of the Franklin Institute*, states that a familiar experiment, illustrating the principle of the stereoscope may be made by looking into a mirror and concentrating the ocular axes upon any spot on the surface of the glass, of an equal elevation with the eyes. If no such spot exists, it can readily be supplied by wetting a piece of paper or wafer the size of a pea.

The reflected images of the eyes being as far behind the glass as the eyes are before it, and equidistant from each other, the ocular axes concentrated upon the surface of the mirror will, if produced, cross and precisely meet them, producing in the centre of the forehead one large cyclopian eye.

CURIOUS OPTICAL PHENOMENON.

At the Aberdeen meeting of the British Association, Sir David Brewster exhibited a curious specimen of chalcedony, in the interior of which was a landscape minutely depicted. The landscape was evidently produced by the action of nitrate of silver, which had been insinuated through pores into the interior of the chalcedony. The most curious fact, however, about the specimen was, that the landscape entirely disappeared after being kept some time in the dark, but was restored again in a most distinct manner, after an hour's exposure to the light.

Acting upon the suggestion afforded by this specimen, he had induced a lapidary in Edinburgh to try the experiment of introducing a figure into the interior of a mass of chalcedony, by drawing it on a polished surface of the stone with nitrate of silver. The attempt was wholly successful, and the figure of a dog could be distinctly seen in the centre of the specimen.

ON THE PRODUCTION OF LIGHT, AND THEORY OF COLOR.

In a paper on the above subject, read before the British Association, 1859, by J. Smith, Esq., of Perth Academy, the author stated that he was unable satisfactorily to account for certain natural phenomena connected with light by reference to either of the commonly received theories. A series of experiments were consequently undertaken with the object of clearing up this difficulty, and these experiments led to the conclusion that varieties of color are produced by pulsations of light and shadow in definite proportions for each shade of color. In order to make this point clearer, let us suppose white light to be caused by motion in a fluid, and black by the absence of motion, then a certain color — blue, for example — would be produced by a certain proportion of alternate rest and motion of this fluid. The following is an account of some of the experiments to which Mr. Smith had recourse during his investigations. He first caused a narrow parallelogram of cardboard to revolve over a black body with a rapidity which he considered equal to the vibrations of light in a second of time. By this motion he obtained a distinct blue, while at another time, in different weather, the same thing produced a purple. He then made a disk, with several concentric rings, which he painted respectively one-third, two-thirds, three-quarters, and one-half black, leaving the remainder white, and on making this disk revolve rapidly, the rings became completely colored — there was no longer any appearance of black or white. On a bright day, with white clouds in the sky, the rings were colored respectively a light yellowish-green, two different shades of purple, and a pink. He also cut a spiral figure of card, the revolution of which produced most beautiful colors in those parts offering certain proportions of black and white. The position, whether horizontal or vertical, in which the disks revolve, does not affect the result, and the colors can be reflected on a white screen; thus proving that they do not result from any illusion caused by the dazzling motion of the eye. From the experiments Mr. Smith concludes that light is simple and not compound, and that the phenomena of prismatic refraction and polarization of light must be explained upon hypotheses altogether different from those of Newton.

WOODWARD'S SOLAR CAMERA.

The Solar Camera, invented by Mr. Woodward, of Baltimore, Md., is, as its name implies, an adaptation of the principle of the solar microscope to the ordinary camera, for the purpose of obtaining a light sufficiently strong to be used for enlarging small photographs. Mr. Woodward is an artist by profession, and it often occurred to him that if he could get sufficiently enlarged copies of ordinary photographs to paint over canvas, it would be of great advantage; and, following up the idea, he has produced the invention in question. The condenser is placed in such a position that the point where the rays of light cross, answers to the diaphragm ordinarily used; and by this plan loss of light is avoided, and the image is free, or nearly so, from spherical aberration. Another advantage of the solar camera is, that the pictures can be printed direct upon the sensitive paper, thus avoiding the necessity of making a second negative, or of developing the paper pictures. Mr. Woodward generally uses ammonio-nitrate paper, and sometimes albumenized paper.

The powers of the Solar Camera have been put to a severe test in the United States Coast Survey. Thus, it was desired to ascertain how far it would be practicable to enlarge small copies of maps to scale; and for this purpose a sheet of paper was prepared with geometrical squares, crossed by diagonal lines. A collodion positive was taken of this, and projected, magnified eighty times, on a screen covering one hundred square feet, and the image was found, on accurate measurement, to be geometrically correct, the lines, etc., being all free from curvature to the edge.

FURTHER RESEARCHES BY M. NIEPCE ST. VICTOR ON THE ACTION OF LIGHT.

Some time since, M. Niepce St. Victor announced the fundamental fact, that a body exposed to solar radiation could act in the dark at a distance on certain bodies, like light which emanated directly from the sun. The observations were made mostly with a cylinder of white pasteboard. M. Niepce has since noticed that the pasteboard that has been exposed to the sun, and then has been preserved, in the dark, in a cylinder of sheet tin (tinned iron), is still active six months afterwards. This action of the chemical fluid calls to mind radiant heat. Nitrate of uranium has, in a high degree, the property of magnetizing the chemical fluid. On exposing to the sun, under a photographic proof, paper impregnated with nitrate of uranium, and then, at the end of a quarter of an hour, plunging it into a solution of nitrate of silver, in the dark, a positive image immediately appears, having the usual maroon color. To fix it, it is only necessary to wash in pure water. If the nitrate of silver is replaced by chloride of gold, the image appears of a deep blue. These pictures resist the action of the cyanide of potassium, even on ebullition; they are therefore far more stable than photographs taken in the ordinary way. Tartaric acid has the same property, though in a less degree. Heat increases the sensibility of the reäction. For on covering with a plate of iron heated to 50° C. both the pasteboard which bears the impression from the sun and the leaf of sensitive paper prepared with chloride of silver, the image will appear at the end of a few minutes, while at 0° C. it requires several hours to obtain a faint impression.

One general result of the researches of M. Niepce is this, that the bodies which preserve the greatest activity when exposed to the sun, are, with the exception of the salts of uranium, those which are the least disposed to fluorescence. This chemical activity which certain bodies may contract under the influence of the sun's rays, or *insolation*, is greater or less according to the nature of the substance; it has its limits. When a substance has reached its maximum of activity, continued exposure does not add anything to it. Paper prepared with the nitrate of uranium changes color in the light, and becomes insoluble; in the dark it is decolorized, and it becomes soluble after some hours, to be colored again in the light. It reduces the salts of gold and silver, so much so as to become colored and insoluble.

A body rendered active by the sun, will transmit this activity, by contact in the dark, to another body — tartaric acid, for example.

M. Niepce proposes to investigate whether the permanent activity communicated to a body by the solar rays is capable of determining the combination of chlorine and hydrogen, and whether it can be acquired in a luminous vacuum. An engraving wet, and subjected to the sun, reproduces itself on sensitive paper. But, if it is covered with some millimetres of water, the effect fails, even with a solution of salt of uranium or tartaric acid.

After having shown that certain bodies acquire, by exposure to the sun, the property of reducing in the dark salts of gold and silver, M. Niepce observes further, that the reduction does not take place without the intervention of an organic substance. Paper is very good for this purpose, while no action is obtained if we take, for example, the edge of a porcelain plate which has just been broken; on impregnating this edge with a solution of nitrate of uranium, no effect is obtained in the sun; but there is an action if we put on the edge a solution of nitrate of silver, containing a little starch or gum, and then sulphate of iron or gallic acid. A coloration is seen in the part subjected to the sun. It is the same if silver be used in place of uranium. The reägents which M. Niepce employs by preference for demonstrating this action of the light, are the salts of gold and silver, tinctures of litmus and turmeric, iodide of potassium, for paper prepared with starch. In many substances that have been exposed to the sun, the activity communicated is apparent in the insolubility; it is, on a similar principle, acquired under the sun's action, by gelatine containing bichromate of potash, that Mr. Talbot has founded his photoglyphy. Heat and humidity promptly cause the loss of this property. M. Niepce cites many examples in which the same results are obtained on inverting the course of operations; thus, a leaf of paper impregnated with gallic acid and exposed to the sun, treated by iodide of potassium, gives a feeble image, which becomes very decided if subjected to nitrate of silver. A sheet of paper impregnated with chloride of mercury, and exposed to the sun, gives an image with chloride of tin, chloride of sodium, soda, potash, and sulphuret of sodium. In the same manner a sheet impregnated with chloride of tin, and exposed to the sun, gives an image with sulphuret of sodium, chloride of mercury, chloride of gold (Cl_3Au_2) and nitrate of silver. — *Correspondence of M. Nicklès, Silliman's Journal.*

In addition to the above, the following results, attained by M. Niepce, were announced by the Abbe Moigno, in the "Cosmos," for July, 1859. "If a solution of starch or dextrine be subjected to the action of solar light for a short time (say for a quarter of an hour, if there be but a very small quantity of matter), it will be found to be completely changed into glucose (grape sugar), whose presence is easily recognized by the ordinary reäctions, and even by its sweet taste. M. Niepce thinks that he has determined, that, by surrounding the bunches of grapes in the early part of autumn by bags of white paper dipped in tartaric acid, not only is their ripening hastened, but the quantity of sugar which they contain is greatly increased. Tartaric acid is now well known to have the power of *storing up* the light in the condition of chemical efficacy."

PHOTOGRAPHS IN NATURAL COLORS.

The following process for obtaining a photograph of the prismatic spectrum, in its natural colors, has been devised by M. Becquerel. He takes a well-polished silver plate, and, after covering the back of it with varnish, so as to leave the front surface alone exposed, he attaches it by copper hooks to the positive conductor of a voltaic battery of one or two cells; to the negative conductor of the battery is attached a piece of platinum. The plate of silver and the platinum are then plunged into a mixture of eight parts of water and one of hydrochloric acid. The electric current decomposes the acid, and causes a deposit of chlorine on the surface of the silver, while hydrogen is liberated at the negative pole. The chlorine gas unites with the silver, and forms a violet tinted coating, which would become quite black if the operation were continued a sufficient length of time. This coating is tolerably sensitive to light when very thin, and in that condition produces the natural tints, although they are very weak. By increasing the thickness of the layer, the tints become much brighter, but the sensitiveness diminishes. In order to ascertain exactly the amount of chlorine deposited on the silver plate, M. Becquerel introduces into the voltaic circuit an apparatus for the decomposition of water, and since chemical decomposition is similar in quantity for each cell of a battery, by measuring the amount of hydrogen produced by this decomposition, the quantity of chlorine liberated on the surface of the silver-plate, is easily arrived at.

An idea of the extreme tenuity of this film may be obtained when we learn that, with six or seven centimetres of chlorine to the square decimetres, the layer of chloride of silver is only one thousandth of a millemetre in thickness, equal to about 0·00004 of an inch. With a film of this thickness the best results are obtained. Before exposure to the spectrum, the surface has a plain wood color, but if it be heated to between 150° or 200° centigrade (300° to 390° Fahrenheit), it becomes rose-colored on cooling. If, however, instead of raising the plate to a high temperature, it be inclosed within a copper box, and gently warmed, say from 90° to 95° Fahrenheit, and maintained at this heat five or six days; or, better still, placed in a frame covered with a deep-red glass, and exposed to the sun's rays for from a quarter to half an hour, upon being submitted to the action of the prismatic spectrum, the natural colors appear in all their beauty, and the green and yellow tints, which previously were obtained with difficulty, are now bright and clearly defined. Thus this great problem of photography is in a fair way of solution, and we may still hope to see not only the beautiful effects of light and shade which we now obtain, but, combined therewith, the brilliancy of nature's coloring.

M. Niepce de St. Victor has also communicated to the Paris Academy of Sciences a process for obtaining photographs of a red, green, violet, or blue color. For red, the paper is prepared with a solution of 20 parts of nitrate of uranium in 100 of water; the paper is dipped into this solution for the space of about twenty seconds, and then dried by the fire, in the night time. It may be prepared several days beforehand. The impression is obtained in the course of eight or ten minutes in the sun, or an hour or two in the shade. When taken out of the frame, the impression must be washed with warm water, marking about 120° Fahrenheit, and then dipped into a solution of two parts of red prussiate of potash in 100 of water, in a few minutes the impression takes a fine red color; it must then be washed repeatedly until the water runs off clear, and then dried. To obtain green, a red impression, like that we have described, must first be obtained; it is then dipped into a solution of nitrate of cobalt, and dried by the fire, without washing; after which it must be fixed by dipping it for a few seconds into a solution of 4 parts of sulphate of iron and 4 of sulphuric acid in 100 parts of water; it is then dipped once into pure water, and dried by the fire. Violet impressions may be obtained on the paper, prepared as above, with the nitrate of uranium; but, instead of the solution of prussiate of potassa, a solution of half a part of chloride of gold in 100 parts of water is used; when the impression has acquired a fine violet color, it must be washed repeatedly with pure water, and dried. For blue impressions, the paper must be prepared with a solution of red prussiate of potash, in the proportion of 20 parts to 100 of water; the paper is then left to dry in the dark. This operation may be performed several days beforehand. The impression should be taken out of the frame when the parts exposed to the sun have acquired a light blue tinge; it is then dipped, for about ten seconds, in a solution of bi-chloride of mercury, saturated at the common temperature; after which it is washed once with water, and a warm solution (temperature about 130° Fahrenheit) of oxalic acid, saturated at the common temperature, is poured over it; it is then washed three or four times with pure water, and then left to dry.

ACCIDENTAL PRODUCTION OF COLORS IN PHOTOGRAPHS.— BY M. MUGUET.

M. Muguet states to the French Academy the circumstances under which he obtained natural colors in a stereoscopic picture of ruins covered with ivy. Each glass plate had been exposed twenty seconds, the sun shining brilliantly, and on developing I was astonished at finding the color strongly developed; the ivy was represented by a deep green tint, some old timber of trees by a brown, the stones by a gray; all with colors in the highest degree varied. Fixing did not alter them; but in drying they lost their brilliancy, with the exception of the green, which has remained as decided as at first. In taking a second picture the same effect was produced, but with less strength.

The collodion was, perhaps, two months old, nearly colorless, and gave a thin coat. It was prepared by Mr. Robinson, chemist, who assured me that he had iodized it with iodide of potassium with a little bromine.

The bath was a neutral solution of crystallized nitrate of silver. I had developed with a solution formed of two grains of pyro-gallic acid, twenty drops of acetic acid dissolved in one ounce of water, and fixed by a concentrated solution of cyanide of potassium.

M. Raymond remarks that if, as soon as a collodion picture begins to develop clearly under the combined action of pyro-gallic and acetic acid, it be exposed to the light without previous drying, it is rapidly changed into a positive picture, and takes more or less perfectly the colors of the model. The stronger the light is, and the less the development of the picture, the more rapid, but at the same time the less perfect, is the transformation. A picture accidentally made in this way was completed in a quarter of an hour, and lasted some months with scarcely any loss of brilliancy; and even now, after more than two years time, is not completely effaced.

In reference to this communication of M. Muguet to the Academy (Paris), M. Bertsch reminded the hearers that every photographer had frequently observed, that when the development of a positive was arrested at a certain point, and the picture placed upon a black ground, effects were obtained, which imitated the natural color very well. The whole picture takes on a rose-color, which imitates tolerably well the tones of the face; and as the hair and dress, which are darker than the face, are but slightly brought out, they allow the black color of the face to appear through them, and thus produces the appearance of a coloring which does not in reality exist. — *Cosmos.*

PHOTOGRAPHIC INFLUENCE OF RADIANT HEAT.

Mr. Crookes, editor of the *London Photographic News*, acting upon a hint conveyed by M. Nièpce de St. Victor's recent experiments on photographic printing, has succeeded in reproducing, by means of radiant heat, and without the previous exposure of any of the materials to sun-light, the experiment of photographing in the dark, which M. Nièpce supposed to be accomplished by the action of light stored up in hermetically sealed tubes. Having lined a tin tube with paper soaked in tartaric acid, Mr. Crookes proceeded as follows:

A little water was introduced inside the tube, so as to well moisten the paper, and the excess poured out. The tube was again closed, and heated to a temperature too high to be borne by the naked hand. It was then opened directly, and applied face downwards upon a sheet of ordinary sensitive chloride of silver paper, — a piece of a handbill having previously been laid on to serve as a negative. It was suffered to remain in that position about ten minutes. The result was precisely similar to that accomplished by M. Nièpce. The circle of the sensitive paper which was covered by the mouth of the tube became visibly blackened in those parts which were unprotected by the piece of handbill, the letters on which were impressed, white on a black ground, and distinctly legible. This, therefore, proves conclusively that light has nothing whatever to do with the operation, inasmuch as the *whole* of the manipulations we have described were performed at night by the light of a small lamp. The whole of the materials employed had also been kept in darkness for some time previously.

Mr. Crookes thinks that "the heat, combined it may be with a chemical reäction between the bodies in the tin tube, is the actual producing cause of the effect," described by M. Nièpce.

PHOTOGRAPHS OF FLUORESCENT SUBSTANCES.

At the British Association, Aberdeen, 1859, Dr. Gladstone stated, that it is well known, on the one hand, that the chemical action of light resides mainly in the most refrangible rays, and on the other hand that these rays are altered in their refrangibility and effect on the visual organs by fluorescent substances. It occurred to the author that such substances would probably exert little photographic action. Hence he had made two drawings on sheets of white paper, one in an acid salt of quinine, the other in a very pale solution of chlorophyll, and had taken photographs of them. Although the drawing in quinine was quite undistinguishable from the white paper, and the chlorophyll drawing nearly so, when they were viewed in the camera, for adjusting the focus, they were strongly marked on the photographic image by the little chemical action that had been exerted by them. The sheets of paper, and the drawings developed on the glass plate, were exhibited, showing that what theory had suggested as probable, was true in fact.

TIME AND PHOTOGRAPHY.

We have heard it affirmed that a fly is a medium-sized object in the scale of living beings, — meaning that there are objects as much smaller than a fly, as an elephant or whale are larger, — and this we believe to be true. But what shall we say to a *second* in respect to photographic action? Taking six hours as the maximum time of exposure, we can show differences in times of exposure and variations in active action on the other side of a second of time, far exceeding anything ever dreamed of in the ordinary practice of photography. In taking photographs of rapidly moving objects, — the waves of the sea, for example, — we have been obliged to judge of the proper exposure requisite to bring out the half-tints, and estimate differences of time varying between the 1-50th and the 1-120th of a second. Expressions like these are, however, enormous when compared with the time occupied in other photographic experiments. Thus in solar photography, according to the experiments of Mr. Waterhouse, an image was produced in a space of time not longer than the 1-9000th of a second, even when a slow photographic process was used; and when wet collodion was employed, one-third of the above time only was requisite, or 1-27000th part of a second. This duration, however, inconceivably short as it appears, will seem to be a tolerable length of time, when we try to bring the mind to appreciate the rapidity with which Mr. Talbot performed his crucial experiment at the Royal Institution, when he photographed a rapidly revolving wheel, illumined with a single discharge of an electric battery. To a casual observer, or reader of this experiment, the wonderful part appears to be, that the wheel appeared perfectly well defined and stationary in the photograph, although in reality it was being rotated with as great a velocity as multiplying wheels could communicate to it. A little further consideration will, however, show that the time occupied in the revolution of the wheel was a planetary cycle compared with the duration of the illuminating spark, which, according to the most beautiful and trustworthy experiments of Wheatstone, only occupies the *millionth* part of a second. — *Photographic News.*

APPLICATION OF PHOTOGRAPHY TO WOOD ENGRAVINGS.

Mr. Robert Hunt, in a communication to the *London Art Journal*, January 1859, on the above subject, says: "It should be understood, that there is not the slightest difficulty in producing very perfect photographic pictures upon boxwood blocks. Even by applying the nitrate or chloride of silver to the surface of the wood, very satisfactory photographs could be obtained; but the difficulty in this case is, that the silver salt gives a brittleness to the wood, and it is liable to "chip off" under the tool; hence it is not possible to produce the fine lines. By coating the wood with albumen, however, this has been avoided; but the wood-engraver complains of the presence of the film of albumen preventing him from working with his usual facility. This objection is, in time, almost entirely overcome by the use of collodion, the attenuated film offering scarcely any obstruction to the engraver's tool. All that is necessary is, to adopt one of the so-called dry collodion processes, and to obtain from a good negative on glass a positive copy on the block. It is important that the processes should be simplified as much as possible, to avoid all risk of injuring the wood. It is well to coat every part of the wood, except the face, with a thin layer of a transparent varnish, so that the iodized collodion may be applied, and the face dipped into the solution of nitrate of silver, without the risk of having any absorption. Again; in the slight fixing process which is necessary, no very high degree of permanence being required, this varnish also protects the wood. By employing a somewhat sluggish collodion process, very charming pictures may be easily obtained and rendered sufficiently permanent.

Now arises the wood-engraver's difficulties. He has been trained to cut along certain well-defined lines, and he does not understand working upon a drawing in which there are none of those lines. It is, however, merely a question of education; the conventional system must be abandoned, and the engraver taught to use some judgment in the execution of his work.

Crookes's Process for applying Photography to Wood Engraving. — The following plan, devised by Mr. Crookes, of London, for placing photographs on wood for the used of wood-engravers, seems to obviate most of the difficulties heretofore experienced. Thin films of albumen, of dry collodion, of collodion transferred from the glass upon a bituminous varnish, of a coating of gelatine and allum, followed by a solution of hydrochlorate of ammonia, etc., have formed the bases of the different methods proposed in this country and in Europe; but in all, or nearly all, it has been found necessary to subject the wood block to a fixing bath, to the certain injury of its surface. The method proposed by Mr. Crookes seems liable to no such objection. The block is to be covered by candle-light, or in a darkened room, "with a mixture composed of oxalate of silver and water, to which may be added a little gum or pulverized Bath brick, to suit the convenience of the engraver." The preparation is spread by the finger, precisely as the draftsman now spreads his solution of flake white, before making his drawing on the block. It is then put in a dark place to dry, and as soon as dry is ready to receive the picture, which is obtained by the ordinary process of photographic printing. "The block requires no subsequent washing, nor any preparation of any description, before being placed in the hands of the engraver," who then proceeds with his engraving in the usual way. But he is warned that he "must not expose the block to the direct action of the solar rays while working at it, or it will gradually blacken on the surface; exposure to diffused day-light is allowable."

Spence's Process. — A method for taking photographs on wooden blocks, patented by W. Spence, of Liverpool, is described as follows: The white of an egg is beat up into froth with one-half its volume of water, and the face of the block carefully moistened with this by a soft brush, then allowed to dry slowly. A solution composed of fine isinglass, thirty grains, chloride of sodium, two grains, to one ounce of warm water, is now also rubbed over the face of the block, and allowed to dry. The block is now heated, so as to coagulate the albumen of the egg in the pores of the wood under the isinglass, and another coat of the latter is now applied, until the surface has a glazed appearance. But no more isinglass is allowed than fills the pores of the wood; any excess is removed with a knife. A solution of nitrate of silver is now applied to the wood, and the block placed in the camera, when the picture is taken. The picture is now fixed in a warm solution of sulphite of soda, which removes the gelatine, but allows the albumen to remain; and the picture being taken directly on the wood, can be engraved with more facility than when it is applied on collodion, which is liable to scale off. The improvement claimed in this process is the application of the albumen in the pores of the wood in such a manner as to form an insoluble base. The nitrate solution is thus prevented from penetrating the pores, while the picture is taken directly on the surface of the wood itself.

ENGRAVING WITHOUT AN ENGRAVER.

One of the most curious of the many remarkable applications of photography, is that of producing by its means copies of engravings and other works of art. The almost perfect reproduction of a drawing or an engraving without the intervention of an engraver or copyist, would have seemed, a few years back, almost an impossible thing; yet we know that photography accomplishes it daily. But we have become so familiar with photography, that we almost cease to wonder at its marvellous doings. Still, the reproduction, true and beautiful as it is, is a photograph, and not an engraving. The *London Literary Gazette*, Oct. 1859, calls attention to a new process, by which, it says, "it has been found possible, without even the aid of photography, — in fact, as we may say, by mere mechanical means, — to make a perfect fac-simile of an engraving, — whether a copperplate or a woodcut, — and not only to make a copy of it, but to produce a plate or block for surface-printing that shall yield impressions by the ordinary printing-presses quite equal to the original. But even this is not all. Blocks can by this process be produced, without the aid of any engraver, which shall print these fac-similes, enlarged or reduced to any extent that may be desired. We have, for instance, seen a whole-page woodcut from the *Illustrated News* reduced to half, and enlarged to double the original dimensions, without any loss of sharpness or vigor, and without the smallest distortion being anywhere discoverable even with a lens. So, again, with an old and imperfect map; and so with an impression from a steel engraving. But it is equally applicable to original designs made with peculiar ink and paper. Without the assistance of an engraver, blocks for surface-printing can be prepared from them, either of the same or any larger or smaller size. But further, the blocks for printing can be produced of an altered form, as well as of a different size. Thus the normal pattern for printing on a dinner-service can be reproduced, say in its original size and round form, for the ordinary dinner-plates, half, or any other proportion of the size, for desserts or cheese-plates, and twice the size and oval for dishes, etc. All this, we have said, is a mechanical process; but it is also a scientific one, and to be properly worked out, we need hardly say, it will require artistic guidance. The textile and the ceramic manufacturer are almost equally interested in this invention with the publisher; but the range of its application seems to be commercially almost unlimited. The process is carried through by means of elastic blocks and electro-metallurgy; all that is required to be furnished the manipulator is an impression of the plate to be copied. The inventor is Mr. H. G. Collins, who has protected his invention by patents, and a company, called the Electro Printing-block Company, has been formed for working it." The details of this process are not as yet given. — *Editor Annual.*

Cutting & Bradford's Photo-lithographic Process. — This process of taking photographic images on stone, which gives promise of great success, is substantially as follows: To reproduce a line-engraving, the lithographic stone may have a polished surface; but to obtain a landscape, where gradations of shade are required, the surface should be grained. This grained surface is coated with a solution of gum-arabic, sugar, and bichromate of potassa, — the sugar preventing the immediate fixing of the gum upon the stone, and the chromic salt causing it to become more firmly fixed, or much less soluble, on exposure to light. When the coating is dry, the stone may be exposed in the camera a sufficient time to fix the gum at those parts of the picture where the lights are to appear. The stone is next to be washed with a solution of soap, which attacks the stone, removing the unfixed portions of the coating, and taking the place of these on the surface of the stone. After this, it is to be washed with clean water, and dried. An inking roller is now to be passed over the stone, to ink the soapy portions of the surface, and give an additional body to the picture, — the fixed parts of the coating having been previously damped, to enable them to resist the ink, — and when brought up to color, the printing off of impressions may be proceeded with.

FIZEAU'S PROCESS FOR PHOTOGRAPHIC ENGRAVING.

A process devised by Mr. Fizeau, of Paris, is as follows: He takes a "Daguerrean" silver plate, and uses on it a mixture of nitrous, nitric, and hydrochloric acids. This mixture does not attack the whites of the picture, but the blacks are acted upon immediately. The resulting chloride of silver, as it impedes the action of the acid, is removed with a solution of ammonia, so that the action may continue. It is complete when a finely-engraved plate has been produced. The lines are then filled up with drying-oil, and the surface electrotyped with gold. The varnish then having been removed out of the engraved lines, by means of caustic potash, the surface has grains of resin sprinkled over it, for the purpose of producing the engraver's aquatint ground, and the action of the acid is renewed, until the lines shall have acquired sufficient depth. The plate being of silver, is too soft to print from; a copy is therefore taken in copper, by electrotype. Not long ago there was shown, at the meeting of a scientific society, a paper covered with representations of coins, printed from a plate engraved in this manner. The engraving was so exquisite, that each coin seemed to be presented actually in relief.

Sella's Process. — M. Sella, of Biella, in Piedmont, has pointed out the applicability of salts of chromium and iron for photographic purposes, in place of those of silver and gold. The salt of chromium — bichromate of potash — is dissolved, and paper steeped in the solution. The salt thus brought into contact with organic matter in the paper, enters into chemical union with it where it is touched by light, and forms an insoluble compound. So much of it as light has not touched is washed away after the picture has been taken on this paper, which is, in the next place, soaked for a few minutes in the solution of a salt of iron. The iron adheres firmly to the mordant image, but is removed from the rest of the paper by another washing. Now dip the paper in a solution of gallic acid, add galls to the iron, and a picture comes out with fine violet-black tints, which is, in fact, a picture in writing-ink, as permanent as writing-ink is known to be. This process has held its ground, standing the test of wider practice, and by it photographic pictures can be made that may be cheap as well as permanent.

PHOTOGRAPHIC NOVELTIES.

Among the new and useful applications of photography, is the taking of copies of machines, in whole or part, as patterns, or advertisements, of the manufacturers. Thus the leading tool and machine makers of New York City take photographic views of every machine which they make, which not only serve as records of their products, but the pictures are sent to persons who wish to order similar machines, so as to give them a clear idea of the article which they may wish to purchase. Several machine-shops, like that of Messrs. Hoe & Co., of New York, have a photographic gallery connected with the drafting department.

Photography has also been applied to furnish a key for detecting fraudulent bank bills. The counterfeit bills are copied by photography on prepared stones, and from these lithographic prints of the bills are obtained at a comparatively low cost.

Pouncey's Photographic Carbon Printing. — This invention of Mr. Pouncey, of England, consists in preparing the paper for printing on, by spreading over it, by means of a hog's-hair brush, a mixture of finely powdered vegetable carbon, and equal parts of a saturated solution of bi-chromate of potash, and a common solution of gum arabic — the proportions being one drachm of the carbon to four drachms of each of the solutions. After it is dry, the paper is ready for printing on, by exposure in a printing-frame, in the usual manner — the time of exposure being from four to five minutes in the sun, and from ten to fifteen in the shade, but varying according to season, character of negative, etc. In washing the picture, it must lie under water for at least five or six hours, when the picture, of which previously scarcely a trace was perceptible, will become visible. The principal difference in the appearance between a carbon print and one prepared with silver, being, according to Mr. Pouncey, " that one may probably fade, while the other remains imperishable."

Photographs, for engraving, upon Copper. — The following method of taking photographs upon copper, for the purpose of engraving therefrom, has recently been brought out in England by Mr. Colin Smart.

Take some perchloride of iron, and pour it over a plate of polished copper (such as is used by engravers), when the plate will at once be affected, and the color changed. It is now washed with cold water, and dried with a soft cloth, when it is sensitive to sunlight. If a negative picture is placed upon it in the ordinary way, and exposed to sunlight, a beautiful black positive picture will be produced on the copper, in the course of ten minutes or a quarter of an hour.

Photograph of Bursting Shells. — Mr. Skaife, an English photographist, has recently succeeded in taking a stereoscopic photograph of a bursting shell, during the practice firing at Woolwich. The results of the experiment he thus describes, in a letter to the *London Times:*

A 13-inch shell, weighing two hundred pounds, was ten seconds in traversing the air, and fell at a distance of six hundred yards from the battery. A photo-stereo was taken as the shell emerged above the smoke, showing three-eighths of an inch of the projectile's track, commencing at a distance of eighteen times the shell's diameter above the mortar, and 1½-inch visual distance above the head of the superintending officer in front.

But though this is, I believe, the first time a mortar shell has ever been photographed in its ascending flight sufficiently intense to print from, it is not that "What next?" to which I wish to call particular attention, but the likeness of the human head, which so distinctly dominates in the smoke. This phantom does not appear to be the result of chance, for, on repeating the experiment, it is invariably reproduced at a certain phase of the smoke's expansion. Further, the apparition is not, nor can it, I believe, be seen by the human eye, excepting through the medium of photography, which, in its highest instantaneity, appears to eternize time, by giving, at the photographer's will, a series of pictures of things, which have their birth, marked phases of existence, and extinction, in a moment (from the 20th to the 20,000th part of a second), much too fleeting to be noted by the naked human eye.

Subsequently, Mr. Skaife took a photo-stereograph of a 36-inch shell in the course of its flight, together with a phase of the mortar's explosion, which is confirmatory of what he intimates in the above letter, viz., that epochs of time, inappreciable to our natural unaided organs of vision, could be made evident to our senses by a photographic camera, as decidedly as the presence of animalculæ in blood or water is by a microscope.

A gentleman well acquainted with the action of shot and shell, to whom the track of the projectile and its terminus in the stereo were pointed out, exclaimed, "But what stopped the ball?" To this Mr. Skaife replies: — A peculiarly rapid motion given to two small (each two inches square) thin pieces of baked India-rubber, by means of a trigger movement, an optical illusion is produced on the transit of a projectile, which may be likened to the stopping of a railway carriage by a brake.

The first application of this optical brake is perceived in the commencement of the shell's track on the side of the mortar. The shell then appears to have gradually decreased in speed, until it has gone the length of four of its diameters after the brake has been applied, when it appears finally to have stopped, and that for an interval sufficiently long to admit of its portrait being photographed accurately enough to give a tolerable idea of its size and shape. After which (it is assumed) the shell proceeded on its rapid course for one mile and a half further, arriving at its goal not one measurable iota of time less for its having lagged by the way to coquet with the photographer. And thus Mr. Skaife accounts for this seeming paradox: — The whole operation of putting on the optical brake to the flying projectile, stopping its course, and photographing its portrait, according to data supplied by this stereo, appears to have been done in the fiftieth part of a second. The shell, at this part of its course, is supposed to be flying at the rate of 500 feet per second (the diameter of the shell is believed to be about two and a half feet), when the now applied brake gradually retards its flight, and finally succeeds in stopping the shell after it has gone four diameters, or ten feet, from the first application of the brake. The commencement of the shell's track on the side of the mortar, it will be perceived, is misty and ill-defined; while, on the contrary, the termination is sharp, and gives a tolerably clear idea of the sort of snail that has been leaving its trail behind. This difference between the beginning and end of this photographed section of the projectile's parabola is thus accounted for: — The vulcanite "spring shutters" admitted to the sensitized collodionized plate, through a pair of lenses, a view of the shell the instant it emerged from the mortar's smoke, by being made to revolve on their axis ninety degrees, at which point they have exposed the full aperture of the lenses, and at this point the 100th part of a second has elapsed. Meanwhile the shell, flying at the rate of 500 feet per second, has just interposed its trail on the collodionized plate, the length of two of its diameters (one-eighth inch), and succeeds in trailing two others while the shutters are having their action reversed and returned to their original light-excluding position, behind the lenses. Now, as the first part of the shell's track (one-sixteenth of an inch wide) has been exposed to the full action of light from the commencement of the shutters' opening to their final closing, this part of it has consequently been undergoing a gradual effacement during the whole period of the fiftieth part of a second; while, on the contrary, the terminus of the track photographed at the final closing of the shutters, must, in the shortness of its exposure to the action of light, bear a *moving* analogy to the rapidity of light itself, known to travel more than one million of times quicker than a cannon ball. And hence the ball's apparent stoppage in the air *malgré* the tremendous physical force argument seen in the act of urging it forward.

BALLOONS AND PHOTOGRAPHY APPLIED TO MILITARY PURPOSES.

It is well known that among the many novelties introduced into the service of war by the French Emperor, is that of the use of balloons; by means of which, "wherever the general goes, he has at his command a tower of great altitude, whence to contemplate all the surrounding country." This employment of balloons was often talked of even in the time of Napoleon I., but it was left to Napoleon III. to render it a reality. In order that the project might be fairly tested, the Emperor summoned to Italy M. Goddard, the most eminent of the French aëronautists, and the consequence has been a marked success. The balloon ascends to the height of several hundred metres, and is held down by cords whilst an officer makes his observations. Very important information respecting the disposition of the Austrian army is said to have been so obtained prior to the battle of Solferino. But we now learn from the *Photographic News* that the Emperor is anxious to employ photography in these balloon observations. Some months ago, M. Nadar, a distinguished photographer, made an ascent from the Hippodrome at Paris, in order to make experiments in taking photographs at different altitudes.

We also learn, from the same source, that M. Porro, who has invented an apparatus, by means of which it is possible "to take a panorama rigorously exact of the whole horizon, in three proofs, by an operation that can be accomplished in a few minutes," has been taken into the service of the Piedmontese government, by whose direction he has completed his apparatus; and is thus able to obtain for the military authorities, almost instantaneously, and without the assistance of any of the usual surveying instruments, all the necessary materials for the construction of a complete topographical plan. The instrument is described as extremely simple and very portable; it being, in fact, a circular or cylindrical camera, little more than a foot in diameter, with a spherical lens in the centre. The sensitive paper is placed on a reel on one side of the lens, from which it is slowly wound off, as the view is taken, on to a similar reel on the other side. When one view is taken, which embraces one-third of the horizon, the instrument is turned one-third of a revolution on its axis, and another view is taken. The operation is then repeated, and the panorama is completed. The reduction of the plan is of course made in the house; but it is rendered easy by special contrivances in the camera, by which every thing is set off to a scale of heights, dimensions, and distances. Happily, the services of the instrument cannot be monopolized for warlike purposes; and if it really can accomplish what is reported of it, a most valuable addition will have been made to the materials at the service of the arts of peace. — *London Literary Gazette.*

ON THE HEAT-CONDUCTING POWER OF METALS AND ALLOYS.

Messrs. Grace Calvert and Richard Johnson, of England, have been for some time engaged in a series of experiments to determine the relative heat-conducting powers of metals in a perfectly accurate and reliable manner, in order that a standard might be obtained from which calculations could in future be made, the numbers at present in use being regarded as unreliable. The following results thus far arrived at, have been communicated to the Royal Society. Taking silver, which is the best conductor, as 1000, they obtained the relative conducting powers of the following metals:

Silver,	1000	Forged iron,	436
Gold, $\frac{1000}{1000}$	981	Tin,	422
Gold, $\frac{991}{1000}$	840	Steel,	397
Copper, rolled,	845	Platinum,	379
Copper, cast,	811	Sodium,	365
Mercury,	677	Cast iron,	359
Aluminum,	665	Lead,	287
Zinc, forged,	641	Antimony, cast horizontally,	215
Zinc, cast vertically,	628	Antimony, cast vertically,	192
Zinc, cast horizontally,	608	Bismuth,	61
Cadmium,	578		

The precision obtained by this process is such, that the authors were able to determine the different conducting powers of the same metal, when rolled or cast, as shown above. They were also able to appreciate the influence of crystallization on conductibility; for they found that the conducting power of a metal was different when it was cast horizontally or vertically, from the different directions which the axes of crystallization took under these circumstances.

The importance of having the metals as pure as the resources of chemistry allow, is shown by the action which one per cent. of impurity exerts on the conductibility of a metal, in some cases reducing it one-fifth or one-fourth. Copper alloyed with one per cent. of various metals, gave different conducting powers, in the same manner as Mr. Thomson has shown that the conduction of electricity by the same metal is effected by a similar amount of impurities.

Alloying a metal with a non-metallic substance, also exerts an influence, as is shown in the case of the combination of iron with carbon, thus:

Forged iron,	436
Steel,	397
Cast iron,	359

Similar results were obtained by combining small proportions of arsenic with copper.

The authors, with a view of ascertaining whether alloys are simple mixtures of metals, or definite compounds, made a large number of alloys of various metals, using equivalent proportions, and determined their conducting powers. The general result obtained is, that alloys may be classed under the three following heads:

1st. Alloys which conduct heat in ratio with the relative equivalents of the metals composing them.

2nd. Alloys in which there is an excess of equivalents of the worse conducting metal over the number of equivalents of the better conductor, such as alloys composed of 1Cu and 2Sn; 1Cu and 3Sn; 1Cu and 4Sn, etc., and which present the curious and unexpected result that they conduct heat as if they did not contain a particle of the better conductor; the conducting power of such alloys being the same as if the square bar which was used in the experiments were entirely composed of the worse conducting metal.

3rd. Alloys composed of the same metals as the last class, but in $a^2 + c^2 > 3b^2$; and the memoir contains a figure showing the form of the surface for the case in question. The equation of the surface is obtained by the elimination of X, Y, Z, between the above-mentioned equations and the equation $\frac{X^2}{a^2} + \frac{Y^2}{b^2} + \frac{Z^2}{c^2} = 1$, as already remarked. This is reduced to the determination of the discriminant of a quartic function, and the equation of the surface is thus obtained under the form $I^3 - 27\,J^2 = 0$, where I and J are given functions of the coördinates.

The apparatus used by Messrs. Calvert and Johnson appears to have been in every way calculated to give reliable results. They provided a deal box (105 millims. in width, 165 millims. in length, and 220 millims. in height), with a cover, and painted white internally and externally. Inside this box are two vulcanized India-rubber square vessels, the sides of which are 15 millims. thick. The larger vessel measures internally 52 millims. on the side, and 125 millims. deep, and is capable of containing 336 cub. cent. of water. The smaller vessel is 27 millims. on the side, and 125 millims. deep, and has a capacity of 90 cub. cent. These vessels are painted white, and surrounded with wadding; and, still further, to prevent any radiation of heat, a deal board is placed between the two vessels. So little heat is radiated from the larger vessel when it contains 200 cub. cent. of water at 90° to the smaller vessel containing 50 cub. cent. at 16°, that in a quarter of an hour, the time required for their experiments, the water in the vessel did not rise one-tenth of a degree centigrade. Therefore, all sensible radiation and conduction was avoided, and the rise of temperature in this vessel during the experiment must have been entirely due to the heat conducted by the square bar of metal used. This bar is 6 centims. long, and 1 centim. square, and is so arranged in experiment that 1 cub. cent. is in the larger vessel; 1 cub. cent. in the smaller vessel; 3 cub. cent. are covered by the sides of the boxes through which it passes; and the last 1 cub. cent. is covered with a piece of vulcanized India-rubber tubing, and the whole made secure from any leakage by lining the sides of the holes through which the bar passes with a varnish made of caoutchouc dissolved in benzoine. All being ready for the experiment, 50 cub. cent. of water, at the temperature of the room, are poured into the smaller vessel, the boxes covered, and each provided with a very sensitive thermometer, and 200 cub. cent. of boiling water poured into the larger vessel by means of a funnel; the temperature of the liquid falls to 86° or 88°, but is again raised to 90°, by a small jet of steam generated in a flask, the water in which is kept boiling during the whole experiment. The conducting power of the metal being tested is noted with the greatest care. For mercury and sodium they employed a very thin sheet-iron box, the internal dimensions of which were exactly those of the square metallic bars they usually employed, and of the conducting power calculated, but the figures are very near the truth.

THE INTERNAL TEMPERATURE OF THE EARTH.

The following is an abstract of a paper recently read before the Royal Institution, London, by William Hopkins, F. R. S., "On the internal temperature of the earth and the thickness of its solid crust:" If we descend beneath the surface of the earth, and observe the temperature at different depths, it is found that within a depth ranging from 50 to 80 feet, the temperature changes periodically, being affected to that depth by the heat which the earth receives from the sun at different seasons of the year. The annual variation, however, becomes less as the depth increases, till at the depth above mentioned it becomes insensible. At greater depths the temperature is invariable at each point, but increases with the depth at the rate, on an average, of 1° Fah. for a depth of between 60 and 70 feet. The best observations which have been made on this subject are those in deep mining shafts and deep artesian wells; the greater the depth, the more completely do anomalous influences counterbalance each other. The greatest depths at which such observations have been made in Western Europe, are at Monkwearmouth and Dukinfield in England; the Puit de Grenelle, at Paris; Mondorff, in the Duchy of Luxemburg; New Seltzwerk, in Westphalia; and at Geneva. At the first two places the observations were made in vertical shafts of coal mines, the depth of the one at Monkwearmouth being upwards of 1800 feet, and that at Dunkinfield upwards of 2000 feet, and in both cases the observations were made while the workmen were sinking the shafts, and with every precaution against the influence of any extraneous causes which might affect the observations. The former gave an increase of 1° Fah. for every 60 feet of depth, the latter for about every 72 or 73 feet. The sinking of the Puit de Grenelle was superintended by Arago. The mean increase of temperature was 1° for every 60 feet. At Mondorff the bore was 2100, being that of an artesian well; the increase was 1° for 57 feet. At New Seltzwerk the artesian well, penetrating to the depth of 2100 feet, giving an increase of 1° Fah. for 55 feet. The average of these is very nearly 1° for sixty feet. Numerous other observations are confirmatory of those results, though observations at smaller depths present many anomalies indicating the operation of local causes. If a sphere of very large dimensions, like the earth, were heated in any degree and in any manner, and were left to cool in surrounding space, it is shown by accurate investigation, that after a sufficient and very great length of time, the law according to which the temperature would increase in descending beneath the earth's surface, within depths small compared with the earth's radius, would be — that the increase of temperature would be proportional to the increase of depth. This coincides with the observed law, if we neglect the anomalous irregular variations which are found to exist more or less in each locality. Now, according to this law, the temperature at the depth of 60 or 70 miles would probably be sufficient to reduce to a state of fusion nearly all the materials which constitute the earth's external solid envelope; and hence it has been concluded that the earth probably consists of a central molten mass, as a fluid nucleus, and an external solid shell, of not more than 60 or 70 miles in thickness; and some geologists, desirous of rendering the conclusion the foundation of certain theories, have considered the thickness even less than that now mentioned. This conclusion, however, rests on reasoning in which an important element is wanting. It involves the hypothesis that the *conductive power* of the rocks which constitute the lower portions of the earth's crust is the same as that of the rocks which form its upper portion. This conductive power of any substance measures the facility with which heat is transmitted through it, and it is easily proved, by accurate investigation, that when the same quantity of heat passes through superimposed strata of different conductive powers, the increase of depth corresponding to a given increase of temperature (as one degree) is in any stratum proportional to the conductive power. Consequently, if the conductive power of the lower portion of the earth's solid crust be greater than that of the thin upper portion of it through which man has been able to penetrate, the depth to which we must proceed to arrive at a certain temperature (as that of fusion for the lower rocks) will be proportionally greater. The precise nature of the rocks situated at a great depth can only be judged of by analogy with those which are accessible to us; but those geologists who adopt the conclusion of the extreme thinness of the earth's crust, will doubtless admit that its inferior part must be of igneous origin, and must therefore be allowed to bear a certain resemblance to igneous rocks on the surface of the earth. Mr. Hopkins had recently made a great number of experiments on the conducting powers of various rocks. That of the softer sedimentary rocks, which are great absorbents of water, is very much increased by the quantity of moisture they contain; but taking chalk, one of the best absorbents, its conductive power, even when saturated, is not half so great as that of some of the igneous rocks on which Mr. Hopkins had experimented. Calcareous, argillaceous, and siliceous substances, reduced to fine powder, stand, with reference to their conductive powers, in the order in which they are now mentioned, the conductivity of the first being the least; and when in a compact state, all that contributes to give hard and crystalline character to the substance, and continuity to the mass through which the heat is conducted, increases the conductive power. These considerations lead to the conclusion that the conductivity of the inferior portion of the earth's solid crust must be much greater, and may be very much greater than that of the less consolidated and more superficial sedimentary beds. Moreover, the temperature of fusion of certain substances, as Mr. Hopkins had shown by experiment, is much increased by great pressure;

and by analogy it may be concluded that such would, at least in some considerable degree, be the case with the mineral matter of the earth's crust. The chalk is that formation in which the most numerous and some of the best observations on terrestrial temperatures have been made; and it would seem impossible to conclude, from actual experiment and the considerations above stated, that its conductive power can exceed one-third of that of the inferior rocks, and may not improbably be a considerably smaller fraction of it. Now the increase of depth in the chalk corresponding to an increase of 1° Fah. is well ascertained to be very nearly 60 feet, and therefore the rate of increase in the inferior rocks must probably be at least three times as great as in the chalk, and may be very considerably greater still. Hence, supposing the thickness of the solid crust would be about 60 miles if the conductive power of its lower portion were equal to that of chalk, its actual thickness must probably be at least about 200 miles, and may be considerably greater, even if we admit no other source of terrestrial heat than the central heat here contemplated. There is also another way of investigating the thickness of the earth's crust, assuming the whole terrestrial mass to consist of a fluid nucleus inclosed in a solid envelope. If the earth were accurately spherical, instead of being spheroidal, its axis of rotation would always remain exactly parallel to itself, on the same principle as that on which the gyrascope preserves, in whatever position it may be held, the parallelism of the axis about which it rotates. But the attraction of the sun and moon on the protuberant equatorial portions of the earth's mass, causes a progressive change in the position of the earth's axis, by virtue of which the north pole, or that point in the heavens to which the northern extremity of the earth's axis is directed, instead of being stationary, describes a circle on the surface of the heavenly sphere about a fixed point in it, called the pole of the ecliptic, with a radius of nearly 23½°, equal to the inclination of the equator to the ecliptic, or the *obliquity*. The whole of this revolution is completed in about 25,000 years; but, as follows from what has just been stated, without any change, beyond small periodical ones, in the obliquity. A corresponding change of position must manifestly take place also in the position of equinoxes, which have thus a motion along the ecliptic in a direction opposite to that in which the signs of the zodiac are reckoned, completing a revolution in the period above mentioned of 25,000 years. It is called *the precession of the equinoxes.* This precessional motion has been completely accounted for under the hypothesis of the earth's entire solidity, and that of a certain law according to which the earth's density increases in approaching its centre; but some years ago Mr. Hopkins investigated the problem with the view of ascertaining how far the observed amount of precession might be consistent with the existence of a fluid nucleus. The result was, that such could only be the case provided the thickness of the solid shell were much greater than that which, as above stated, has been supposed by many geologists. The numerical result was that the least admissible thickness of the crust must be about one-fifth of the earth's radius; but, without assigning any great importance to an exact numerical result, Mr. Hopkins had a full confidence in the investigation, as showing that the thickness of the crust could not be so small as 200 or 300 miles, and consequently that no geological theory can be admitted which rests on the hypothesis of the crust being nearly as thin as it has been frequently assumed to be. The influence of the interior fluidity on the precessional motion above described, is due to the difference between the motions which the attractions of the sun and moon tend to produce on a solid mass in one case, and a fluid mass on the other. It has been recently stated, as an objection to this investigation, that the interior fluid mass of the earth *may* move in the same manner as if it were solid. The only reply which could be given to such an objection was, Mr. Hopkins conceived, that it was mechanically impossible that these motions should be the same, though the resulting precessional motion for the solid crust, under certain conditions, to be determined only by the complete mathematical solution of the problem, might be the same as if the whole mass were solid. The effect of the attractions of the sun and moon also depends on the ellipticity of the inner surface of the solid shell; and it has been said that since that ellipticity depends on the law of the earth's density, which can only be imperfectly known, no result can be depended on which involves that ellipticity. This was not a correct statement of the problem. It was assumed, in the solution referred to, that the ellipticity of the inner surface would depend partly on the law of density, and partly on the forms of the isothermal surfaces. Mr. Hopkins had supposed it possible, at the time he was engaged in this investigation, that a surface of equal solidity might approximate to a surface of equal pressure; he has now experimental reasons for believing that it must approximate much more nearly to an internal surface of equal temperature. Now for depths greater, probably much greater, than those which have often been supposed to correspond to the thickness of the earth's solid crust, there is no doubt that the inner isothermal surfaces have a greater ellipticity than the external surface itself; a conclusion which is independent of the law of density. Hence, a like conclusion will hold with reference to the internal surface of the shell, if it approximate sufficiently to the surface of equal temperature; and this is the conclusion most unfavorable to the thin shell supposed by some geologists. Restricting the interpretation, then, of Mr. Hopkins's results to the question, whether the earth's solid shell be as thin as some geologists have supposed, or at least several hundred miles in thickness, — and this is the only question of geological importance, — Mr. Hopkins denied the validity of either of the objections above stated. Thus, both the modes of investigation which had been described lead to like conclusions respecting the least thickness which can be assigned to the solid envelope of our globe. It must be much greater than geologists have frequently imagined it to be.

MOTION PRODUCED DIRECTLY BY HEAT.

A new apparatus for producing motion in metals directly, by means of heat, has recently been devised by Mr. C. Gore, of Birmingham, England. It consists of a massive circular railway of copper, the rails of which are made red-hot, and balls of German silver placed upon them, and so arranged as not to run off. Whenever this is effected, the balls roll on the rails, making revolution after revolution on the track, as long as the rails remain sufficiently hot.

ON EFFECTS OF HEAT ON DIFFERENT GASES.

Dr. Tyndall, in a recent lecture before the Royal Institution, London, stated that he had been engaged in a series of experiments to ascertain the correctness of the views of M. Pouillet, respecting the effect of aëriform bodies in absorbing the rays of heat, and he had arrived at conclusions which are quite new, and calculated to be of great importance in explaining some of the great phenomena of nature. His experiments have been conducted with the aid of a thermo-electric pile, which is far more sensitive to the effects of heat than the most delicate thermometer, and the results he had arrived at are, that the invisible rays of heat are absorbed in passing through most transparent gaseous bodies, but that the luminous heat of the sun is transmitted through them unimpeded. Mr. Tyndall repeated successfully some of these experiments, which require the most careful manipulation. He first showed, by means of a galvanometer connected with the thermo-electric pile, that rock-salt transmits the rays from a non-luminous source of heat which are obstructed by glass; and in the construction of his apparatus he accordingly used the former substance. The apparatus consisted of a tube four feet long and three inches diameter, closed at each end with rock-salt, and so contrived that it might be exhausted of air, and other gases substituted. Some fusible metal was kept heated at one end of the tube, and at the other was placed a thermo-electric pile, which was connected with a delicate galvanometer. Another sensitive pile was also heated by a non-luminous body, and connected with the galvanometer, the indications of which were, by an ingenious arrangement of the electric light, reflected on a screen. The two sources of heat were so regulated as to neutralize each other, and to bring the galvanometer needle to zero, when the tube contained atmospheric air. When the tube was exhausted, and the rays of heat passed through the partial vacuum, a decided deflection of the needle was observed. The difference in the effect was, however, small when compared with the brisk action of the needle when the tube was afterwards filled with coal-gas, which absorbed the rays of heat much more than common air. Dr. Tyndall having shown by these experiments — which he said might be repeated with similar effects with all other gases — that the invisible rays of heat are variously absorbed by gaseous bodies, he next employed a source of heat combined with light, resembling that of the sun. For this purpose he used the oxyhydrogen light, the rays of which were passed through the tube when filled with air; when exhausted, and when filled with coal-gas, in every instance the effect was the same; for the luminous rays were not absorbed, and the galvanometer needle, after having been brought to zero, remained there. These experiments, Dr. Tyndall observed, have an important bearing on the phenomena of nature; for they seem to explain how the planets most distant from the sun may yet be sufficiently heated by its rays to become habitable. Even the planet Neptune, though so remote from the source of heat, may in the course of time have become heated by continually receiving luminous rays, the heating portion of which, when not combined with light, may be retained by the absorbing power of the atmosphere. In short, the conclusions arrived at by Dr. Tyndall may be popularly stated as follows: Obscure rays of heat — that is, the rays of heat unaccompanied by light — are absorbed by passing through the atmosphere, while those heat rays which are luminous pass through it freely. *Luminous* solar heat, which passes uninterruptedly through the atmosphere, on reaching the earth becomes changed into *obscure* heat, and is no longer capable of free atmospheric transmission or radiation; therefore it is not sent back into space, but remains in the atmosphere, serves to increase and preserve its temperature: or, in other words, the atmosphere, acting in the same way as a ratchet-wheel in mechanics, allowed the solar heat to come to the earth, and when there, prevented it from radiating back again into space.

OCEAN TEMPERATURE.

Some interesting information has been given by Captain Pullen, R. N., of H. M.'s ship *Cyclops*, relative to the temperature of the Atlantic and Indian Oceans at great depths, in his recent voyage to the East. The first soundings for temperature was in 32° 13′ N., long. 19° 15′ W., where, at 400 fathoms, the minimum temperature was 50·5°, the surface at the time being 70°. Subsequently, two thermometers were sent down at 500 and 800 fathoms; at the greater depth, the minimum temperature was 44·5°, at the lesser 50°. The next sounding was in lat. 10° 7′ N., long. 27° 32′ W., when there was no bottom with 2000 fathoms of line. In 4° 16′ N., and 28° 42′ W., two thermometers were sent down to 1500 and 1000 fathoms, the greater depth showing a minimum temperature of 39·4°, the lesser of 42·5°. In the next cast, in lat. 2° 20′ N., long. 28° 44′ W., ninety miles from St. Paul's Island, two thermometers were sent down on a regular deep-sea line, with bottom at about 1080 fathoms: the thermometer showed a minimum temperature of 38·5° at the lowest depth, and 46·2° at 680 fathoms. An attempt to get a cast directly on the Equator was unsuccessful, resulting in the loss of a large portion of the line. After crossing the Equator, thermometers were sent down at nearly every tenth parallel, three at a time, at 12, 8, and 400 fathoms, and portions of the water brought up were reserved to be sent home for analysis. In lat. 26° 46′ S., and long. 23° 52′ W., soundings were obtained at 2700 fathoms. A thermometer sent down to this depth came in showing a minimum temperature of 35° Fahrenheit; the bottom brought up in the valve was a very fine, brown-colored sand. Running the casting down between the parallels 35° and 38° S., to outside the Mauritius, the lead was brought into play on the Brunswick shoal, which is marked 85 fathoms, but bottom was not reached with 1410 fathoms. Then came the Atalanta, marked as an extensive shoal; here a cast was obtained with bottom at 1120 fathoms. The bottom consisted of what appeared to be very fine sand covering a hard substance, supposed at first to be coral, but which, under the microscope, was found to be some very beautiful specimens of Diatomaceæ. Steering now to pass to the east of Mauritius, a little south of parallel 20°, about ninety miles from land, there was no bottom with 1375 fathoms of line. Captain Pullen states that this gave him the first idea that his previous opinion of the Indian Ocean not being so deep as the Atlantic was wrong. Forty or fifty miles west of the northern part of Cargados, 1400 fathoms of line reached the bottom; at the doubtful St. George's Island, bottom was not reached with 2000 fathoms of line. Steaming then for Rose Galley Rocks, bottom was obtained with 2254 fathoms of line: the minimum temperature was 35°. A thermometer was sent down at 2000 fathoms, and returned with a minimum temperature of 38·5°. Now 35° was the minimum temperature at 2700 fathoms in the Atlantic, further south than this cast. Captain Pullen was therefore inclined to think that this is the minimum temperature of the great depths of the ocean, and that it commences soon after passing 2000 fathoms.

HALL'S THERMOGRAPH.

A thermograph, invented by Mr. S. W. Hall, of Philadelphia, consists of a spiral glass tube, terminated outwardly in a branch, which is prolonged with a smaller curvature; this tube is delicately balanced upon a horizontal axis.

The spiral portion of the tube contains alcohol (or any other liquid or gas), while the prolonged branch contains a plug of mercury, which is in contact, at its inner surface, with the alcohol, while on its other side it has a partial vacuum formed in the outer end of the tube. Of course, as the alcohol expands or contracts, the mercury is moved farther from, or nearer to, the axis, and the change in the position of the centre of gravity of the system causes a rotation around the axis, and this motion is transferred by levers to a needle-point, which is lifted or depressed, according as the alcohol is expanded or contracted. In front of the needle, a band of paper is made to pass with an uniform motion, communicated to it by rollers, which at the same time print upon it a series of horizontal and vertical lines, the former of which correspond to certain temperatures, and the latter record the hours. And, by a modification of its striking works, the same clock-work which governs the motion of these rollers, causes a vertical bar to press, at the end of every five minutes, the needle-point through the paper, from which it is immediately withdrawn by a spring, thus impressing a permanent and easily visible mark, recording the temperature of the instrument at that instant of time.

As regards the practical value of this invention, a committee of the Franklin Institute, Philadelphia, have reported as follows:

1st. The power developed by the instrument is considerable. The mechanical force exerted by the displacement of a mass of mercury with a considerable leverage from the centre of motion, is so great as to insure the satisfactory operation of the instrument, and to allow of considerable resistance at its working parts, without deranging its action.

2d. This instrument is invariable; being once graduated and set, very ordinary care is sufficient to prevent any derangement of its mechanism; its record will, therefore, probably remain the same, without derangement of its zero, or change in the length of its degree.

3d. It is, considering its utility, not too expensive. The inventor estimates that a perfect instrument can be made for twenty to fifty dollars. This includes, of course, no estimate for ornamentation. For a meteorological observatory, or for the ordinary recording of atmospheric temperatures at home, this is not an extravagant expense. And it does not appear that any more repairs ought to be required for an apparatus of this kind, than for the common clock, which forms its basis.

It is, however, only for recording atmospheric temperatures, and for observatories or houses, that the apparatus is fitted. It occupies considerable space, and from its structure could not be conveniently carried in travelling, except by sea. As, however, the scale and the motion of the paper may be varied at pleasure within extensive limits, it appears possible to arrange the apparatus either for very delicate registering during a comparatively short time, or for a long-continued course. If the clock could be kept in motion, as is now quite possible, there is no reason why the apparatus might not be left to itself, to record the temperatures during a whole year, during which time it would require neither superintendence nor adjustment.

Mr. Hall, moreover, proposes modifications in the form of the instrument, by means of which it may be made to record within an apartment the temperature of the air outside, indicating the actual temperature at every instant, while it records them as usual every five minutes.—*Journal Frank. Inst., June* 1859.

ILLUSTRATION OF THE DEVELOPMENT OF HEAT BY SOLIDIFICATION, ETC.

In most chemical text-books, no good examples are given of the development of heat by mere solidification. It is, indeed, usually mentioned that water may be cooled many degrees below the freezing-point, and remain liquid; and that on congealing, its temperature suddenly rises to 32° F. But the experiment is so troublesome to make, especially in the lecture-room, that these truths commonly pass as matters of faith rather than of sight, and the important principles which they illustrate, often fail of being distinctly impressed on the mind of the student. Now, many of the hydrated salts, and among them the nitrates, melt at points above the common temperature of the air, and are therefore well adapted for showing, at all seasons, and with great ease and clearness, the inertia of bodies with regard to change of form and the liberation of sensible heat by crystallization.* Nitrate of lime is pre-eminently suitable for the exhibition of these properties, since, after having been fused and heated above 150° F., it may be cooled in a glass vessel as low as 60°, and kept in the liquid state a long time, often for several days; but on dropping in a bit of solid nitrate, crystallization immediately commences, and an inserted thermometer soon rises to 110° F.

A substance which may be had both liquid and solid at a temperature considerably below the melting-point, is obviously very convenient for displaying the comparative densities and specific heats in the two forms, as complications caused by differences of temperature, may be entirely avoided. Thus, the specific gravity of a specimen of nitrate of lime in the liquid state, at 60° F., was found to be 1·79. Some of the same was poured into oil of turpentine, made to solidify, and cooled to 60° F. Its density was now 1·90. The contraction may be rendered appreciable by the eye, if we cool to a certain degree some melted nitrate contained in a long-necked flask, fill with an oil up to a marked height, effect the crystallization, and then cool to the same point as before.

To illustrate the absorption of heat during the liquefaction of solids, freezing mixtures are commonly employed, in which one of the ingredients, ice, is already cold. The experiment is more striking, when all the articles used are at the temperature of the surrounding air. Such may be the case if we take crystallized sulphate of soda and a sesquinitrate. A mixture of thirty-six grams of powdered pernitrate of iron crystals, and fifty-seven grams of fine Glauber's salt, liquefied and lowered the thermometer from 65° F. to zero. It readily froze water contained in a test-tube. In cold weather, eight grams of the nitrate and 9·5 grams of the sulphate, brought the thermometer from 22° to —10°. — *J. M. Ordway, Silliman's Journal, Jan.* 1859.

ON THE MELTING AND SOLIDIFICATION OF WATER.

M. Mousson reports, in the *Bibliotheque Universelle de Genève*, an interesting set of experiments, made by him for the purpose of determining the effect of pressure on the melting-point of ice.

* In an excellent work published in 1857, — "Lehrbuch der physikalischen und theoretischen Chemie, von H. Buff, H. Kopp und F. Zamminer," — hyposulphite of soda is mentioned as capable of affording a very striking example of the heat becoming free during fixation; but this salt is less easy to prepare than most of the nitrates.

He first exposed a number of capillary tubes, of diameters varying from 0·0074 inch to 0·1 inch, and containing columns of water about 12 inches long, to the air. The exposure lasted seven days, during which the temperature never rose above 28·5° Fah., and went down every night below 23° Fah. Upon withdrawing the tubes, all those whose diameter was greater than 0·36 inch, had frozen; and all those whose diameter was less than 0·275 inch, had remained liquid, nor did a sudden blow cause them to freeze. By arranging the tubes in an inclined position, so as to plunge them in a vessel of water, it was found that the formation of the ice externally, favored their freezing. The two tubes of least diameter (0·013 and 0·0074 inch) alone remained liquid.

The sheet of water between two plates of glass, pressed together by screws, will not freeze; but, if they be simply laid on each other, the sheet which is then thicker, will freeze.

Blocks of ice, from 3 to 4·5 inches cube, were placed in a hydraulic press, and reduced to sheets of a few hundredths of an inch in thickness. Although the temperature of the air was only a few degrees above the freezing-point, the water trickled from the blocks on all sides.

In order to prevent the expansion of the water during freezing, a quantity was introduced into a cylindrical cavity of about 0·24 inch in diameter, in a heavy prism of wrought iron. The water in the cavity was compressed by a powerful screw, and then exposed to cold. The water remained liquid at 26·6° Fah. In an attempt to reduce the temperature to 23° Fah., the apparatus began to leak.

A quantity of water was then introduced into a cavity in a similar prism of steel, and, after being frozen, the ice was compressed by means of a powerful screw moving a copper cone. The apparatus was surrounded by a freezing mixture, the temperature of which varied from —0·4° to —6·7° Fah.; the temperature of the air was below 32°, and the movement of the screw was performed so slowly as to make but two turns (or forward motion) of 0·36 inch in four hours. The ice was liquefied by the pressure, as was indicated by the position of a small wire index which had been frozen into the mass.

The pressure to which it had been exposed was 13,070 atmospheres, by which the freezing-point was reduced below 0° Fah.

ICE PHENOMENA.

A recent number of the *Canadian Journal of Industry and Science* contains some interesting information regarding the expansion and contraction of ice, as observed on Rice Lake, C. W., by J. H. Dumble, C. E. A bridge of the Cobourg and Peterborough Railway runs through this lake, and in the Southern States, or in a mild climate, it would have answered every purpose; but, with the expansion of the ice on this lake, in such a cold climate, it has become a complete wreck. *Glare ice* is that which is smooth on the surface; it has been found that such ice, when acted on by the mid-day sun, is immediately set in motion by expansion, and it generally sets in towards the shore. Sometimes this movement is very gradual, and accompanied with a slight crackling noise; sometimes it is rapid and violent, and accompanied by a succession of vigorous jerks, and a hollow, rumbling sound, seemingly from under the ice, while at intervals there occur loud and sharp reports, like those of cannon.

Sometimes the ice expands several feet on the shore, without any fissures being created in the lake: this is caused by a temperature of the atmosphere higher than that which previously existed. If the thermometer indicates a temperature of 30° below zero, and then suddenly rises to zero, expansion of the ice results. When the thermometer indicates 30° above zero, and then falls to zero, contraction of the ice is the result. The force with which ice expands depends entirely on the *extent* of the *change* of temperature.

The most forcible movements of ice occur previous to rain storms. A sudden rise of 20° in temperature produces violent expansion. Strong oak piles in the bridge, which would not bend, were cracked and splintered by the ice expansion; heavy cap timbers of pine were snapped like reeds, and heavy iron rails were curved and doubled up, as if put into a huge press. Trees growing on the shore have been torn up by the roots, by the ice expansion, and boulders weighing several tons have been lifted from the shore, and forced into the bridge timbers. On one occasion, the ice expanded no less than six feet along the whole shore. A uniform temperature of the atmosphere neither causes expansion nor contraction of ice; it matters not whether the temperature is high or low, no movement of any kind takes place. A coating of snow six inches deep effectually prevents any motion in the ice, as it is a most effectual nonconductor, and protects it from the influence of the atmosphere.

Ice does not possess the power of contraction to the same extent as that of expansion. It has been noticed that when it expands some feet, it does not recede when the temperature falls to its former situation; it only contracts by inches for its expansion in feet.

The following are the general inferences deduced by Mr. Dumble, from his observations:

1st. That ice is capable of expansion and contraction.

2d. That ice (up to 32°) expands with a temperature *higher* than that which *had just previously* existed.

3d. That ice contracts with a temperature lower than that which had just previously existed.

4th. That ice does not expand or contract with a uniform temperature.

5th. That ice is susceptible of expansion to a much greater extent than of contraction.

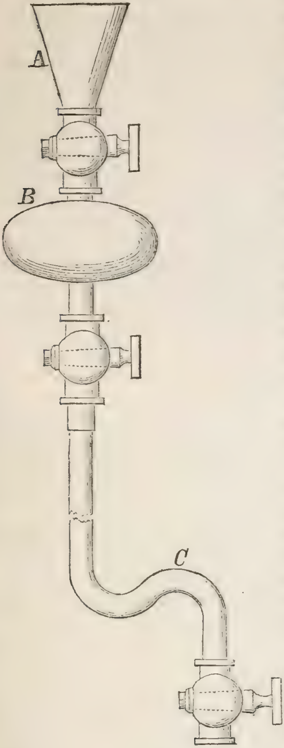
6th. That when ice is equally dense, thick, and glare, and equally acted on by a heated atmosphere, it expands from the centre towards the circumference.

7th. That ice expands towards the line of *least resistance.*

NEW FORM OF AIR-PUMP.

The accompanying figure represents a curious air-pump proposed by A. Gairaud, of France, to supersede the common piston air-pump. The agent for producing a vacuum in this pump is mercury, acting by gravity; and instead of a flap-valve, as in the air-pump, air-tight faucets are substituted.

It is conceded by all philosophers that, with the common air-pump, the rarefication of the air can be carried on only to a certain limit; the best air-pump not being able to bring the column of mercury in the barometer attached to it below one-sixteenth of an inch; and it is obvious that the air in the receiver will not be able to raise the valve, on account of its rarity. These defects are proposed to be removed by the mercurial air-pump which is the subject of this article. This pump consists of a barometer tube about 33 inches long, and 5-16 to 3-8 of an inch in diameter. Its lower end, C, is bent in the form of an S, and it is closed by a cock. The upper end of the tube is firmly secured to a glass egg-shaped vessel, B, containing from half a pint to one quart, and is provided with a stop-cock below and with another one above; this latter faucet being covered by a funnel, A. The several fastenings and cocks are all made of iron, and the apparatus is screwed on a table.



To set the pump in operation, it is filled with mercury through the funnel on the top, and the upper cock is closed. By opening the stop-cock at the lower end of the tube, the mercury escapes into a vessel placed underneath, a column of 30 inches remaining in the tube; and a complete vacuum is obtained in the egg-shaped vessel, forming in this case the vacuum of Torricelli.

To apply this apparatus to the Magdeburg hemispheres, the lower one is secured to the top of the tube, and a hole is drilled in the upper one, which is stopped up by a cock, so that it can be filled with mercury and closed. By opening the stop-cock at the lower end of the tube, a perfect vacuum is attained in the hemispheres.

To exhaust or to rarefy the air in a common receiver, this apparatus is also superior to the common air-pump, as by its aid the rarefication can be carried on *ad infinitum.* The receiver is placed on the table and made to communicate with the glass egg-shaped vessel on the top of the tube by means of an iron pipe which is provided with a stop-cock. If the contents of the receiver and of the glass egg-shaped vessel are equal, the density of the air is reduced one-half by each operation; and after repeating the operation ten times, its density is not more than 1-1024; and after twenty times, it is not more than 1-1048576 of its original density. In this case, however, it is desirable to place the receiver on a ring or dish of India-rubber, instead of closing the joint by means of tallow.

This apparatus is much cheaper than any of the common air-pumps; and by the aid of 20 or 25 lbs. of mercury, all the usual experiments can be performed. It would be still less expensive if made of gutta-percha. If the tube is long and large enough, water may be used instead of mercury, and the apparatus may be employed for exhausting the air wherever it it desirable to make use of the atmospheric pressure, or in order to boil certain substances in a partial vacuum. — *Dingler's Polytechnic Journal.* — *Scientific American.*

A NEW FORM OF MERCURIAL BAROMETER.

M. de Celles has exhibited to the Academy of Sciences, of Paris, a mercurial barometer, constructed under his direction. The barometer is the instrument of Torricelli, with the following modifications: 1st, the diameter of the barometric chamber is increased in proportion as it is desired to make the instrument more sensitive; 2d, the cistern is replaced by a horizontal tube 0·15 ins. or 0·2 ins. in diameter, and of a length proportionate to the sensibility of the instrument. The instrument has the form of a square. Slight variations of the height of the vertical column correspond to considerable, but always proportional movements of the horizontal leg. This ratio is inversely as the squares of the diameters. An index of iron, placed in the horizontal tube, is pressed outward while the pressure of the air is diminishing, and is left when the column returns. It marks the minimum pressure, and may be brought back by a magnet. M. de Celles claims for this instrument the three advantages: 1st, of very great sensitiveness. 2d, a constant level. 3d, a minimum index.

ON THE HEIGHT OF THE ATMOSPHERE.

A letter from Mons. Emm. Liais, published in the *Comptes Rendus* (Jan. 10, 1859, p. 109), gives the results of his inquiries into the height of the atmosphere, as deduced from observations on polarization made at the tropics at the commencement of dawn and the end of twilight. The letter is dated San Domingo, Bay of Rio Janeiro, Dec. 6, 1858. His observations at that place, Dec. 1st, 2d, and 3d, indicated that the limit of atmospheric polarization was 9′ 40″ in passing from 20° east of the zenith to 20° west; but at San Domingo, of which the latitude is 23° S., the limit of the shadow passes over 25.6 kilometres per minute, or 247·5 kilometres in 9′ 40″. From this the height of the atmosphere is calculated to be 340 kilometres, or 211 miles.

THE PHONAUTOGRAPH.

At the last meeting of the British Association, the Abbe Moigno read a paper describing a new method of reproducing the human voice and other sounds in such a manner as to be visible to the eye. The instrument by which this is effected is called the phonautograph, and is the invention of a young Frenchman, M. E. L. Scott. The phonautograph consists of a tube, enlarged at one end in the same manner as a trumpet, in order to concentrate the sounds, which are conveyed through it to a thin membrane tightly strained over the other end of the instrument. This membrane carries affixed to it an excessively light style or pencil, which is put in motion by every vibration produced by the action of the air upon the membrane. Behind this style a band of paper, covered with lampblack, is unrolled by clock-work; and as this band passes along, the point of the style traces upon the lampblack all the curvilinear and rectilinear movements originating in the vibrations of the membrane, and thus it produces, in its own peculiar characters, a faithful reproduction of the sound.

M. Moigno also exhibited a collection of sheets of paper, on which were self-registered the sounds of the human voice, organ-pipes, etc., to the amount of five hundred or a thousand vibrations. This continued enregistration forms an undulatory curve, so perfectly and distinctly traced that the naked eye can easily reckon the atmospheric vibrations, especially when it is divided in periods by the periodical intervention of a chronometer. It is very curious to examine the variations which the curves undergo when the sounds are the results of the component parts of different harmony; for instance, a note with its octave, third, fourth, or fifth, or any other consonant relation, as the seventeenth or nineteenth. When the sounds are very nearly in harmony, but not in perfect accord, their simultaneous resonance produces beats, and these beats are perfectly indicated or made known to the naked eye.

Concerning this invention, the *London Literary Gazette* says: "The science of acoustics has received at the hands of M. Scott a means of development of which we can form no idea at present. We can only compare his invention to that of M. Daguerre, which, in its infancy, was treated as a mere toy, but which has now become one of our most valuable scientific instruments of observation. The human voice offers certain difficulties at present; but there is little doubt that eventually the phonautograph will be made capable of superseding every species of stenography, and not only the words, but the very tones of our talented speakers and actors will, by its aid, be registered for future generations.

ON THE VIBRATIONS OCCASIONED BY WATERFALLS, DAMS, ETC.

Prof. Snell, in an article in *Silliman's Journal*, Sept. 1859, in reviewing the subject of the vibrations occasioned by water falling over dams, etc., says:

This seems to be one of the numerous cases in which the body which excites vibrations in another, is itself thrown into synchronous vibration by reäction, and then, by its own inertia, or elasticity, controls the common rate of both. The sheet of water in its descent first produces rarefaction of the inclosed air by removing a part of it. The immediate effect is a collapse of the sheet of water, as well as a rush of air in at the ends. But the inertia of a thick mass of water will prevent its recovering its natural position so soon as if it were thinner; hence the air-column divides itself into such a number of segments, that the water and the air can adjust their movements to each other. In a manner somewhat like this, a stream of air from the lips, driven across the embouchure of a flute, excites vibrations in the column of air, with such frequency that it can itself vibrate in unison with it. But, if the stream is blown more and more swiftly, its elasticity will at length be too great for so slow a rate, and then the column will divide into shorter segments, and the two will continue their vibrations harmoniously upon a higher key. A skilful player can in this way, by his mere breath, produce six or eight harmonic notes on the flute, when all the holes are closed.

In one instance, at Holyoke, Mass., where the oscillations were only eighty-two per minute, I was surprised by the great strength of the current of air, as it rushed into the opening at the end of the dam. I could not venture within the passage through the pier, lest I should be swept in behind the sheet; nor could I stand at the entrance of the arch, without bracing myself, by placing both hands on the corners. There was, however, no alternate outward blast, but only a lull, or cessation of all motion; which shows that the excess of air that pours in at every pulse, is carried out again in some other way: and there is no conceivable way for it to escape, except to be driven down by the falling water, and poured up externally in a bed of foam. It had never occurred to me before, that the velocity of the air-current must be greater, the longer the interval between the pulses, since the rarefaction within the tube will be greater nearly in the ratio of the same interval.

DOVE'S EXPERIMENT IN ACOUSTICS.

This experiment consists in rendering the tone from a vibrating diapason very distinct, so that it could be heard through a large hall, by causing it to vibrate in a certain relation to a glass flask containing water. The flask should not be filled, and the diapason should not touch it, but be held in the hand in the prolonged neck of the balloon. The sound returned depends on the relation of the two limbs of steel to the neck of the flask. The perception of sound is most distinct when the plane of the two branches is in the axis of the neck, and is null when the plane is perpendicular to the axis. Dove ascertained these facts while engaged in researches as to the question whether the ear, which is for a time sensible to a certain tone, becomes insensible to it again, as the eye does to a given color, when it has for some time contemplated it. The eye may be said to habituate itself to certain colors, as the olfactory nerves do to persistent odors. Dove's researches returned an affirmative reply to the point in question. — *Silliman's Journal.*

CURIOUS ACOUSTIC EFFECT.

At a recent meeting of the Royal Institute of Architects, London, Mr. Parris, who renovated the painting in the dome of St. Paul's, said he had remarked, from his experience of that cathedral, that he could be heard distinctly at the distance of two hundred and twenty feet, when he was immediately under the eye of the dome. Any person standing on a particular part of the pavement below, at a right angle, or nearly at a right from where his voice would strike the roof, could hear even a whisper with the greatest distinctness; in fact, he had often held conversations in that way. As he moved to a different part of the dome, the person below would have to move to a different position, but in the same angle; but when this became too great, the voice was lost. He had often tried the experiment, and found that the reverberations in a dome were always repeated thirty-two times, exactly corresponding with the points of the compass. It was the same at the Colosseum, London, where he had tried it with the flute, voice, and every means. He had tried experiments in the same way in St. Paul's, upon the level of the organ, and above and beneath it; and he found invariably that the sound was always best heard at the point opposite to where the voice had struck. It was precisely the same with the voice ascending as descending; in fact, his attention had been called to the matter by hearing a man below ask another for sixpence; he exclaimed, "Take care, he is giving you a bad one," and the man immediately turned round, surprised as to where the voice could be coming from. — *Builder.*

EXPERIMENTS ON THE SUMMIT OF MT. BLANC.

Some interesting experiments on combustion, sound, etc., recently made on the summit of Mt. Blanc, by Professors Tyndall and Frankland, were detailed to the British Association, 1859, as follows: Six candles were chosen at Chamouni, and carefully weighed. All of them were permitted to burn for one hour at the top; and were again weighed when we returned to Chamouni. They were afterwards permitted to burn an hour below. Rejecting one candle, which gave a somewhat anomalous result, we found, to our surprise, that the quantity consumed at the top was, within the limits of error, the same as that consumed at the bottom. The result surprised us all the more, inasmuch as the light of the candles appeared to be much feebler at the top than at the bottom of the mountain. The explosion of a pistol was sensibly weaker at the top than at a low level. The shortness of the sound was remarkable; but it bore no resemblance to the sound of a cracker, to which, in acoustic treatises, it is usually compared. It resembled more the sound produced by the explosion of a cork from a champagne-bottle, but it was much louder.

DYNAMOSCOPY.

This name has been given to a new mode of ausculation directed towards the examination of sounds hitherto not studied. The author, Dr. Collongues, examines these sounds, in case of a deceased person, with an instrument with one extremity on the part to be ausculted and the other at the ear. It is with this instrument that Dr. Collongues supposes he is able to detect the evidence of actual death.

He found this evidence in 1851, in the case of a woman attacked with cholera, who was not believed to be dead. Examining about the heart with his dynamoscope, he distinguished a crackling sound, which continued even to the tenth hour after death. He followed up this trial with others, and has arrived at the following conclusions respecting this sound.

1. After the respiration and the beating of the heart have ceased at death, a crackling sound may be heard, which he calls "bourdonnement."

2. The sound continues from five to ten hours after death.

3. It goes on decreasing from the time of death, and is last perceived about the præcordial and epigastric regions.

The results have been confirmed by observations on animals. It hence results that life continues until the cessation of this sound has ceased, and the cessation is a positive sign of death. This observation offers a means of distinguishing *lethargy* from death, as the sound does not cease in lethargy.

On applying the instrument to the extremity of the fingers, a sound of similar kind is heard which varies with the age, sex, state of health, activity or repose. The crackling is more rapid in children than in adults, and still more so than in aged persons. It is more gentle in woman than in man of the same age, and the crackling sounds ("pétillemens") are in general twice as numerous as those of man. There is also a great difference for different temperaments, and for different seasons and climates.

A singular experiment made with the instrument is to hear a faint and agreeable harmony which is made at the extremity of the fingers of a man asleep, whilst when awake there is only a great discordance in the "bourdonnement." Dr. Collongues supposes that these sounds have their seat in the nerves. — *Silliman's Journal.*

UNIFORM MUSICAL DIAPASON.

Very considerable inconvenience has long been felt in the musical world, in consequence of the want of a uniform standard by which the pitch of musical instruments, whether used individually or in concert, might be regulated. The tendency in all the most celebrated orchestras to an increased elevation of pitch, has been attended with evils which affect the interest of music in no small degree; composers, instrument-makers, and artists are alike sufferers from this cause, and the great difference existing between the pitches (or diapasons, as they are called) of various countries, or of various musical establishments, is frequently a source of embarrassment in musical transactions. With a view to remedy this acknowledged and growing evil, the French Government, sometime ago, appointed a commission of distinguished men to discuss and collect information upon the whole question; and the result of their labors has lately appeared in the *Moniteur*, in the shape of an elaborate report. The commission consisted of fourteen members, all of them eminent in the world of music or of science; as Auber, Despretz, Lissajous, Meyerbeer, Rossini, etc.

Any opinions emanating from a body of men so well qualified to judge upon a subject of this nature, must necessarily be worthy of attention; and we think a short summary of their report may not be uninteresting to our readers.

The report commences by stating that it is an undoubted fact that the diapason, or pitch, has been steadily rising for at least a hundred years, and that it is now quite a whole tone higher than it was in the middle of the last century. As a proof of this, we have the internal evidence of the scores of Gluck, Monsigny, Grétry, and others, besides the more certain testimony of the organs of the time. Rousseau (*Dictionnarie de la Musique*, article *Ton*) states that the pitch of the opera in his time was lower than that of the chapel, and consequently more than a tone lower than that of the opera of the present day. The first question, then, that naturally presents itself for consideration is, what were the causes which have led to this result? Vocalists cannot fairly be charged with any participation in producing this change. They screamed, it seems, even in those days, without the facilities afforded them by the operas of Signor Verdi. Besides, it is manifestly never for the interest of the singer that the diapason should be forced up — a circumstance which can only tend to increase his fatigue, and make inroads upon his voice. The interests, too, of composers are, for many reasons, opposed to an undue elevation of the pitch. They have, moreover, but little power of influencing an orchestra in this respect. The composer does not fix the diapason — he submits to it. It is, then, says the report, to the instrumentalists and the instrument-makers that this result must be attributed. They are the persons who have evidently a joint interest in raising the diapason of the orchestra. Up to a certain point, the more elevated the pitch the greater the brilliancy and sonority of an instrument.

The numerous inventions and improvements which have been effected in wind instruments, have, more than anything, induced the unnatural height which the diapason has now reached. A direct confirmation of this is afforded in a particular instance by a letter addressed to the commission by M. Kittl, the director of the conservatory at Prague, who states that the Emperor Alexander I., upon becoming proprietor of an Austrian regiment, ordered new instruments to be made for the band. The manufacturer, in order to increase the brilliancy of tone, raised the pitch considerably. This having produced the desired effect, the example was followed by other military bands, who all raised their diapason.

With a view of obtaining as much valuable information as possible upon the subject, which is one of universal interest to musical art, the commission wrote to all the most celebrated musical centres in England, Belgium, Holland, Italy, and America. Almost all the answers which they received agree in their estimation of the importance of the subject, and in deprecating the undue height of the diapasons now in use. Some of these communications, coming as they do from composers and conductors of the first eminence, are very interesting. It would, however, occupy more space than we can afford, to attempt anything more than a very brief mention of one or two of the most striking. Reissiger writes, from Dresden, that he hopes all Europe will warmly applaud the establishment of the commission. The great elevation of the pitch, in his opinion, destroys the effect and effaces the character of ancient music — of the master-pieces of Mozart, Gluck, and Beethoven. Ferdinand David, Franz Abt, and Lachner, express with equal decision their approval of the step which the French government has taken. Herr Wieprecht, the director of the military music of Prussia, and Dr. Furke, each forwarded able papers upon the subject, and manifested a lively sympathy with the objects which the commission had in view. From several quarters tuning-forks, to the number of twenty-five, were received. Of these, Messrs. Broadwood sent three, which afford a striking example of the necessity which exists in our own country for some reädjustment and assimilation of the pitches now in use. The first is a quarter of a tone lower than that of Paris, and is used exclusively for piano-fortes destined to be employed for the accompaniments at vocal concerts. This, it seems, was the pitch used about thirty years ago by the Philharmonic Society. The second, which is higher than the Paris pitch, is that to which Messrs. Broadwood ordinarily tune their instruments, as being most likely in general to be in tune with harmoniums, flutes, etc. It is the diapason of instrumentalists. The third, still higher, is that now used by the Philharmonic Society, and, with one exception — viz., that employed in the band of the Belgium regiment of guides — is the highest which the commission received. This latter vibrates nine hundred and eleven times in a second, whereas the No. 1 of the Messrs. Broadwood, the lowest of all the tuning-forks sent in, gives only eight hundred and sixty-eight vibrations in the same time. This difference is nearly equivalent to a semitone.

With these and various other similar communications before them, the commissioners unanimously come to the conclusion that it was desirable — first, that the diapason should be lowered; and, secondly, that when so lowered, it should be taken as an invariable regulator. The determination of the particular diapason to be adopted naturally presented considerable difficulties, and accordingly led to some diversity of opinion. All agreed that a depression of more than a semitone was neither practicable nor necessary. One member alone advocated a depression of less than a quarter of a tone. He, indeed, proposed that the alteration should at the most extend to half a quarter of a tone — fearing that any greater change, coming suddenly into operation, might act prejudicially upon the trade in musical instruments, which is one of the most successful branches of French industry. It is difficult, however, to see much force in this objection, when we consider the great variety which exists in the diapasons already in use throughout Europe. In a letter addressed to the Minister of State by the principal French instrument-makers, they enlarged upon the embarrassment resulting "from the continually increasing elevation of the diapason, and from the variety of diapasons," and go on to request his Excellency "to put an end to this kind of anarchy, and to render to the musical world a service as important as that rendered to the industrial world by the creation of a uniform system of measures." It is evident from this that the manufacturers themselves do not regard with apprehension the contemplated change of diapason.

Ultimately, a depression of a quarter of a tone was fixed. This, is was thought, would afford an appreciable relief to vocalists; and, "without introducing too great a derangement in established habits, insinuate itself, so to speak, *incognito* into the presence of the public. It would render the execution of the ancient master-pieces more easy; it would lead us back to the diapason employed (in Paris) about thirty years ago, — the period of the production of works which have, for the most part, retained their places in the repertory, and which would accordingly be restored to the original condition of their composition and representation. It would also be more likely to be accepted in other countries than the depression of half a tone." In accordance with the recommendations of the commission, an official order has been issued, establishing by law a uniform pitch to be used by all the musical establishments of France which have any connection with the government. This "normal diapason" is an A, given by a standard tuning-fork to be preserved at the Conservatoire, which vibrates 870 times in a second. All musical establishments authorized by the state must be provided with a tuning-fork, verified and officially stamped as consonant with this standard. — *Journal of the Society of Art, London.*

The diapason adopted by the *Congress Scientifique* held at Stuttgard in 1834, was *la* $(a') = 880$. This movement is therefore towards lowering the concert pitch. Savart gave as the diapason of the opera at Paris in 1834, *la* $= 886\frac{8}{15}$. Another diapason given by M. Scheibler as that of the Academy of Music at Paris in the same year, was 867·5. The starting-point will now be $c = 1{\cdot}01953125$. And the gamut will be as follows: — *ut* $(c') = 522$. *re* $(d') = 587{\cdot}25$. *mi* $(e') = 652{\cdot}5$. *fa* $(f') = 696$. *sol* $(g') = 783$. *la* $(a') = 870$. *si* $(b') = 978{\cdot}75$. *ut* $(c'') = 1044$.

Uniform Musical Pitch in England. — The following is an abstract of the proceedings of a meeting called under the auspices of the Society of Arts, London, June 3d, 1859, to consider the question of the alteration of the musical pitch by the French Government, and how far such alteration was likely to affect musical performances in England. The chair was taken by Dr. Whewell, of Cambridge, who in his opening remaks said that he believed that he was the first person who determined the pitch by ascertaining the number of vibrations in a second which gave particular notes. This was done in the pipes of the organ at Trinity, and might be said to be the fundamental determination of the pitch in England, so far as mathematical definition was concerned. The subject has recently been more prominently brought before the musical world, in the report issued by the commission appointed by the French Government to investigate this question, with the view to the establishment of a uniform pitch to be adopted in that country. In that report an historical view of the question had been taken, and the number of vibrations of various notes at different periods during the last century and a half had been stated. The question with the commission was, from which of those various numbers the selection was to be made. The first question to be determined was, whether it was desirable that a uniform musical pitch should prevail; and, secondly, whether it was possible to establish such a uniform pitch in this country. The establishment of a uniform pitch was to be enforced by stringent legal means in France, a course which could not be imitated in this country. They had to consider what means short of these could be used here, and whether any influence beyond a general understanding among those engaged in music could be brought to bear. These were points upon which those present were well qualified to give opinions, which, he was sure, would be listened to with interest and deference.

Letters were then read from gentlemen who were unable to attend, most of whom were in favor of establishing a uniform diapason.

Professor John Donaldson (in his letter) suggested what he considers to be a very simple standard of pitch: "Let a column of air, say an organ pipe thirty-two feet long, be put into vibration or undulation, it will be found to give thirty-two vibrations or undulations at each oscillation of the pendulum. The length in the latitude of London being 39·1393 inches, allowance could easily be made for the slight variation of length in the lower or higher latitudes. If 32 feet in length = 32 vibrations, then as the vibrations are inversely as the lengths: a 16-foot pipe = 64 — 8 ft. = 128 — the pitch of the lowest string of a violincello; computing the vibrations or undulations as course and recourse, the pitch adopted in Paris by Rheica in his treatise on harmony."

Mr. Alfred Mellon was of opinion that "there is no doubt that the musical pitch has been much elevated during the last quarter of a century, and that some disadvantages result therefrom; but it may be questioned whether greater disadvantages would not now be caused by a resumption of the former pitch, or any depression of it. Many of the wind instruments now in use would be injured, and the artists put to the expense of new ones. The principal organs in Birmingham, Liverpool, Bradford, and other large towns, would have to be altered at great expense. All purely orchestral performances would also lose much of their brilliancy in the lowering of the stringed instruments. Many other disadvantages occur to me, and will doubtless be brought to your notice. On the other hand, I am not aware (writes Mr. Mellon) that the proposed alteration would benefit any persons except the singers and the wind instrument makers. But considering that music is the universal language of Europe, it is desirable to establish a uniform pitch between England and the Continent; and I would therefore recommend that the pitch now in use at the Royal Italian Opera, Covent-garden, under the direction of M. Costa, Esq., should be established as the definite limit to prevent further elevation. But it must be borne in mind that even this pitch cannot be maintained as an absolute rule throughout an entire evening's performance; the warmth of the temperature and the breath of the performers would have the effect of sharpening the wind instruments, and necessarily drawing the rest of the orchestra with them."

Mr. Hullah thought a uniform pitch was highly desirable. Of course a uniform pitch aspiring to universal adoption, must be regulated eventually by what was convenient to the human voice. But there was a question whether there was any particular number of vibrations per second which was more convenient than another for simplifying musical calculations. He had found the number of 512 vibrations per second for the C gave the simplest series of numbers representing the other notes, and was very favorable for musical calculations; at the time of which he was speaking, this pitch was a little above some of those then in use, and a little below others, so far as a correct comparison could be made, for that was a difficult matter. He had then with him a pocket full of tuning-forks which he had collected, and no two of them were alike, except those which had been made to his order by a scientific process. He put himself in communication with Mr.

Tomlinson and a gentleman who had given a great deal of attention to the subject. Mr. Tomlinson, on being supplied with one of Cagniard de la Tour's instruments for measuring vibrations, — the Sirène, — satisfied himself that he could regulate this instrument, which every one knew was very difficult to keep at the same pitch, so as to ascertain what was 512 vibrations per second; and he made certain tuning-forks, of which he (Mr. Hullah) had seen and tried hundreds, and he had never found the slightest discrepancy in them, except on that morning, for the first time in his life. He tried two of those forks with the greatest care again and again that morning. He placed one of them upon a hot plate, and allowed it to remain until it became heated, when he found that the pitch was considerably lowered. This was nothing new; but the extraordinary part of the matter was, that the fork had never since recovered its former pitch, and there was still some little discrepancy between it and the fork which had not been heated. He thought a uniform pitch was so highly to be desired that whatever the pitch might be — whether the highest ever conceived or the lowest, he would vote for it for the sake of uniformity — though he certainly should prefer, and do his best to bring about, the adoption of a pitch considerably lower than that at present in use.

Mme. Goldschmidt (Jenny Lind) was of opinion that if the present pitch were adhered to, all the voices would be more or less spoiled, and that was one of the reasons why we had so few really good singers. For her own part, there was a considerable amount of music that she could not think of singing at the present pitch; and music which she sang with the greatest ease about twelve years ago, when the pitch was lower, she would not now attempt. If the raising of the pitch went on as it had hitherto done, the human voice would lose its beauty and strength; and she did not consider it was proper to tax the voice to that extent. In her opinion, the standard of the pitch ought to be regulated by the human voice.

M. Goldschmidt did not suggest that they should adopt the French pitch merely because it was French, but chiefly because it was the pitch of the Philharmonic Society and of Broadwood thirty years ago. As it was adopted by France, why should we not also adopt it, especially as it was the good old pitch of olden times?

Mr. Hullah would be glad to hear, from Mr. Walker, what would be about the expense, in round numbers, of lowering the pitch of an organ worth £2000 a quarter of a tone.

Mr. Walker, at a rough guess, should say perhaps £50.

Mr. Hullah could assure the meeting that he was not bigoted to any pitch, but would vote for any upon which they could all agree. The difference between the pitch which had been designated his and the French, was ten vibrations per second. The French pitch was 522 vibrations per second; his was 512. He thought if it were an open question to decide between the two pitches, they were so near that it would be wise to decide in favor of the lower pitch. He would put on record a remarkable expression which was used some time since by Sir George Smart, in reference to this subject. He said: "It is not the Philosopher who has settled the pitch; God Almighty has settled the pitch in making the human voice."

Dr. Arnott suggested that as inconvenience had been experienced from the rise of the pitch of the organ in the course of an evening's performance, an apparatus might be connected with the bellows of the organ communicating with the outer air, and so keeping up a blast of cold air through the pipes, thus preventing their expansion by heat.

Mr. Walker remarked, that the cold air must be blown upon the exterior of the pipes as well as upon the interior. Moreover, the front pipes of an organ were generally more affected by the heat than the interior pipes.

The Chairman said, that, with regard to Mr. Hullah's remarks, he would say that every mathematician, at first sight, might have a strong bias in favor of what Mr. Hullah called his standard of 512. Chladnir had founded his system upon that number, and no mathematician who expressed the relation of musical notes in numbers, could fail to be struck with the advantage for such purposes of that scale, which gave to the middle C 512 vibrations per second. That did not give A a whole number, but it gave a great amount of whole numbers, and in many ways was convenient. On the other hand, the numerical advantages of the standard were not important. Where the note was determined, they knew that it was by the number of vibrations, whether counted in fractions or decimals, and by that means they could recover the note at any time. Therefore, he thought the conveniences and inconveniences were of another kind, and must be considered by practical musicians. The difficulty urged by one speaker, that a change of pitch would involve the destruction of a great body of existing instruments, was one which must not be overlooked, though some of them, no doubt, might be modified. The alterations of organs to the new pitch would also be a matter of considerable expense. These were difficulties of far more importance than any want of symmetry in numerical calculations. Still, if the French system were adopted over a great part of Europe, so far as there were any perceptible difference between that and 512, musicians would gain more by adopting it than mathematicians would lose.

A committee, of which Dr. Arnott is Chairman, was then appointed to consider the whole subject, and report at a future meeting.

INTERESTING BALLOON VOYAGE.

The greatest balloon voyage on record, was performed on the 1st and 2d of July, by Messrs. Wise, LaMountain, Gager, and Hyde, — four persons, — who passed over a distance of eleven hundred and fifty miles in nineteen hours, or from St. Louis, in Missouri, to Henderson, Jefferson County, New York. The special object of the experiment was to establish the existence of a constant current of air, at a high elevation, from west to east, over the North American continent, and, by means of it, to pass in the balloon from St. Louis, on the Mississippi, to a point on the Atlantic sea-board. The ascension was made from St. Louis, at 7.20 P. M., on the 1st of July, and the course at starting was north of east. During the night nothing of any particular moment occurred, -- the balloon sailing along in a north-easterly direction, at a varying height above the earth from five hundred to ten thousand feet. The sky was clear, and the whole dome of the heavens is described by Mr. Wise as "lit up with a mellow phosphorescent light. So remarkable was this phosphorescent light of the atmosphere, that the balloon looked translucent, and looked like light shining through oiled paper. We could also tell prairie from forest, and by keeping the eye for a moment downward, we could see the roads, fences, fields, and even houses, quite distinctly, at any elevation not over a mile, and even at the greatest elevation we could discern prairie from woodland, and from water. Whenever we hallooed, it was followed by a distant echo, and even this served as a differential index to height."

At 6 A. M., on the morning of the 2d, the voyagers arrived at the shore of Lake Erie, a little north of Sandusky. The course was at first held along the southern shore of the lake; but by 10.20 the lake was crossed, and the Canada shore reached. In attempting to make a landing in the vicinity of Rochester, N. Y., the aëronauts encountered a hurricane, and after being blown for a great distance, — a part of the time over and near the surface of the lake, — they brought up in a forest in the town of Henderson, Jefferson County, N. Y. None of the party were seriously injured, but the balloon was nearly destroyed. The entire distance travelled, from St. Louis to the point of landing, was eleven hundred and fifty miles, which was done in nineteen hours and fifty minutes, being very nearly a mile per minute. The longest journey heretofore made in a balloon was five hundred miles, performed many years ago by Mr. Green, the well-known English aëronaut.

ON THE FORM AND FLIGHT OF PROJECTILES FROM RIFLED CANNON.

From a recent work on rifled cannon, published in England by Mr. Thomas, we derive the following memoranda relative to the construction of the projectiles to be used in connection with this new ordnance.

In the practical adaptation of these new engines of war, it must be remembered that it is the *gun*, rather than the shot, which has to be carefully studied; because, for the production of great velocities, heavy charges of powder are required, and these again demand greater thickness — and therefore greater weight — to enable the gun to withstand the greatly increased strain upon it. Hence, the object is to obtain such a projectile that it can be thrown from a gun of the same weight as that which throws the round shot, — but which shall be, at the same time, a much heavier missile. "Now this," adds Mr. Thomas, "can be accomplished by the use of elongated shot — shot in which, while the *weight* is the same as that of the 32 lb. shot, the diameter is only that of a 9 lb. shot; and therefore the surface, upon which the resistance of the air acts, will be the same, or nearly the same, for the heavy shot as for the lighter.

To secure the accurate flight of an elongated missile, it is of paramount necessity to keep its axis coincident with the line of its flight; for, if this be not attended to, the resistance of the air becomes greater, and the shot is liable to turn over on its shorter axis. To maintain this coincidence, the projectile must be made to rotate upon its axis; and this rotation can only be obtained by means of the turn or twist it acquires during its constrained passage along the rifled grooves of the gun's barrel. Again, as this rotation varies according to the length of the turn given, it becomes of primary importance to determine accurately how much the turn should be, and whether it should be the same or different, according to the cannon or the projectile required. Mr. Thomas, who has paid especial attention to this question, states that the lengths of turn now in use vary between that of the Enfield bullet, which has one turn in seventy-eight inches, and those adopted by Major Jacop and Mr. Whitworth, which are, respectively, one in twenty-four and one in twenty inches. He points out that this remarkable disparity arises, in a great measure, from the difference in the shapes of the bullets; and sums up his whole investigation with two general conclusions — first, that the velocity of rotation, or, in other words, the appropriate turn, must be increased, proportionally, with any increase in the length of the projectile; and, secondly, that it is not advisable that the projectile should, in length, exceed the triple of its diameter.

Another question of great importance to be satisfactorily determined is, whether the varying size of the projectile produces a similar effect upon the turn of the grooves of a rifled cannon. Now, this cannot be ascertained beforehand by theory, but depends entirely upon experiment, and on experiment alone. It is true, that where the shot differ only in their diameters, a law may be readily laid down; where, however, they differ *both in form and weight*, a laborious series of experiments must be made before any definite principles can be enounced. Here, as in so many branches of the great subject of gunnery, no clear views appear hitherto to have been held or published; hence, Mr. Thomas has been compelled to examine into and to state all the bearings of the case with great minuteness. It would be impossible, in this place, to follow him through all his reasonings; but we may notice, generally, that the retarding effect of the air, for shot differing in size, but of the same form and density, would appear to be *nearly as the square roots of their diameters.*

Having discussed these matters as fully as possible, Mr. Thomas goes on to describe, with equal minuteness, the different forms of projectiles advisable under different circumstances. We cannot enter here into these details; but we may state the general principles at which he has arrived, experimentally. Thus, he states that the necessary qualifications for an elongated projectile are: 1. That it should possess a certain definite density, so as to insure the greatest possible range. 2. That it should completely fill the bore, so that its axis should coincide exactly with it. 3. That its centre of gravity should be thrown well forward, in order that the axis on which it rotates should be, practically, a tangent to the line of its flight. And, 4. That its form should be such as to expose it to the least possible resistance from the air. Lastly, he shows that solid iron unexpanding shot can never really produce the results attainable by compound shot, because in their case space must always be allowed for their windage, for the fouling of the bore, and for the contraction of the gun itself, when heated by repeated firing.

Mr. Thomas remarks, that it has generally been hitherto held that, on firing, the whole of the powder is at once converted into an elastic fluid, and that the ball is expelled by the gradual expansion of this fluid. The result, however, of many interesting experiments made by him, appear to show that, besides the ordinary explosive property of gunpowder, there resides in it a peculiar force, which (for want of a better name) Mr. Thomas has termed *impulsive;* and that owing to this, large guns are much more liable to burst than smaller ones. It is no less certain that, with a finely granulated powder, a comparatively short gun may be safely used, — such tribes as the Afghans, on the other hand, who manufacture a powder much inferior to ours, being compelled to use guns of a length apparently altogether disproportionate, with the simple object of completely igniting the powder.

WIND OF A SHOT.

M. Pelikan, a Russian, has made some curious observations upon the contusions supposed to be produced by the wind of passing balls. Mr. P. applied to the committee on artillery of St. Petersburg, and having obtained some pieces of large calibre, had a machine constructed for measuring the force exerted by the wind of balls passing at various distances. The results obtained were constantly the same. At the distance of three inches, a passing ball produced not the slightest effect. The conclusions deduced by Mr. Pelikan are: 1. A projectile passing very close to any object exercises only an insignificant influence upon it. 2. That what is called the wind of the ball, even with a full charge of powder, has so trifling a force as to be incapable of determining any lesion.

LUNAR TIDE UPON LAKE MICHIGAN.

At a meeting of the Chicago Historical Society, November 30th, 1858, Col. Graham, U. S. A., stated, as the result of a long and carefully conducted series of observations, his discovery of a lunar tidal wave upon Lake Michigan. From the comparatively small area of the body of water acted upon by the lunar influence, the coördinate of altitude could not be but small. This circumstance, added to that of the almost constant disturbance of the lake surface by winds, renders this coördinate of altitude measurable only in calm weather, and when the moon is in conjunction with or in opposition to the sun. At such times its average is about two-tenths of a foot, or say two and one-half inches.

UNITS OF WORK.

The following are the results obtained in units of work or foot-pounds for one unit of heat, by different authors:

	Centigrade thermometer. Foot-pounds.	Fahrenheit thermometer. Foot-pounds.
By Holtzman's formula, ...	1227	682
By Joule's experiments, ...	1386	770
By Rankine's formula, ...	1252	695
By Thompson's formula, ...	1390	772
For the best Cornish engine, by M. De Pambour,	148	82
For a perfect low-pressure condensing engine, .	90·8	50·4
For an actual Boulton and Watt's engine, .	46	25·5

ON THE STRENGTH AND TENACITY OF GLASS.

A series of interesting experiments have been recently made in England on the strength and tenacity of glass. By tearing rods and sheets of glass asunder, the following mean results of tenacity per square inch, expressed in pounds, were obtained: Flint glass, 2.413; green glass, 2.896; crown, 2.916. The experiments on the resistance offered by glass to a crushing force, were made upon small cubes and cylinders, crushed between parallel steel surfaces, by means of a lever — the force employed being sufficient to reduce the glass to a fine powder. The results, expressed in pounds, were as follows: Flint glass, 13.190; green glass, 20.206; crown, 21,867.

BLASTING WITH GUN-COTTON.

It is generally said that gun-cotton produces three times the effect of gunpowder; but military engineers aver that the effect which the explosion of a certain quantity of gun-cotton will produce, can never be exactly foretold. If the cotton is very strongly compressed when the electric spark is applied to it, the effect which it produces is very great; but if it is at all loose, it is much less efficacious than gunpowder. If a few pounds of powder explode in a room, the devastation must necessarily be great; but if the same weight of gun-cotton is strewn loosely on the floor and then ignited, a sudden "puff" takes place, but the articles in the room are uninjured. The Austrian Government has expended a great deal of time and much money in making experiments; but it is beginning to discover that powder is preferable to cotton.

A SIMPLE MEANS OF DEMONSTRATING THE WORKING OF LIQUID FIRE-SHELLS.

The bi-sulphide of carbon is first poured into the shell, and then small bits of phosphorus are dropped in; the mouth of the shell is then closed with a cork, partly projecting, like the cork in a wine-bottle. The shell may then be laid on canvas, or other combustible matter; and in about ten minutes, the fermentation of the mixture will force its way through the pores of the cork, and, meeting the oxygen of the atmosphere, will become ignited, — the cork acting like the wick of a candle, and the liquor underneath feeding it. A leaden shell thus charged, and adapted to a military rifle, will continue to burn for ten minutes with an intense flame, which cannot be extinguished by water. — *London Mech. Magazine.*

ON THE FREEZING-POINT OF WATER IN CAPILLARY TUBES.

Many years ago, M. Donné showed that water enclosed in narrow tubes of a substance capable of being welled up by it, might be raised to a temperature considerably above 212° without boiling. Mr. H. C. Sorby, in a note communicated to the London, Edinburgh, and Dublin *Philosophical Magazine*, completes these researches by showing that in capillary tubes the temperature of water may be lowered far below 32° without freezing, even when the tubes are shaken. In tubes of from $\frac{1}{200}$ or $\frac{1}{300}$ inches in diameter, the water may be reduced to 5° Fah., without freezing, provided it be not in contact with ice. These experiments go to show that these phenomena are caused by the adhesion of the water to the walls of the tube interfering with its change of state.

CHEMICAL SCIENCE.

ON THE NATURE OF THE SIMPLE BODIES.

The *Comptes Rendus* for December 1858, contains a long memoir, by Despretz, on his researches to ascertain whether certain of the so-called elements are decomposable. His laborious and careful investigations have led to no decomposition; and he announces the conclusion, that the substances called elementary are really elementary, or incapable of decomposition. The author should have added, that they were not decomposable by the methods he used, for it is not probable that there is nothing more to be done in this branch of research. His process consists in submitting the element — cadmium, for example — to the physical and chemical reägents ordinarily employed in analysis. He transforms it into an oxide, then into salts of all kinds; decomposes these salts by chemical and galvanic methods; precipitates the metal at one time at the positive pole, another at the negative; examines the crystalline form; turns it again into salts, which he decomposes; vaporizes the metal by means of the pile; and thus causes an element to pass through a great number of different states, and still arrives at the same element. While rendering justice to the zeal and patience of Mr. Despretz, we have to regret that these good qualities have been here wasted; for the researches would be a hinderance to the progress of science, if taken seriously.

Dumas took upon himself the refutation of M. Despretz, and brought to the subject his well-known ability. He prefaced his remarks by presenting the following table, which exhibits an interesting relation between the equivalents of certain simple and compound bodies.

Fl 19	Cl 35·5	Br 80	I 127		Difference 5.
N 14	Ph 31	As 75	Sb 122		
Mg 12·25	Ca 20	Sr 43·75	Ba 68·5	Pb 103·5	Difference 4.
O 8	S 16	Se 39·75	Te 64·5	Os 99·5	
Ammonium 18	Methylamine 32	Ethylamine 46	Propylamine 60, etc.		Diff. 3.
Methylium 15	Ethylium 29	Propylium 43	Butylium 57, etc.		

As this relation suggests a doubt as to the elements being simple, Dumas took occasion to express his opinion on this important question.

Since the radicals (elements) in mineral chemistry present the same general relations as those in organic, he believes there is reason for bringing the two branches more closely together than is usually done. We can decompose the latter, and there is no proof that we may not decompose the former. The following are the conclusions in his memoir, which will soon be published.

1. The compounds which the three kingdoms offer for our study, are reduced by analysis to a certain number of radicals which may be grouped in natural families. 2. The characters of these families show incontestable analogies. 3. But the radicals of mineral chemistry differ from the others in this, that if they are compound, they have a degree of stability so great that no known forces are capable of producing decomposition. 4. The analogy authorizes the inquiry whether the former may not be compound as well as the latter. 5. It is necessary to add that the analogy gives us no light as to the means of causing this decomposition, and if ever to be realized, it will be by methods or forces yet unsuspected.

To these remarks of Dumas, Despretz subsequently replied in his turn, criticizing the ideas of Dumas on the unity of matter. According to him, there is not a sufficient analogy between the radicals of organic chemistry and the simple bodies of mineral chemistry. The first are decomposed by heat, and converted by oxygen into water and carbonic acid. These organic compounds thus disunited can never be again recomposed. It is well understood to be quite otherwise in respect to the elements of mineral chemistry. From this M. Despretz concluded that there is not only no analogy, but that there is a complete contrariety, between the elements of organic and inorganic chemistry; in a word, as far as he can discern, science furnishes no indication favoring a belief in the decomposition of the bodies considered simple, even by the aid of new forces. On the contrary, he thinks he has demonstrated that the metals and metalloids are simple bodies. We have already seen by what processes he thinks he has arrived at this conclusion; he returns to the subject now to show in what respects his experiments are new, and says: "All chemists have ignited iron and platinum to a white heat, but no chemist, to our knowledge, has ignited these metals in a barometric vacuum for the purpose of ascertaining whether any gas was disengaged; and this is my experiment."

"Nothing is disengaged under the action of heat, or of a spark from a powerful induction apparatus. This negative result is of a nature to astonish the partisans of the theory of Dr. Prout, if any exist. According to this hypothesis, iron should retain about 80,000 and platinum 200,000 volumes of hydrogen gas condensed into only one volume. How can we suppose that a condensed gas could resist the test to which iron and platinum are subjected in my experiment? Is there a single fact in physics and in chemistry which authorizes such a supposition? In my process, the disengagement of one-twentieth of a cubic centimetre of gas would have been readily appreciable. To this slight weight the most delicate chemical balances would have been insensible."

The reply of Dumas is briefly as follows: "I demand of M. Despretz why he expects the metals to resolve themselves into gas? why is it necessary that the primary elements of bodies should be gaseous? As regards the analogies between organic and inorganic chemistry, which are denied by M. Despretz, I ask where is the chemist who would not unite in one group cyanogen and chlorine, bromine and iodine? Where are the differences between these two sets of substances? Do they not blend in all their chemical affinities? Does not the analogy between them extend even to a similarity of atomic volumes? It is true, cyanogen has been decomposed, while the others have resisted decomposition; but he is greatly mistaken who believes that the discovery of cyanogen did not suggest doubts to the minds of chemists, and to Gay Lussac himself, on the nature of chlorine."

"Is not the same the case with ammonium and the radicals of the ethers? Do not these radicals furnish oxides, chlorides, sulphurets? Do not these oxides, acting the part of bases, resemble potassa and soda so strongly as even to mislead? Have we not in the combination of these radicals the same system as in inorganic chemistry? Who is the chemist to whom these discoveries, succeeding one upon another, have not suggested doubts concerning the nature of metals?"

"In a word, the efforts of modern chemists, for forty years, have resulted in proving that organic chemistry is made up of substances which are subject to the very same laws with which Lavoisier enchained inorganic chemistry, and subordinated to the same scheme through all its products. It was Lavoisier, who, in tracing out the route for us to follow, more than seventy years ago, defined organic chemistry as the chemistry of *compound radicals*, and mineral chemistry the chemistry of undecomposable radicals."

Dumas then refuted, one after another, the facts brought forward by Despretz in proof of his views. "If M. Despretz thinks that by distilling mercury, zinc, or cadmium, these substances can be decomposed, he forgets that alchemists and the arts long ago threw light on this point. If he compounds with the decomposition of a single body the analyses of a mixture, I regret it, but I remain convinced that there is not the slightest connection between the successive separations and the decomposition of simple bodies; that there is nothing in common between those fortunate concentrations to which we owe the discovery of iodine, cadmium, selenium, and bromine, and a philosophical discussion concerning the principle of the unity of matter." Dumas further sums up with the following conclusions: 1. It appears to me more and more probable that the equivalents of simple bodies are multiples of the same unit. 2. That the radicals of mineral chemistry behave in the same way as the radicals of organic chemistry. 3. That it is impossible to prove that bodies reputed simple are undecomposable. 4. That if, even at the present time, simply by employing forces and means already known, it is easy to contrive processes more powerful than those which M. Despretz has employed for the purpose of accomplishing this decomposition, I regard it as my duty to affirm anew that, in my opinion, these processes, though more rational, will not probably be more effectual. — *Silliman's Journal, Nos.* 81 *and* 82 — *Correspondence of M. Nickles.*

UNITARY NOTATION IN CHEMISTRY.

The so-called system of "Unitary Notation" in Chemistry, which is adopted and taught at the present time by the younger school of chemists in Great Britain, — viz., Dr. Odling, of Guy's Hospital, Prof. Brodie, of Oxford, Prof. Williamson, of the University of London, and others, — consists mainly in doubling the atomic weights of ten of the elementary bodies, viz., oxygen, sulphur, selenium, tellium, carbon, boron, silicon, tantalum, titanium, and tin. Those who are acquainted with Chemistry, will see at a glance the enormous number of compounds which are thus affected. Water, which under the old system was regarded as a compound of one of hydrogen and one of oxygen, is now regarded as having two of hydrogen and one of oxygen. Its atomic number is 18, instead of 9. Nitric acid, whose formula is written NO_5HO, is to be NO_3H. The theory of the constitution of salts is also changed. The acid of the salt is to be regarded as uniting directly with the metal, and not with its oxide, according to the old system, — the oxygen of the oxide being referred to the acid. Thus nitrate of silver, on the old system, was written $NO_5 + AgO$; but, according to the new system, the metal takes the place of the hydrogen in the acid, and it is expressed NO_3Ag.

ON THE INFLUENCE OF PRESSURE ON CHEMICAL AFFINITY. — BY DR. LOTHAR MEYER.

In the twelfth volume of Poggendorff's *Annalen*, there is a note by Babinet, which contains the proposal to use, as a measure of chemical affinity, the pressure which a gas generated by chemical decomposition must attain in order that the decomposition may cease. The author states that for zinc and sulphuric acid the limit is reached when for 0° C., the pressure of the liberated hydrogen amounts to thirteen atmospheres; at 25° C., on the contrary, this pressure exceeds the height of thirty-three atmospheres.

Experiments which I have made in Prof. Werther's laboratory do not agree with these statements. With the most varied strengths of sulphuric acid, even in the presence of large quantities of different sulphates, and by the use of citric and acetic acids, the pressure of the hydrogen liberated by zinc far exceeds the limits given by Babinet. The reason of this appears to lie in the fact, that Babinet used copper vessels closed by a cock, while I used sealed glass tubes.

The decomposition appears, however, to attain a limit; at any rate, the liquid, even with excess of zinc, has still a strong acid reäction after standing for months. But what the maximum of this pressure may be, I have not been able to determine, inasmuch as the only tubes I could obtain which would stand the pressure were too narrow to allow a manometer to be introduced. The greatest pressure which I observed directly at the manometer was sixty-six atmospheres. The acid consisted of one volume SH_2O_4, and three volumes of H_2O; the temperature was 0° C. The tube exploded shortly after observing this pressure. — *Poggendorff's Annalen*, vol. civ., p. 189.

FURTHER OBSERVATIONS ON THE ALLOTROPIC MODIFICATIONS OF OXYGEN, AND ON THE COMPOUND NATURE OF CHLORINE, BROMINE, ETC.

The following remarks on the above subject, were addressed as a letter by Professor Schönbein, to Professor Faraday, and by him communicated to the *L. E. and D. Phil. Mag.*, xvi., 178:

These last six months I have been busily working on oxygen, and flatter myself not to have quite in vain maltreated my old favorite; for I think I can now prove the correctness of that old idea of mine, that there are two kinds, or allotropic modifications of active oxygen, standing to each other in the relation of + to —; *i. e.*, that there is a positively active and a negatively active oxygen, — an ozone and an antozone, which, on being brought together, neutralize each other into common or inactive oxygen, according to the equation $(+\overset{o}{O}) + (-\overset{o}{O}) = O$. At present I confine myself to general statements; but a full detail will, before long, be published in the *Transactions of the Academy of Munich.*

Ozonized oxygen, as produced from common oxygen by the electrical spark or phosphorus, is identical with that contained in a number of oxy-compounds, the principal ones of which are the oxides of the precious metals, the peroxides of manganese, lead, cobalt, nickel, and bismuth; permanganic, chromic, and vanadic acids, and even the peroxides of iron and copper may be numbered among them.

The whole of the oxygen of the oxides of the precious metals exists in the ozonic state, whilst in the rest of the oxy-compounds named, only part of their oxygen is in that condition. I call that oxygen negatively-active, or ozone *par excellence*, and give it the sign $-\overset{\circ}{O}$, on account of its electromotive bearing. Though generally disinclined to coin new terms, I think it convenient to denominate the whole class of the oxy-compounds containing $-\overset{\circ}{O}$ "ozonids." There is another less numerous series of oxy-compounds in which part of their oxygen exists in an opposite active state, *i. e.*, as $+\overset{\circ}{O}$ or antozone, wherefore I have christened them "antozonids." This class is composed of the peroxides of hydrogen, barium, strontium, and the rest of the alkaline metals; and on this occasion I must not omit to add, that what I have hitherto called oxonized oil of turpentine, ether, etc., contain their active oxygen in the $+\overset{\circ}{O}$ state, and belong therefore to the class of the "antozonids."

Now, on bringing together, under proper circumstances, any ozonid with any antozonid, reciprocal catalysis results; the $-\overset{\circ}{O}$ of the one and the $+\overset{\circ}{O}$ of the other neutralizing each other into O, which, as such, cannot be retained by the substances with which it had been previously associated in the $-\overset{\circ}{O}$ or $+\overset{\circ}{O}$ condition. The proximate cause of the mutual catalysis of so many oxy-compounds, depends therefore upon the opposite states of the active oxygen contained in those compounds.

I will now give some details on the subject.

1. Free ozonized oxygen $= (-\overset{\circ}{O})$, and peroxide of hydrogen $= HO + (+\overset{\circ}{O})$, or peroxide of barium $= BaO + (+\overset{\circ}{O})$, the latter suspended in water, on being shaken together, destroy each other, $HO + (+\overset{\circ}{O})$ or $BaO + (+\overset{\circ}{O})$ being reduced to HO or BaO, and $+\overset{\circ}{O}$ and $-\overset{\circ}{O}$ transformed into O.

2. Aqueous permanganic acid $= Mn_2O_2 + 5\,(-\overset{\circ}{O})$, or a solution of permanganate of potash mixed with some dilute nitric acid, is almost instantaneously discolored by peroxide of hydrogen or peroxide of barium; the nitrate of the protoxide of manganese being formed in the first case, and in the second, besides this salt, the nitrate of baryta. It is hardly necessary to state, that in both cases the $-\overset{\circ}{O}$ of the permanganic acid and the $+\overset{\circ}{O}$ of the peroxide of hydrogen or barium are disengaged as O.

3. An aqueous solution of chromic acid containing some nitric or sulphuric acid and peroxide of hydrogen, are rapidly transformed into the nitrate or sulphate of oxide of chromium, HO, and inactive oxygen, which is of course disengaged. A solution of chromic acid mixed with some nitric acid and BaO_2, gives a similar result, — nitrate of baryta and oxide of chromium being formed, and O disengaged.

4. If you add to a mixture of any peroxide salt of iron and the red ferrosesquicyanuret of potassium (both substances dissolved in water) some peroxide of hydrogen, Prussian blue will be thrown down and inactive oxygen set free. On introducing into a mixture of nitrate of peroxide of iron and

the ferro-sesquicyanuret of potassium the peroxide of barium, a similar reäction takes place, Prussian blue, nitrate of baryta, etc., being formed, and inactive oxygen eliminated. From these facts it appears that, under certain conditions, even peroxide of iron and HO_2 or BaO_2 are capable of catalyzing each other into FeO and HO, or BaO and O.

5. Under certain circumstances, PbO_2 or MnO_2 are soluble in strong acetic acid; now, if you add to such a solution HO_2 or BaO_2, the peroxides will be reduced to HO or BaO, and PbO or MnO, inactive oxygen being disengaged.

6. It is a well-known fact, that the oxide of silver $= Ag\,(-\overset{\circ}{O})$, or the peroxide of that metal $= Ag\,(-\overset{\circ}{O})_2$, and the peroxide of hydrogen $= HO + (+\overset{\circ}{O})$, catalyze each other into metallic silver, water, and inactive oxygen. Other ozonids, such as $PbO + (-\overset{\circ}{O})$ or $MnO + (-\overset{\circ}{O})$, on being brought in contact with $HO + (+\overset{\circ}{O})$, are transformed into PbO or MnO, HO and O. Now the peroxide of barium $= BaO + (+\overset{\circ}{O})$, acts like $HO + (+\overset{\circ}{O})$. If you pour water upon an intimate mixture of AgO, or AgO^2 and BaO_2, a lively disengagement of inactive oxygen will ensue, AgO, AgO_2 and BaO_2 being reduced to metallic silver and baryta. In concluding the first part of my letter, I must not omit to state the general fact, that the oxygen disengaged in all cases of reciprocal catalysis of oxy-compounds, behaves in every respect like inactive oxygen.

There is another set of chemical phenomena, in my opinion closely connected with the polar states of the active oxygen contained in the two opposite classes of peroxides. It is known that a certain number of oxy-compounds, for instance, the peroxides of manganese, lead, nickel, cobalt, bismuth, silver, and also permanganic, chromic, and vanadic acids, furnish with muriatic acid chlorine, whilst another set, such as the peroxides of barium, strontium, potassium, etc., are not capable of eliminating chlorine either out of the said acid or any other chlorid. This second class of oxy-compounds produces, however, with muriatic acid, the peroxide of hydrogen; and it is quite impossible in any way to obtain from the first class of the peroxides HO^2, or from the second chlorine.

You are aware that, from reasons of analogy, I do not believe in the doctrine of chlorine, bromine, etc., being simple bodies, but consider those substances as oxy-compounds, analogous to the peroxides of manganese, lead, etc., in other terms, as "ozonids." Chlorine is, therefore, to me the peroxide of murium $= MuO + (-\overset{\circ}{O})$, hydrochloric acid $= MuO + HO$, and, as already mentioned, the peroxide of barium $= BaO + (+\overset{\circ}{O})$, that of hydrogen $= HO + (+\overset{\circ}{O})$, and the peroxide of manganese $= MnO + (-\overset{\circ}{O})$. Proceeding from these suppositions, it is very easy to account for the different way in which the two sets of peroxides are acted upon by muriatic acid.

From reasons as yet entirely unknown to us, HO can be chemically associated only with $+\overset{\circ}{O}$, and with no other modification of oxygen, to constitute what is called the peroxide of hydrogen; and in a similar way MuO (the hypothetically anhydrous muriatic acid of older times) is capable of being united only to $-\overset{\circ}{O}$, to form the so-called chlorine which I denominate peroxide of murium. If we cause $MuO + HO$ to reäct upon $BaO + (+\overset{\circ}{O})$, MuO unites with BaO, and HO with $+\overset{\circ}{O}$; but if you bring together $MuO +$

HO with $Mn + (-\overset{\circ}{O})$, part of MnO is associated to MnO, another part to $-\overset{\circ}{O}$, water being eliminated, according to the equation

$$2(MnO, HO) + MnO + (-\overset{\circ}{O}) = MnO, MnO + MnO, (-\overset{\circ}{O}) + 2HO.$$

As you will easily perceive from these views, it would follow that, under proper circumstances, two opposite peroxides, on being intimately mixed together, and in the right proportion, and acted upon by muriatic acid, could yield neither chlorine nor peroxide of hydrogen, but merely inactive oxygen. If somewhat dilute muriatic acid be poured upon an intimate mixture of five parts of peroxide of barium and two parts of peroxide of manganese, the whole will be rapidly transformed into the muriates of baryta and protoxide of manganese, the active oxygen of both the peroxides being disengaged in the inactive condition, and not a trace of free chlorine making its appearance. The same result is obtained from dilute hydrobromic acid.

Another consequence of my hypothesis is this: that an intimate and correctly-proportioned mixture of two opposite peroxides, such as the peroxide of barium and that of lead, on being acted upon by any oxy-acid, cannot produce the peroxide of hydrogen; or, to express the same thing in other terms, muriatic acid must act upon the said mixture exactly in the same way as the oxy-acids do; and that is indeed the case. Mixtures of the peroxides just mentioned and acetic or nitric acids, are readily converted into the acetates or nitrates of baryta and protoxide of manganese, the active oxygen of both the peroxides being of course disengaged in the inactive condition.

Before I close my long story, I must mention one fact more, which, in my opinion, is certainly a very curious one. If you mix an aqueous and concentrated solution of bromine with a sufficient quantity of peroxide of hydrogen, what happens? A very lively disengagement of inactive oxygen takes place, the color and the odor of the bromine solution disappears, the liquid becomes sour, and on adding some aqueous chlorine to it, bromine reäppears. From hence we are allowed to conclude, that, on bringing bromine into contact with peroxide of hydrogen, some so-called hydrobromic acid is produced. The hypothesis at present prevailing cannot account for the formation of that acid, otherwise than by admitting that bromine takes up the hydrogen of HO_2, eliminating the two equivalents of oxygen united to H. I, of course, take another view of the case: bromine is to me an ozonid, like peroxide of lead, etc., *i. e.*, the peroxide of bromium = $BrO + (-\overset{\circ}{O})$. Now $HO + (+\overset{\circ}{O})$ and $BrO + (-\overset{\circ}{O})$ catalyze each other into HO, BrO, and inactive oxygen, $BrO + HO$ forming hydrobromic acid, or what might more properly be called hydrate of bromiatic acid.

It will be perceived that I am growing more and more hardened in my heretical notions, or, to speak more correctly, in my orthodox views; for it was Davy who acted the part of a heretic in overthrowing the old, venerable true creed. Indeed, the longer I compare the new and old doctrine on the nature of chlorine, etc., with the whole material of chemical facts bearing upon them, the less I am able to conceive how Davy could so lightly and slightly handle the heavy weight of analogies which, in my opinion, speak so very strongly and decisively in favor of Berthollet's views. There is no doubt Sir Humphrey was a man of great genius, and consequently very imaginative; but I am almost inclined to believe that, by a certain wantonness, or by dint of that transcendent faculty of his mind, he was seduced to conjure up a theory intended to be as much out of the way and "*invraisem-*

blable" as possible, and serve, nevertheless, certain theoretical purposes; and certainly, if he entertained the intention of solving such a problem, he has wonderfully succeeded. But what I still more wonder at, is both the sudden and general success which that far-fetched and strained hypothesis met with, and the tenacity with which the whole chemical world has been sticking to it ever since its imaginative author pleased to divulge it: and all this could happen in spite of the fact that the new doctrine, in removing from the field of chemistry a couple of hypothetical bodies, was, for analogy's sake, forced to introduce fictitious compounds, not by dozens only, but by hundreds, — the oxy-sulphion, oxy-nitrion, and the rest of those "nonentia." But enough of this subject, upon which I am apt to grow warm and even angry. Although the results I have obtained from my recent investigations cannot but induce me to begin another, and, I am afraid, endless series of researches, I shall for the present cut short the matter, and indulge for some time in absolute idleness.

ACTION OF OZONE ON ALBUMEN, CASEIN, AND OTHER ORGANIC COMPOUNDS. — BY PROF. GORUP-BESANEZ.

Ozonized air oxidizes cyanide of potassium in watery solution to cyanate, uric acid to allantoin and urea; but its most remarkable action is that on albumina and casein. If a stream of highly ozonized air be conducted through a solution of albumina, the latter turns opaque and changes its color, assuming a reddish hue in falling, a greenish-yellow in transmitted light. The froth which soon appears on the surface, is mixed with numerous white coagulations, which, when pressed between the fingers to expel the inclosed air, shrink to tough, grayish-white fibres, having an unmistakable resemblance to fibrine, though so far insoluble in a solution of nitre. The formation of these coagula increases up to a certain point, when it lessens, and those formed are redissolved, while, at the same time, the liquid turns paler. The frothing gradually subsides under the continued action of the ozonized air, and the liquid finally becomes clear. Evaporated in the water bath, it left a brown extract, partly soluble in alcohol. This solution in alcohol, on evaporation, left a sirupy residue. The insoluble portion bore a great resemblance to the residue from urine which is insoluble in the same menstruum. Its watery solution is of a distinctly acid reäction evaporated, leaves a brownish residue, which, when burnt, emits the odor of burnt horn, and leaves a voluminous coal which gives but little ashes. It is only precipitated by tannic acid, but is clouded, when concentrated, by acetate of lead, corrosive sublimate, the salts of copper, lime-water, and by nitrate of silver with a yellowish cloudiness, which colors the liquid a brownish-red on boiling. Neither the alcoholic nor aqueous solution contained sugar. These experiments prove that albumina is acted on very powerfully by the ozonized air, losing, as it does, nearly all the properties peculiar to albuminous compounds. The results are of great interest physiologically, because they bear a close relation to the properties of the pectonous substances, the products described by Lehmann as formed by the action of the ferment of the stomach on albuminates.

Casein is acted on as energetically as albumina, but without change of color or formation of coagula; the final changes and products are the same as those from albumina. At one stage of the process, while the solution is not precipitated any more by acetic acid, thereby showing the absence of soluble casein, it coagulates on boiling, like albumina, and is precipitated by nitric acid. Milk treated with ozonized air, in a few days shows no casein, while the fatty ingredients remain unchanged, and a good crop of sugar of milk is obtained on evaporation. Fibrin is not acted on by ozone.

NEW FACTS RESPECTING OZONE.

Oil of Bitter Almonds as an Ozonizer. — Schonbein, in his investigations on ozonizing substances, has found in oil of bitter almonds an excellent medium to induce the allotropic properties in atmospheric oxygen. In the following we give a summary of the results arrived at in experimenting with this agent.

Arsenic in the form of metallic stains, as obtained by the Marsh apparatus, readily disappears under access of air and solar light, when some oil of bitter almonds is poured upon it, generally within five to ten seconds, at the common temperature. The liquid resulting is decidedly acid, and shows the reäctions of benzoic and arsenic acid.

Antimonial stains treated in the same manner do not disappear, which fact may be adopted to distinguish them from those of metallic arsenic.

Cadmium, in the form of thin sticks or lamina, on which oil of bitter almonds has been poured and left in contact with, under direct sunlight and access of air, is partly converted into benzoate of cadmia.

Lead is oxidized to binoxide by the oil of almonds in direct sunlight, though this binoxide be almost immediately reduced to a benzoate of the oxide.

Copper. A few drops of the oil of bitter almonds spread over a bright piece of copper, in the direct light of the sun, causes a bluish-green color, and the liquid soon solidifies into crystals of that color, which are a mixture of benzoate of copper and benzoic acid.

Silver, treated in the same manner as copper, will soon give a reäction with sulphuretted hydrogen, and form a crystalline mass of benzoate of silver and benzoic acid.

Sulphide of Lead, in the state of a fresh precipitate, thinly spread on paper and exposed to the direct action of light and air, is readily converted into white sulphate by oil of bitter almonds.

Sulphide of copper, in the same manner, into sulphate.

Shaken with a solution of pure *protosulphate of iron*, oil of bitter almonds produces a basic salt of the peroxide.

The above experiments prove that the ordinary oxygen is ozonized by this oil and light combined, in a similar manner as by phosphorus or by electricity.

On the preparation of Ozone by Von Babo, and by Messrs. Bunsen and Magnus. — The apparatus in which ozone is obtained by the combustion of phosphorus, permits of separating the gas from the phosphorus acid with which it is ordinarily mixed. This result is attained by causing the gas to pass through a solution of chromic acid. This acid not only oxidizes the phosphorous acid, but, as Baumert has shown, it increases the quantity of ozone; for, after the washing, there is more ozone than before, evidently because the oxidation of phosphorous acid is itself a cause of ozonization.

Von Babo has succeeded in drying ozone so far as to render it anhydrous, whence it follows that ozone, or at least this kind of ozone, cannot be confounded with the hydrogenated ozone HO_3 discovered by Baumert. — *Correspondence of Silliman's Journal.*

Ozonometry in the Crimea. — During the Crimean war, the French army physicians established three observatories for ozonometric, thermometric, and other meteorological observations, morning and evening each day, and also for keeping statistics of diseases and deaths. Dr. Berigny, of Versailles, has in charge a reduction of the observations, and the following are his conclusions on the subject of ozone.

1. The more the ozonometric test-papers were colored in the open air, the more numerous were the sick that were taken to each of the hospitals. One of these hospitals was situated at the general quarters at Sebastopol (Observatory No. 1), the second at the south border of the Inkerman plateau (Observatory No. 2).

2. The higher the temperature, the smaller the number of sick entered, and also of deaths.

3. At the three observatories, the ozone curve was essentially the same; and 4, the same was true for the temperature.

5. At observatory No. 1, the less the ozone, the greater the number of deaths, whilst at observatory No. 2, it was the reverse.

This is almost the only positive result which science and humanity have derived from that destructive war, which has cost so much money and so many lives. — *Silliman's Journal.*

THEORY OF THE FORMATION OF DIAMONDS. — BY M. SIMMLER.

Brewster, in 1826, called attention to the expansible fluids frequently inclosed in minerals, mostly in topaz, quartz, amethyst, but also, at times, in calc-spar, celestin, heavy-spar, fluor-spar, and in diamonds. By examining these liquids, and the cavities of the last mentioned, Brewster was led to the conclusion that the diamond was the congealed gummy secretion of a vegetable; but, although the observations he made on the physical properties of those fluids are highly interesting, he came to no definite opinion as to their nature.

The author, on the strength of the observations of Brewster and others, advances the theory, that in most cases these fluids are liquid carbonic acid. This assumption is, firstly, strengthened by the concurrent expansiveness of those fluids, and liquid carbonic acid, which, for temperatures of from 10° to 27° C., is almost evenly 0·015 for each degree of temperature. When Brewster investigated the subject, liquid carbonic acid had not been discovered by Faraday. He, however, noticed that the liquids possessed the property of refraction, in a much smaller degree than water, which Davy and Faraday found to be the case, also, with condensed carbonic acid. Thilorier and Mitchell further describe this acid as not mixable with water, the same property which Brewster noticed on the more expansible inclosed fluids, while he found those of a less degree of expansibility to be chiefly water, or aqueous solutions of solids or gases. These data induced the author to presume that the inclosed fluids, especially when expansible, were liquid carbonic acid; and that it possesses the property of dissolving other substances, reconciles this assumption with the fact that those mineral fluids, on evaporation, at times deposit a precipitate. He further concludes, that the diamond is the product of condensed carbon, crystallized from liquid carbonic acid. It is known that diamonds not rarely show cavities, in which, according to all appearances, a considerable pressure must have taken place. Supposing these cavities to contain some kind of gas, there is no reason why this might not be carbonic acid under a high pressure, and this theory would furnish a ready explanation of the color-rings, with black crossing, observed by Brewster around the cavities in diamonds, by supposing them to be caused in a similar manner as those of unevenly compressed glass. The carbonic acid, then, stands in the same relation to diamonds as the mother lye inclosed in a number of native and artificial crystals. That there are large quantities of carbonic acid under a high pressure in the body of our planet, is shown by the immense quantities escaping at various localities, as, for instance, at the springs of Nauheim (Hessia), where, according to Bunsen, not less than a million pounds are annually carried to the surface.

Actual experiments, as to the solubility of carbon in liquid carbonic acid, have, as yet, failed in the hands of the author. He has, however, no doubt that numerous experiments in the same direction will be, and have been made, the results of which should not be concealed from a fear of prejudice against the scheme of diamond-making. Negative results are the more valuable, as they prevent much unnecessary research in the same field. — *Poggendorff's Annalen.*

PREPARATION OF CALCIUM.

MM. Lies-Bodart and Jobin announce to the Academy of Sciences, at Paris, that they have succeeded in preparing calcium in a purely chemical way, by heating the iodide, with potassium, in an iron crucible, closed by a cover screwed on air-tight.

This mode may, at present, be convenient to chemical professors and students, who do not often see this metal, and the fact evolved, that this reäction takes place under high pressure, which it does not under the pressure of the atmosphere, may perhaps lead to results more important on the large scale of industry.

LARGE SPECIMENS OF TITANIUM.

At a late meeting of the Manchester (England) Philosophical Society, Mr. William Brockbank exhibited some large specimens of titanium, which have recently been found in considerable quantities, filling the crevices and under the hearths of the fire-brick linings of the furnaces of the Hematite Iron Company, of Whitehaven. In one instance it occurred in a large mass weighing nearly four cwts., under the furnace hearth, having found its way through the crevices between the fire-bricks. Smaller masses, weighing from fifty or sixty pounds to a few ounces, were found filling the hollows and crevices in the lining of the furnace, around that part which holds the molten metal. The occurrence of titanium in such large quantities is a new and interesting circumstance, previous instances being confined to a few furnaces in South Wales (where hematite ore is used as a mixture), and to some in the Hartz Mountains, in both of which cases the specimens found were comparatively small.

ON THE MANUFACTURE OF STEEL BY THE UCHATIUS PROCESS.

The following is an abstract of a paper and discussion on the above subject, reported from the "Proceedings of the Institution of Mechanical Engineers," by the London *Civ. Eng. Journal*, January 1859:

To compare the Uchatius with other processes, it must first be considered what steel really is, and in what manner it may be produced. This point may be illustrated by the following series, comprising the various degrees of wrought iron, steel, and cast iron, arranged according to the amount of carbon in each, beginning with the softest wrought iron, that is, with iron containing no carbon, or the least amount of carbon:

Soft wrought iron,	containing	0·0	per cent.	of carbon.
Hard wrought iron,	"	0.4	"	"
Soft steel,	"	0.5	"	"
Hard steel,	"	2.4	"	"
Cast iron,	"	2.5	"	"
Hard cast iron,	"	5.0	"	"

In this series, beginning with the softest wrought iron, containing little or no carbon, the proportion of carbon increases until there is one-half per cent., which then forms soft steel; a further increase of carbon, up to two and one-half per cent., forms cast iron; and the proportion of carbon increasing to five per cent., gives the hardest cast iron. Hence, it appears that the operation of steel-making may be effected in two methods, — either by adding a certain amount of carbon to pure wrought iron; or conversely, by taking away a certain amount of carbon from cast iron, removing at the same time the impurities of the cast iron.

The English, or converting process, is carried on according to the first of these methods, by adding a certain amount of carbon to wrought iron. The cast iron is first made into wrought iron, which is then converted into steel, forming blister steel; this is broken into small pieces and melted in crucibles, which renders it homogeneous, and is then poured, while fluid, into ingot moulds, after which it is known as cast steel. The chemical changes which the cast iron has undergone in this process are — firstly, when it was manufactured into wrought iron, all or nearly all the carbon was abstracted from it; and secondly, by the converting process a certain amount of carbon was restored to it; and finally, the steel thus produced was made homogeneous by melting and casting. It is evident that this is a very circuitous way of manufacturing cast steel, and it has the following disadvantages: the great loss of weight in manufacturing the cast iron into wrought, the difficulty in converting the wrought iron so as to carbonize it equally in all parts, the great length of time that this process requires for the production of cast steel, and the great cost of manufacture.

The German, or puddling process, is effected by the converse method, by taking away a certain amount of carbon from cast iron. The pig iron is puddled in the same way as in making wrought iron, except that the process is stopped when a certain amount of carbon has been taken away, a point which it is difficult to judge of. This partially puddled iron, so-called puddled steel, is then made homogeneous by melting it in crucibles in the ordinary way. The chemical change which the cast iron has undergone by this process is, the abstraction of a portion of the carbon in the puddling furnace, and the puddled steel has then been rendered homogeneous by melting and casting. The disadvantages of this method are — the waste of iron by the puddling process; the uncertainty of getting equally discarbonized iron, owing to the difficulty of measuring the quantity of oxygen acting on the puddled metal; and also the cost of manufacture.

The Uchatius process is based upon the same principle as that last described, consisting in taking away as much carbon only as is required to produce steel, and removing at the same time the impurities of the cast iron.

The first and most important of these objects is effected by bringing a certain measured quantity of oxygen, in the shape of oxides of iron, in contact with the cast iron, so that while the iron is hot the oxygen combines with the carbon, and passes off in the form of carbonic acid gas. The purification of the cast iron from silica, sulphur, magnesia, etc., is effected by bringing the iron, when it is in a melted state, into contact with the alkaline earths, so that the impurities combine with them, and remain floating on the top of the melted metal.

In order to effect these two operations at the same time, the pig iron is first melted in a furnace, or ordinary foundry cupola, and then run into a cold water tank, where it is reduced into small granules. The mode in which the granulation is performed is stated to be as follows: The cold water tank has a horizontal wheel placed in it at one end, provided with wooden floats dipping below the surface of the water, and driven at considerable speed; the melted metal running into the tank from the furnace, falls on the wheel, which scatters it in a finely divided state towards the deep end of the tank, and it falls to the bottom in the form of small granules. This granulated cast iron is mixed with pulverized oxide of iron and some alkaline earths, and the whole put into the ordinary steel-melting crucibles, and placed in the furnaces, and brought into a fluid state. The degree of hardness of the steel is thus capable of being regulated by the size of the granules, and by the quantity of oxides used.

The chemical change which takes place in the crucible is as follows: Each granule being surrounded by the pulverized oxides, etc., the decarbonization takes place first on the outside of each granule, and so progresses towards the centre as the heat increases, the oxygen in the ores combining with the carbon in the granules and passing off as carbonic acid gas; if, therefore, during the process, the granule could be examined, it would be found that the outside of each is entirely deprived of its carbon, the next portion partially decarbonized, and the centre not decarbonized at all; so that each granule would be composed of pure wrought iron, steel, and cast iron. By increasing the heat, the cast iron centre portion of the granule first becomes fluid, and the granule bursts, and falls by its own weight to the bottom of the crucible. At the same time, the earths mixed with the ores melt and rise to the top, forming a layer of scoria or dross floating on the surface of the melted iron. Each granule of melted metal has therefore in falling to pass through the rising scoria; and it is in the passing through that the combination of the impurities of the metal with the alkaline earths takes place, so that the decarbonized iron, on reaching the bottom of the crucible, is cleansed from all impurities. The heat continuing to increase, melts the outside portions of the granules, and the whole is reduced to one homogeneous fluid mass in the crucible, which is then ready for being poured into the ingot mould. The iron contained in the oxides mixes at the same time with the fluid mass, and yields about six per cent. more of cast steel than the weight of granules put into the crucible.

The oxides employed in this process are iron ores of the finest quality, such as spathose and hematite, which are previously calcined and pulverized. The proportion of the oxide to the granulated iron is according to the hardness of steel required, say from twenty to thirty per cent.; the greater the quantity of the oxide employed, the greater the decarbonization, and consequently the softer will be the steel produced.

The process is attended with the following advantages: A rapid manufacture of cast steel, the pig iron being turned into cast steel in the space of a few hours; certainty in producing a uniform quality of steel, that is, steel containing a determinate proportion of carbon, which is accurately determined beforehand by the weight of oxide mixed with the granulated iron; and less cost than the ordinary methods of making cast steel, since the processes are fewer, and the materials used are simply pig iron and iron ores.

Some experiments in making cast steel by the Uchatius process have been made at the Newburn Steel Works, near Newcastle-on-Tyne, from which it appears there is little doubt that a very fine quality of cast steel can be produced at a cost little more than one-half of that entailed by the common processes.

A specimen of steel bar was shown, made by the process described in the paper, which had been tested, and broke with a load of thirty cwt. at the centre, the bar being one inch square, and three feet in length between the bearings; the deflection was three and three-eighths inches at the time of breaking. A specimen was also exhibited showing the welding of the two pieces of the steel, and specimens of the granulated iron and the pulverized ore used in the manufacture, and of the bars and plates produced, with some volute springs made from the steel; also a piece of the steel twisted cold, to show its toughness.

Mr. T. Spencer said that he had not tested the tensile strength of the steel at present, but found it stood well in the volute springs that had been made of it, which had proved quite satisfactory in working. Only some small plates had been rolled from the steel at present as a trial, but these had proved quite satisfactory; and he did not anticipate any difficulty in making any size required. It would be observed in the specimen exhibited, that the plate was quite sound on the edges, although it had not been rolled edgeways, but simply rolled down lengthways. No wire has yet been made from it; the bars and plates made had been hammered and rolled down from the ingots of cast steel. The total cost of the finished bars was about one-half of that by the ordinary process; but where the makers hammered and rolled their own steel, and the cost of the ingot only had to be compared, the proportion would be considerably less.

Mr. W. Fairbairn thought this process was a very important step in steel manufacture, and would prove of great advantage in the construction of machinery, if a sound uniform steel could be obtained at a moderate price. The bar of the new cast steel that was exhibited certainly showed great strength, having sustained nearly three times as great a weight as iron; and he thought in process of time they might reasonably expect to obtain plates cast and rolled of that manufacture at least double the strength of the present wrought-iron boiler plates for the same thickness, and not much more expensive for the strength; and it had now become a very important desideratum to get plates for boilers only half the thickness at present used, as the thinner plates were so much less liable to injury from overheating and unsoundness in manufacture.

Mr. T. S. Prideaux thought the dropping of the melted iron into water, in the process of granulating it, would have a beneficial effect in assisting to free the metal from sulphur, by the metal coming in contact with water in a red-hot state; the plan had been tried in Austria, he believed, with success. It was not at all easy to separate sulphur from iron by simple exposure to oxygen in atmospheric air; and he thought the plunging of the highly-heated granules in water would be the means of removing the sulphur, to a considerable extent, from the iron.

Mr. W. Smith thought the process that had been tried in Austria was that of Capt. Uchatius now described; the plan of granulation seemed a very ingenious and important step towards obtaining steel by the direct process of decarbonizing, and offered the best chance of carrying that process to a successful and economical result. Great advances were being made at the present time in steel manufacture, and they were doubtless greatly indebted for these advances to the investigation of the subject that had been excited by the publication of Mr. Bessemer's plans, although he had not succeeded in all that he had attempted himself; and they were also much indebted to Mr. Binks for having called more minute attention to the chemical principles involved in the manufacture of steel. The new process described in the paper appeared to have effected a great success in obtaining cast steel by the direct process; and if the uniformity of quality could be maintained, the economy of manufacture would allow of the use of cast steel being extended to many important new applications, such as boiler plates, and steel wire for the manufacture of telegraph cables.

Mr. A. Lenz explained, respecting the process, in the absence of Capt. Uchatius, that the only object in dropping the melted iron into the water was to effect its granulation, and not for the purpose of depriving it of sulphur. The process of this manufacture of steel was to decarbonize the cast iron by the action of oxides under a high temperature, the great object being to expose the largest possible surface of the iron to this action, and by granulation this object was obtained to a remarkable extent. As to the actual composition of the steel, Capt. Uchatius had come to the conclusion, from the results of his observations, that the best steel required some small portion of what are considered impurities, such as sulphur, silica, etc.; and that chemically pure steel was not the result to be aimed at, and he had found that even with one-fourth per cent. of sulphur the steel was of good quality. The great desideratum was to make steel at a very cheap price; and he had hopes it might even be practical to apply it ultimately to the manufacture of railway bars.

Mr. A. Lenz said that only the good qualities of iron were attempted to be used for steel-making by the Uchatius process, and the Indian and Swedish iron was principally used, containing very little trace of phosphorus, as it was doubtful whether any phosphorus could be removed in the process.

In Chenot's process, the principle was to employ pure magnetic iron ore in powder, which was found in a few situations in the Pyrenees in a natural state of powder, and was separated by a machine from the earths mixed with it. This powder was put into a furnace like a cupola, within a tube in the centre, protecting the ore from the fuel, and exposed to a great heat; the powder then became in a spongy state, by reduction to nearly pure iron, but was not able to melt. It was then compressed cold with great force under a hydraulic press, to solidify the mass, and was finally carbonized by covering with mixtures of oils and other carbonaceous substances, and melted in a close crucible. He doubted the process being adapted for the actual manufacture of steel on any large scale, and thought it more suitable for the laboratory than the shop. Various articles have been made of the steel for trial, which he believed were of a good quality, although he thought there was not any regular manufactory carried on.

Mr. W. Fairbairn had seen the process in operation two years since in Paris, and the steel that was manufactured by that means was of good quality; but the process was carried out only on a small scale, and seemed scarcely suitable for any wholesale manufacture.

Mr. T. Spencer observed, that a magnetic machine was employed to separate the iron from the earthy matter, when in the state of powder, as found naturally. The pig iron was broken into six or eight inch pieces, and was at first put into the cupola for melting in the ordinary way; but they had now constructed a furnace for the purpose, as the ordinary cupola rather increased the proportion of sulphur in the metal by absorbing some from the fuel; the new furnace was a kind of reverberatory furnace, melting the iron in a chamber separate from the fire. The fluid metal was then run into the granulating tank; and the granules of iron were collected at the bottom of the tank by drawing off the water.

ON THE HARDNESS OF METALS AND ALLOYS.

The following paper read before the Philosophical Society of Manchester, England, by Prof. F. Grace Calvert, we obtain from the *Journal of the Society of Arts*, No. 314.

The process at present adopted for determining the comparative degree of hardness of bodies, consists in rubbing one body against another, and that which indents or scratches the other is admitted to be the harder of the two bodies experimented upon. Thus, for example:

Diamond,	**Quartz,**	**Iron,**	**Tin,**
Topaz,	**Steel,**	**Copper,**	**Lead.**

This method is not only very unsatisfactory in its results, but it is also inapplicable for determining with precision the various degrees of hardness of the different metals and their alloys. We therefore thought that it would be useful and interesting if we were to adopt a process which would enable us to represent by numbers the comparative degrees of hardness of various metals and their alloys.

To carry out these views, we devised the following apparatus and method of operating. The machine used is on the principle of a lever, with this important modification, that the piece of metal experimented upon can be relieved from the pressure of the weight employed without removing the weight from the end of the longer arm of the lever. The machine consists of a lever, with a counterpoise and a plate, on which the weights are gradually placed; the fulcrum bears on a square bar of iron, passing through supports. The bar is graduated, and has at its end a conical steel point, 7 *mm.* or 0·275 of an inch long, 5 *mm.* or 0·197 of an inch wide at the base, and 1·25 *mm.* or 0·049 of a inch wide at the point which bears on the piece of metal to be experimented on, and this is supported on a solid piece of iron. The support, or point of resistance, is lowered or raised by a screw, and when, therefore, this screw is turned, the whole of the weight on the lever is borne by the support and the screw. When it is necessary, by turning the screw, the weight on the lever is reëstablished on the bar, and experimented upon.

When we wished to determine the degree of hardness of a substance, we placed it on the plate, and rested the point upon it, noticing the exact mark on the bar, and then gradually added weights on the end of the lever until the steel point entered 3·5 *mm.* or 0·138 of an inch during half an hour, and then read off the weight. A result was never accepted without at least two experiments being made, which corresponded so far as to present a difference of only a few pounds. The following table gives the relative degree of hardness of some of the more common metals. We specially confine our researches to this class, wishing the results to be practically useful to engineers and others who have to employ metals, and often require to know the comparative hardness of metals and alloys.

Names of Metals.	Weight employed.	Calculated Cast Iron = 1000.
Staffordshire Cold Blast Cast Iron — Gray, No. 3,	4800 lbs.	1000
Steel,	4600?	958?
Wrought Iron,*	4550	948
Platinum,	1800	375
Copper — pure,	1445	301
Aluminum,	1300	271
Silver — pure,	1000	208
Zinc, "	880	183
Gold, "	800	167
Cadmium, "	520	108
Bismuth, "	250	52
Tin, "	130	27
Lead, "	75	16

This table exhibits a curious fact, viz., the high degree of hardness of cast iron as compared with that of all other metals; and although we found alloys which possessed an extraordinary degree of hardness, still none were equal to cast iron.

The first series of alloys we shall give, is that of copper and zinc.

Formulæ of Alloys and per centages.		Weight Employed.	Obtained Cast Iron = 1000.	Calculated† Cast Iron = 1000.
$Zn\,Cu_5$	Cu 82·95, Zn 17·05	2050 lbs.	427·08	280·83
$Zn\,Cu_4$	Cu 79·56, Zn 20·44	2250	468·75	276·82
$Zn\,Cu_3$	Cu 74·48, Zn 25·52	2250	468·75	276·04
$Zn\,Cu_2$	Cu 66·06, Zn 33·94	2270	472·92	261·04
$Zn\,Cu$	Cu 49·32, Zn 50·68	2900	604·17	243·33
$Cu\,Zn_2$	Cu 32·74, Zn 67·26	Broke with 1500 lbs. without the point entering.		
$Cu\,Zn_3$	Cu 24·64, Zn 75·36	Broke with 1500 lbs. with an impression ½ *mm.* deep.		
$Cu\,Zn_4$	Cu 19·57, Zn 80·43	Entered a little more than the above; broke with 2000 lbs.		
$Cu\,Zn_5$	Cu 16·30, Zn 83·70	Entered 2 *mm.* with 1500 lbs.; broke 1700 lbs.		

* This wrought iron was made from the above mentioned cast iron.

† To calculate the hardness of an alloy, we multiplied the per centage quantity of each metal by the respective hardness of that metal, added the two results together, and divided by 100. The quotient is the theoretical hardness.

These results show that all the alloys containing an excess of copper are much harder than the metals composing them, and, what is not less interesting, that the increased degree of hardness is due to the zinc, the softer metal of the two which compose these alloys. The quantity of this metal must, however, not exceed 50 per cent. of the alloy, or the alloy becomes so brittle that it breaks as the steel point penetrates. We believe that some of these alloys, with an excess of zinc, and which are not found in commerce, owing to their white appearance, deserve the attention of engineers. There is in this series an alloy to which we wish to draw special attention, viz., the alloy Cu Zn composed in 100 parts of

Copper,	49·32
Zinc,	50·68
	100·00

Although this alloy contains about 20 per cent. more zinc than any of the brasses of commerce, still it is, when carefully prepared, far richer in color than the ordinary alloys of commerce. The only reason that we can give why it has not been introduced into the market is, that when the amount of zinc employed exceeds 33 per cent., the brass produced becomes so white that the manufacturers have deemed it advisable not to exceed that proportion. If, however, they had increased the quantity to exactly 50·68 per cent. and mixed the metals well, they would have obtained an alloy as rich in color as if it had contained 90 per cent. of copper, and of a hardness three times as great as that given by calculation. In order to enable engineers to form an opinion as to the value of this cheap alloy, we give them the degrees of hardness of several commercial brasses:

Commercial Brasses.		Weight employed.	Cast Iron = 1000.	
			Obtained.	Calculated.
"Large Bearing,"	Copper, 82·05 * Tin, 12·82 Zinc, 5·13	lbs. 2700	562	259
"Mud Plugs,"	Copper, 80·00 * Tin, 10·00 Zinc, 10·00	3600	750	262
"Yellow Brass,"	Copper, 64·00 Zinc, 36·00	2500	520	258
"Pumps and Pipes,"	Copper, 80·00 * Tin, 5·00 Zinc, 7·50 Lead, 7·50	1650	343	257

The alloy Cu Zn possesses another remarkable property, viz., the facility with which it is capable of crystallizing in prisms half an inch in length, of extreme flexibility. There is no doubt that this alloy is a definite chemical compound, and not a mixture of metals, as alloys are generally considered to be. Our researches on the conductibility of heat by alloys, recently presented to the Royal Society, leave no doubt that many alloys are definite chemical compounds.

* These alloys all contain tin.

On Bronze Alloys.

Formulæ of Alloys and Percentages.	Weight Employed.	Obtained Cast Iron=1000.	Calculated Cast Iron=1000.
$Cu\,Sn_5$ { Cu 9·73, Sn 90·27 }	400 lbs.	88·33	51·67
$Cu\,Sn_4$ { Cu 11·86, Sn 88·14 }	460	65·81	59·56
$Cu\,Sn_3$ { Cu 15·21, Sn 84·79 }	500	104·17	68·75
$Cu\,Sn_2$ { Cu 21·21, Sn 78·79 }	650	135·42	84·79
$Cu\,Sn$ { Cu 34·98, Sn 65·02 }	At 700 pounds the point entered one-half and the alloy broke.		
$Sn\,Cu_2$ { Cu 48·17, Sn 51·83 }	At 800 pounds the alloy broke without the point entering.		
$Sn\,Cu_3$ { Cu 61·79, Sn 33·21 }	At 800 pounds the alloy broke in small pieces (blue alloy).		
$Sn\,Cu_4$ { Cu 68·27, Sn 31·73 }	At 1300 pounds divided the alloy in two, point not entering 1 *mm.*		
$Sn\,Cu_5$ { Cu 72·90, Sn 27·10 }	The same as the preceding.		
$Sn\,Cu_{10}$ { Cu 84·32, Sn 15·68 }	4400	916·66	257·08
$Sn\,Cu_{15}$ { Cu 88·97, Sn 11·03 }	3710	772·92	270·83
$Sn\,Cu_{20}$ { Cu 91·49, Sn 8·51 }	3070	639·58	277·70
$Sn\,Cu_{25}$ { Cu 93·17, Sn 6·83 }	2890	602·08	279·16

The results obtained from this series of alloys lead to several conclusions deserving our notice. First, the marked softness of all the alloys containing an excess of tin; secondly, the extraordinary fact that an increased quantity of so malleable a metal as copper should so suddenly render the alloy brittle, for the

Alloy $Cu\,Sn_2$, or

Copper, ... 21·21 } is not brittle.
Tin, ... 78·79 }

whilst the alloy Cu Sn, or

Copper, ... 34·98 } is brittle.
Tin, ... 65·02 }

Therefore, the addition of 14 per cent. of copper renders a bronze alloy brittle. This curious fact is observed in all the alloys with excess of copper, $Sn\,Cu_2$, $Sn\,Cu_3$, $Sn\,Cu_4$, $Sn\,Cu_5$, until we arrive at one containing a great excess of copper, viz., the alloy $Sn\,Cu_{10}$, consisting of copper 84·68 and tin 15·32, when the brittleness ceases; but, strange to say, this alloy, which contains four-fifths of its weight of copper, is, notwithstanding, nearly as hard as iron. This remarkable influence of copper in the bronze alloys is also visible in those composed of

$Sn\,Cu_{15}$, containing 88·97 of copper.
$Sn\,Cu_{20}$, " 91·49 "
$Sn\,Cu_{25}$, " 93·17 "

Copper acquires such an increased degree of hardness by being alloyed with tin or zinc, that we thought it interesting to ascertain if alloys composed of these two metals would also have a greater degree of hardness than that indicated by theory; we accordingly had a series of alloys prepared in equivalent quantities, and these are the results arrived at:

Formulæ of Alloys and per centages of each.	Weight employed	Obtained Cast Iron=1000.	Calculated Cast Iron=1000.
$Zn\ Sn_2$ { Zn 21·65, Sn 78·35 }	300 lbs.	64·50	60·63
$Zn\ Sn$ { Zn 35·60, Sn 64·40 }	330	68·75	82·70
$Sn\ Zn_2$ { Sn 47·49, Zn 52·51 }	400	83·33	110 00
$Sn\ Zn_3$ { Sn 37·57, Zn 62·43 }	450	93·70	124·58
$Sn\ Zn_4$ { Sn 31·14, Zn 68·86 }	506	105·20	131·22
$Sn\ Zn_5$ { Sn 25·57, Zn 73·43 }	600	125·00	142·08
$Sn\ Zn_{10}$ { Sn 15 32, Zn 84·38 }	580	120·33	158 33

These results show that these metals exert no action on each other, as the numbers indicating the degrees of hardness of their alloys are rather less than those required by theory. Our researches on the conductibility of heat by the three above series of alloys, throw, we believe, some light on the great difference which the alloys of bronze present, as compared with those of tin and zinc; for we have stated above, that the latter conduct heat as a mixture of metals would do, and not as the former series, which conduct heat as definite chemical compounds.

We shall conclude by giving the degree of hardness of two other series of alloys, viz., those composed of lead and antimony, and lead and tin. In the series of lead and tin, we find that tin also increases the hardness of lead, but not in the same degree as it does that of copper.

Lead and Antimony

Formulæ of Alloys and percentages.	Weight employed.	
$Pb\ Sb_5$ { Pb 24·31, Sb 75·69 }	lbs.	Entered 2·5 *mm.* with 800 lbs.; then broke.
$Pb\ Sb_4$ { Pb 28·64, Sb 71·36 }		Entered 2·7 *mm.* with 800 lbs.; broke with 900 lbs.
$Pb\ Sb_3$ { Pb 34·86, Sb 65·14 }	875	
$Pb\ Sb_2$ { Pb 44·53, Sb 55·47 }		Entered 2·5 *mm.* with 500 lbs.; broke with 600 lbs.
$Pb\ Sb$ { Pb 61·61, Sb 38·39 }	500	
$Sb\ Pb_2$ { Pb 76·32, Sb 23·68 }	385	
$Sb\ Pb_3$ { Pb 82·80, Sb 17 20 }	310	
$Sb\ Pb_4$ { Pb 86 52, Sb 13·48 }	300	
$Sb\ Pb_5$ { Pb 88 92, Sb 11·08 }	295	

ON THE CHEMICAL CHANGES WHICH PIG IRON UNDERGOES DURING ITS CONVERSION INTO WROUGHT IRON.

The following important communication has been made by Messrs. Calvert and Johnson, of England, to the *L. E. and D. Philosophical Magazine:*

Wishing to make some improvements in the manufacture of iron, we carefully examined the various analyses which had been made of pig iron and wrought iron; but we found that no comparison could be made between the recorded results, as the samples analyzed had been obtained from different sources, and as also no detailed analysis had been published of the various chemical changes which pig iron undergoes in the process of puddling, during its conversion into wrought iron. We therefore decided to undertake this task, with the hope of throwing some light upon this important operation in the manufacture of iron, and of thereby enabling practical men to make those improvements in the puddling of iron which, on many accounts, are so much to be desired. To closely follow the progressive changes which pig iron undergoes during its conversion into wrought iron, we took samples every five or ten minutes, after the pig iron had melted in the furnace. These chemical actions are clearly defined in the furnace, by the peculiar appearance which the mass assumes as the operation proceeds.

It is necessary that we should describe, in a rapid manner, the physical conditions which pig iron assumes during its conversion into wrought iron. When first heated in the puddling furnace, it forms a thick, pasty mass, which gradually becomes thin, and as fluid as mercury. When it has reached this point, it experiences a violent agitation, technically termed the "boil," which is produced, no doubt, by the oxidation of the carbon, and the escape of the carbonic oxide then generated. During this period of the operation, the mass swells to several times its primitive bulk, and the puddler quickly agitates the melted mass, to facilitate the oxidation of the carbon. After a short time the mass gradually subsides; the puddler then changes his tool, and takes the "puddle," to gather with it the granules of malleable iron floating in the melted mass of scoria or slag. The granules or globules of iron gradually weld together, and separate from the scoria; and this separation is hastened by the puddler gradually forming large masses, called balls, weighing about eighty pounds, from which the scoria drains out. This part of the operation requires great skill in the puddler; for nearly the whole of the carbon has been oxidized; so that if the current of air is not managed with great care, the iron itself is oxidized, or, as it is technically termed, "burnt;" and thus not only does great loss ensue in the quantity of malleable iron produced, but also the iron containing a certain quantity of oxide of iron, is brittle, and of bad quality.

We shall now examine the various chemical changes which pig iron undergoes during its conversion into wrought iron.

The iron we took for our experiments was a good cold-blast Staffordshire iron; the pig was rather gray, being of the quality used for making iron wire, or a gray No. 3. Its composition was as follows:

	First analysis.	Second analysis.	Mean.
Carbon,	2·320	2·230	2·275
Silicium,	2·770	2 670	2·720
Phosphorus,	0·580	0·710	0 645
Sulphur,	0·318	0·288	0·301
Manganese and aluminum,	traces	traces	
Iron,	94·059	94·059	94 059
	100·047	99·957	100·000

Two hundred and twenty-four pounds of the above pig iron were introduced at 12 o'clock, on the 4th of April, 1856, into a puddling furnace which had been cleaned out with malleable iron scraps. After thirty minutes, the pigs began to soften and to be easily crumbled, and ten minutes more had hardly elapsed when they entered into a state of fusion. The first sample was taken out of the furnace at 12h. 40m. P. M., from the centre of the melted mass, with a large iron ladle, and poured on a stone flag to cool.

On breaking the sample as taken out of the furnace, it had no longer the appearance of gray No. 3 pig iron, but a white, silvery, metallic fracture, similar to that of refined metal. The rapid cooling of the sample was no doubt the cause of the change noticed, for it contained quite as much carbon as the pig iron used; and further, the carbon was in a very similar condition, as in both cases a large quantity of black flakes of carbon floated in the acid liquors in which the iron was dissolved. The following is the amount of carbon and silicium which the above sample contained per cent.:

	First analysis.	Second analysis.	Mean.
Carbon,	2·673	2·780	2·726
Silicium,	0·893	0·938	0·915

These results are highly interesting, as they show that the iron had undergone, during the forty minutes which it had been in the furnace, two opposite chemical changes; for whilst the proportion of carbon had increased, the quantity of silicium had rapidly decreased. This curious fact is still further brought out by the sample which we took out of the furnace at 1 P. M., or twenty minutes later than the last sample analyzed, as is shown in this table:

	Carbon.	Silicium.
Pig iron used,	2·275	2·720
First sample taken out at 12h. 40m.,	2·726	0·915
Second sample taken out at 1h. 0m.,	2·905	0·197

Therefore the carbon had increased 0·625, or 21·5 per cent. of its own weight, and the silicium had decreased in the enormous proportion of above 90 per cent. It is probable that these opposite chemical actions are due, in the case of the carbon, to the excess of this element in a great state of division, or in a nascent state in the furnace, and that under the influence of the high temperature it combines with the iron, for which it has a great affinity, whilst the silicium and a small portion of iron are oxidized and combined together, to form protosilicate of iron, of which the scoria or slag produced during this first stage of puddling consists, and which plays such an important part in the remaining phenomena of the puddling process.

Second Sample, taken out of the furnace at 1h. 0m. P. M.

This sample contained the following quantities of carbon and silicium:

	First analysis.	Second analysis.	Mean.
Carbon,	2·910	2·900	2.905
Silicium,	0 226	0·168	0·197

It had the same white, silvery appearance as No. 1; but had this difference, that it was slightly malleable under the hammer, instead of being brittle like No. 1. The scoria also was on the upper surface of the mass when cold, and not mixed with the metallic iron, as in succeeding examples.

Third Sample, taken out at 1h. 5m. P. M.

The mass in the furnace having become very fluid, and beginning to swell, or enter into the state called "the boil," a small quantity was ladled out. When cold, it was quite different from that of the two previous ones, being composed of small globules adhering to each other, and mixed with the scoria; the mass, therefore, was not compact, like the former ones, but was light and spongy; its external appearance was black, and the small globules, when broken, presented a bright metallic lustre, and were very brittle under the hammer. We had for some time considerable difficulty in separating the scoria from the globules of iron; but we found that by pulverizing the whole for a long time, the scoria was reduced to impalpable powder, and by sieving we could separate it from the iron, which was much less friable. The iron thus cleansed from its scoria gave us the following results:

	First analysis.	Second analysis.	Mean.
Carbon,...........................	2·466	2·421	2·444
Silicium,.........................	0·188	0·200	0·194

Fourth Sample, taken out at 1h. 20m. P. M.

As soon as the last sample had been taked out, the damper of the furnace was slightly raised, so as to admit a gentle current of air, which did away with the smoke which had been issuing from the puddler's door, and a clear and bright flame was the result. This was done, no doubt, to facilitate the oxidation of the carbon of the iron, and to increase this action the puddler quickly agitated the mass. Under these two actions, the mass swelled up rapidly, and increased to at least four or five times its original bulk; and at 1h. 20m., the mass being in full boil, this fourth sample was taken out. Whilst cooling, it presented the interesting fact, that in various parts of it small blue flames of oxide of carbon were perceived, no doubt arising from the combustion of carbon by the oxygen of the atmosphere. It is curious that this phenomenon was not observed in the previous samples. It is due probably to the following causes: first, that the cast iron, having been brought by the boil to a state of minute division, offers a large surface to the action of the oxygen of the air, and thus the combination of the oxygen with the carbon of the iron is facilitated: and second, that at this period the carbon seems to possess little or no affinity for the iron; for one of us has often observed that when pig iron, rich in graphite, is puddled, the carbon is liberated from the iron; for if a cold iron rod is plunged into the mass of melted iron in the puddling furnace, it is covered with iron and abundant shining scales of graphite carbon.

The appearance of this No. 4 sample was most interesting; and the best idea that we can give of it is, that it is so light, and formed of such minute granules, as to be exactly like an ant's nest. The particles have no adherence to each other, for by merely handling of the mass it falls into pieces. This is due to each particle of iron being intimately mixed with scoria. The granules of iron have a black external appearance, are very brittle under the hammer, and when broken they present a bright, silvery, metallic fracture. The scoria was separated by the method above described for No. 3, and the quantities of carbon and silicium which the iron contained were as follows:

	First analysis.	Second analysis.	Mean.
Carbon,	2·335	2·276	2.305
Silicium,	0·187	0·178	0·182

Fifth Sample, taken out at 1h. 35m. P. M.

This sample is a most important one in the series, as it is the first in which the iron is malleable, and flattens when hammered. It was ladled out of the furnace just as the boil was completed, and the swollen mass began to subside. The damper at the top of the chimney was drawn up, so that a very rapid draft was established through the furnace. The puddler also changed his tool, leaving the rubble, and taking the puddle to work with. When cold, it partakes of the appearance of Nos. 3 and 4 samples, the mass being spongy and brittle, as in No. 4, but less granulated, and like No. 3, being in separate globules, mixed with the scoria. The granules are black externally, but are bright and metallic when flattened. The analysis of these globules proves that the mass of iron in the furnace has lost during the quarter of an hour which has elapsed since the taking of No. 4 sample, a large proportion of its carbon, equal to 20 per cent. of its weight, while the silicium, on the contrary, has remained nearly stationary.

	First Analysis.	Second Analysis.	Mean.
Carbon,	1·614	1·681	1·647
Silicium,	0·188	0·178	0·185

Sixth Sample, taken out at 1h 40m P. M.

The reason why this sample was taken out only five minutes after the last sample, was, that the mass in the furnace was rapidly transforming itself into two distinct products, viz., the scoria on the one hand, and small globules of malleable iron on the other. We attached some importance to this sample, as the workman was on the point of beginning the balling or agglomerating the globules of iron, so as to form large balls, of about eighty pounds weight, to be hammered and rolled out into bars. Whilst the mass taken out for analysis was cooling, small blue flames of oxide of carbon issued from it. These were similar to those observed in Nos. 4 and 5, but were not so abundant. The appearance of this sample was very similar to the last one, with the exception that the scoria was not so intimately mixed with the globules of iron, and that these were larger, and slightly welded together when hammered. The proportions of carbon and silicium were as follows:

	First Analysis.	Second Analysis.	Mean.
Carbon,	1·253	1·160	1·206
Silicium,	0·167	0·160	0·163

When these figures are compared with those of the previous analysis, it is interesting to observe, that whilst the silicium remains nearly stationary, the carbon rapidly diminishes; for in the five minutes which elapsed between the taking out of the two samples, there was twenty-eight per cent. of the carbon burnt out. This rapid decrease of carbon in the iron is maintained during the remaining ten minutes of puddling. In fact, in one quarter of an hour, viz., from 1h 35m to 1h 50m., the iron lost fifty per cent. of the carbon which it contained at 1h 35m.

Seventh Sample, taken out at 1h 45m P. M.

This sample was obtained when the puddler had begun to ball. The appearance of the sample, although similar to the last, differs from it by the granules being rather larger, and nearly separated from the scoria, which forms a layer at the top and bottom of the mass. These granules are also much more malleable, for they are easily flattened under the hammer. This last fact is easily accounted for by the small amount of carbon which it contains, as stated above and shown by these results:

	First Analysis.	Second Analysis.	Mean.
Carbon,	1·000	0 927	0·963
Silicium,	0 160	0·167	0 163

Eighth Sample, taken out at 1h 50m P. M.

This last sample was taken a few minutes before the balls were ready to be removed from the furnace, to be placed under the hammer, and was a part of one of the balls, which were separated and placed to cool. It was observed that no blue flame issued from the mass as it cooled. The appearance of the sample showed that the mass constituting the ball was still spongy, and granulated similar to the previous ones. The only difference was, that the granules adhered together sufficiently to require a certain amount of force to separate one from the other, and also that they were much more malleable under the hammer. They were found to contain the following quantities of carbon and silicium per cent.:

	First Analysis.	Second Analysis.	Mean.
Carbon,	0·771	0·773	0·772
Silicium,	0·170	0·167	0·168

We should observe here, that the black coating which covers the granules of iron, even of No. 8 sample, preserves the iron from all oxidation; for none of the samples became oxidized during the nine months they were in the laboratory, exposed to the atmosphere, and to the various acid fumes floating about. This black coating is probably composed of a saline oxide of iron.

Ninth Sample.—Puddled Bar.

The balls taken out of the furnace were hammered, and then rolled into bars, and in these we found the following:

	First Analysis.	Second Analysis.	Mean.
Carbon,	0·291	0·301	0·296
Silicium,	0·130	0·110	0 120
Sulphur,	0·142	0·126	0·134
Phosphorus,	0·139		0·139

Tenth Sample.—Wire Iron.

The puddled bars were cut into billets of about four feet in length, and heated in a furnace to a white heat, and then rolled into wire iron. The proportion of carbon, silicium, sulphur, and phosphorus, were as follows:

	First Analysis.	Second Analysis.	Mean.
Carbon,	0·100	0·122	0 111
Silicium,	0·095	0·082	0 088
Sulphur	0 093	0 096	0·094
Phosphorus,	0·117		0·117

To complete the series of products in the conversion of pig iron into wrought iron, we analyzed the scoria or slag which remained in the furnace after the balls had been taken out, and found its composition to be as follows:

Silica,	16·53
Protoxide of iron,	66·23
Sulphuret of iron,	6·80
Phosphoric acid,	8·80
Protoxide of manganese,	4·90
Alumina,	1·04
Lime,	0·70
	100.00

Therefore, in the scoria are found the silicium, phosphorus, sulphur, and manganese, which existed in the pig iron; and probably the phosphorus and silicium are removed from the iron by their forming fusible compounds with its oxide.

We shall conclude this paper by giving our results in a tabulated form, so that the removal of the carbon and silicium may be better appreciated by those who may consult it with the view of obtaining such information as may lead them to those improvements to which we think our investigations tend.

Pig Iron used.	Time.	Carbon.	Silicium.
		2·275	2·720
Sample No. 1	12·40	2·726	0·915
" " 2	1·0	2·905	0·197
" " 3	1·5	2·444	0·194
" " 4	1·20	2·305	0·182
" " 5	1·35	1·647	0·183
" " 6	1·40	1·206	0·163
" " 7	1·45	0·963	0·163
" " 8	3·50	0·772	0·168
Puddled bar, 9		0·296	0·120
Wire iron, 10		0·111	0·088

IMPROVEMENTS IN THE MANUFACTURE OF IRON AND STEEL.

Morgan's Improvement in Iron Smelting. — This invention relates to the smelting of iron ores, in which the quantity of alumina present is equal to, or exceeds, one-half the quantity of silica; and the invention consists in employing as a flux in the blast-furnace, when smelting such ores, sandstone, sand, or, in fact, any other matter which contains silica in a comparatively pure form — that is to say, where the proportion of that substance is about seventy per cent.; any substance containing less than this would be altogether unsuitable as a flux, according to this invention, owing to the increase of fuel it requires, and also the large quantity of impurities which would be introduced by it into the furnace. When ores containing silica in a quantity less than double the alumina are smelted in the ordinary manner, the alumina renders the slag infusible and thick, and the working of the furnace is imperfect, while the iron becomes at the same time deteriorated. In carrying out his invention, Mr. Morgan operated upon ore known as Cleveland iron-stone, which ore contains of alumina 7.96, and of silica 8.62. Now when, according to this invention, iron ores are employed which contain certain proportions of silica and alumina different from that above, the quantity of sandstone should be regulated so that the silica and alumina in the charge may bear to each other the same, or nearly the same, proportion, as was the case with the Cleveland iron-stone, which was as follows: Calcined iron-stone, 11 cwt.; sandstone containing ninety-three per cent. of silica, 1½ cwt.; limestone, contaning fifty-three per cent. of silica, 4 cwt. This invention consists in adjusting the proportion of the silica and alumina in the charge by the addition of silica, where ores are employed which do not contain such a quantity of silica (when combined with lime to form a slag) as will carry down the alumina which the ore contains, and at the same time produce a sufficiently fluid slag. In this manner Mr. Morgan is enabled to smelt ores of this description as advantageously as ores which naturally contain silica and alumina in such proportions as to produce fluid or fusible slag. It will be seen that the principal feature in this method consists in employing silica as a flux. Now, as has been remarked, the use of silica is as well known, or ought to be, by all who have charge of furnaces, as limestone, and consequently the mere employment of that substance for that purpose would not prevent its use by others either in the form of sandstone or sand; but we are told by Mr. Morgan that he is aware that silica has been used before as a flux; but heretofore it has been used with ores which do contain sufficient silica to carry down the alumina, — that is to say, at least two of silica to one of alumina, — but which, nevertheless, do not contain silica enough to make sufficient slag to protect the iron from the blast, and for the proper working of the furnace. This inventor claims only the employment of silica, where it is used together with ores, in which the quantity of alumina present is equal to or exceeds one-half of the quantity of silica. — *New York Tribune.*

Carmont and Cobett's Improved Furnace. — In this invention, the flues of furnaces for the production of wrought iron or steel are so constructed as to rise perpendicularly from the grate, so as to carry off all deleterious gases generated in the process of manufacture, and also in preventing such deleterious gases coming in contact or being incorporated with the metal so manufactured. Furnaces thus constructed cause the heat powerfully to reflect and reverberate upon the metals, and at the same time prevent all flame or smoke passing over or coming into contact with the metal while in a state of fusion. — *New York Tribune.*

Improvement in the Manufacture of Cast Steel. — In a communication to the London *Engineer*, Mr. Robert Mushet, in commenting upon the "Bessemer process" for manufacturing iron, describes improvements which he has made in producing steel from cast iron. In an experiment with Welsh No. 1 pig iron, which was purified in a Bessemer furnace, he added ten pounds of a triple compound of malleable iron, carbon, and manganese, to every seventy-two pounds of the cast iron, and the ingots made from this were good welding cast steel; on the other hand, ingots made from the same pig metal without the manganese and carbon being added, were so brittle that they cracked to pieces, at both a high and low heat, when worked under the hammer. He asserts that there never was, or can be, a bar of first-rate cast steel made by the Bessemer process alone. It is generally held that molten iron cannot contain oxide of iron in solution, but Mr. Mushet is of a different opinion. He also asserts that a very small quantity of metallic manganese, introduced among molten cast iron, counteracts all the pernicious effects of phosphorus and sulphur in it. He says: "I have merely availed myself of a great metallurgical fact, namely, that the presence of metallic manganese in iron or steel, conferred upon both an amount of toughness, when cold and heated, which the pressure of a notable amount of sulphur or phosphorus cannot overcome." In another portion of his letter he says: "The great remedy for red-shortness in iron or steel is simply the addition of a little metallic manganese thereto. Why are the Prussian irons celebrated for their excessive red-toughness and cold-toughness? Simply because they contain a small alloy of metallic manganese."

Tissier's Experiments on the De-carbonization of Iron. — It has oftentimes been a subject of remark, that wrought-iron tubes employed in the production of *sodium* are never converted into cast iron, although the carbonate of soda, from which sodium is distilled, contains a large amount of carbon. M. Tissier, of Paris, has recently made some experiments in connection with this subject, and has ascertained that wrought iron is not affected in any way by the carbonate alluded to, even at a very high temperature. He tried the action of the carbonate of soda upon malleable and cast iron at the melting-point of the latter, and found that while the malleable iron was not affected, the cast iron was deprived of its carbon and silicon, and converted into malleable iron. M. Tissier also operated on gray pig iron, containing six and a half per cent. of silicon, and graphitic carbon. The iron was heated with an excess of carbonate of soda, at a bright red heat, for several hours. It boiled up, evolving bubbles of carbonic oxide, and when this action ended, the iron was withdrawn and immersed in water. The result was, that this iron, formerly so brittle, could now be forged under the hammer, and welded; its granular structure had disappeared — it had become fibrous crystalline. The action of the carbonate, as reported in the *Le Technologiste,* removed all the sulphur and phosphorus from the iron, as well as the silicon. M. Tissier has only made experiments with small masses of iron; and although the results of his efforts are interesting as a matter of science, yet practically they are of little value, because the metal so treated, although changed from pig to malleable and wrought iron, becomes too porous.

New mode of treating Cast Steel. — A new mode of treating cast steel has been recently patented by Perry G. Gardiner, of New York. Pure iron is softened by heat, but does not melt; hence it is shaped into tools and pieces of machinery by forging, and costs from 12 to 25 cents per pound. Cast iron, which is a combination of iron, with 3 or 4 per cent. of carbon, does not soften by heat, but at certain temperatures suddenly melts; hence this metal is worked into useful shapes by casting into moulds, and costs from 2 to 4 cents per pound. Steel is iron, combined with from $\frac{3}{4}$ to $1\frac{1}{2}$ per cent. of carbon. This metal, when heated to 2000° Fahr., becomes soft, and can be forged and welded; heated to 3500°, it melts, and can be poured into moulds. The ordinary mode of working steel is by forging, and articles made of steel thus prepared, cost from 25 to 75 cents per pound. Many have attempted to make these articles by casting into moulds, but they were unsuccessful; the metal was not as tough as after being hammered; besides, some air remaining in the mould, and mixing with the fluid metal, produced those defects technically called honey-comb and piping. Mr. Gardiner seems to have succeeded in overcoming the difficulties. His process is as follows: Moulds of fire-clay or blacklead are prepared in a substantial frame, so as to be used a great number of times. Each mould communicates, by a straight vertical pipe, with an air-chamber placed above it, and this air-chamber is closed by a valve on top, opening outside. By the side of this mould, but on a higher level, is a cup, from the bottom of which a curved pipe leads to the lowest portion of the mould; the opening of this pipe in the cup is closed by a plug. Each time this mould is to be used, it is first heated to cherry heat — that is, from 2000° to 2500° — in a proper oven. The air contained in the several portions of the mould, expands to about fifteen times its original bulk, and in so doing, escapes through the valve at the top of the air-chamber. The mould is swiftly taken from the oven, the melted steel poured into it, and it is replaced in the oven till the metal is congealed and brought down to cherry red. From the shape of the mould, it results that the melted metal entering the mould from below, pushes out the small portion of air remaining, without mixing with it; as for the few bulbs which might have entered the steel when falling down the pipe in its way from the cup to the bottom of the mould, it is very little, and all collects in the sprue formed in the passage to the air-chamber, which is afterward broken off. After the metal is congealed, it is taken from the mould and plunged into oil at 150°. This hardens it to the right point, and the articles do not require tempering, beside being smooth, without cracking or warping. — *New York Tribune.*

NEW PROCESS FOR PREPARING INFLAMMABLE PHOSPHURETTED HYDROGEN.

This process, which is completely free from danger, is based on the action which cyanide of potassium in powder is capable of exerting on hydrated phosphuret of copper, obtained in the humid way. The latter compound is procured by decomposing, at the boiling temperature, a solution of sulphate of copper by means of phosphorus; the product constitutes a powder of a grayish black, composed of phosphuret of copper and basic phosphate. This powder is kept under water. When it is dried, it may with impunity be mixed with cyanide of potassium; the disengagement takes place only when a little water is added.

The cyanide of potassium cannot be replaced by potassa or soda, and water should not be replaced by dilute alcohol. In the former case, no disengagement occurs; in the second, uninflammable phosphuretted hydrogen is developed.

It is known that phosphuretted hydrogen readily blackens solutions of nitrate of silver. M. Boettger applies this reäction to the production of a kind of sympathetic ink; for this purpose, it is sufficient to expose to the disengagement of gas a paper on which characters have been traced in a solution of nitrate of silver; the characters immediately appear black, and are very stable, resisting not only the action of alkaline liquors, of solutions of cyanide of potassium or hypochlorite of lime, but also the influence of dilute sulphuric nitric, or hydrochloric acid.

The amorphous phosphorus reduces sulphate of copper only in as much as it still contains ordinary phosphorus. The author proposes to turn this property to account in industry for freeing amorphous phosphorus from the ordinary phosphorus which it may contain, if we do not prefer to have recourse to the very simple and practical process of separation, which M. E. Nickles has made known.

The phosphuret of copper in question is composed according to the formula $Ph\ Cu_3$. In the crude state it is mixed with the basic phosphate of copper, which does not impede the disengagement of phosphuretted hydrogen, but which may be averted by boiling with a solution of bichromate of potassa acidulated with sulphuric acid.

The phosphuret of copper which resists this latter agent is decomposed, although slowly, when it is boiled with hydrochloric acid; the products of the reäction are uninflammable gas and chloride of copper. However, this phosphuret may inflame spontaneously when exposed to the solar rays. This, at least, is what happened to M. Boettger in placing the crude phosphorus in the sun for the purpose of drying it.

NEW METHOD OF PREPARING SULPHUROUS ACID.—BY E. F. ANTHON.

The author placed two ounces of sulphur, in fragments, and twenty-five ounces of concentrated sulphuric acid, into a glass flask, furnished with a gas tube, and heated it over a spirit-lamp. The sulphur soon melted, and in a short time there was an evolution of sulphurous acid, which was conducted into water. The evolution was very uniform, and the burning of the spirit-lamp was continued until, after about six hours, there was only a comparatively small residue in the flask.

During this treatment, the sulphur constantly floated in the form of a transparent hyacinth-red, thickly fluid mass on the hot sulphuric acid, and a small portion of it sublimed; part of this condensed again in drops upon the walls of the flask, and flowed back into the acid, whilst another part was deposited in the form of a thin crust in the neck of the flask. Very small quantities of sulphur were carried further mechanically by the sulphurous acid, and deposited in the connecting tube. At the conclusion of the process, the flask contained only 4½ drachms of sulphuric acid and 32 grains of unaltered sulphur.

The advantages of this process are: that it furnishes a pure product; that it is easily and cheaply effected; the evolution of the sulphurous acid gas is very uniform; and no solid deposit settles at the bottom of the vessel of evolution, which, in other methods, so often occasions the cracking of the vessel.—*Dingler's Journal*, c. l. p. 379.

COAL-TAR—ITS COMPOSITION AND ITS APPLICATIONS.

The following popularly-written article contains a summary of what has been effected, during the last few years, in the treatment and application of "coal-tar" and its products.

Every reader is perfectly familiar with the color, odor, and generally disagreeable nature of tar. We don't mean the rich, fragrant, foreign fluid, prepared from the roots and otherwise useless portions of resinous firs, and known as Stockholm tar; nor yet the purer extract furnished by the wood-vinegar or pyroligneous acid maker. These are tars, but they are not our tar: our tar is far more disagreeable than any other kind, and is usually called, in allusion to the source whence it is obtained, coal-tar.

Coal-tar is torn from the long embrace of its parent coal, at the period when that parent yields up to the service of man a no less cherished offspring, gas. As coal is heated in confined chambers, the carburetted hydrogen, for the production of which the operation is performed, is separated, and with it a quantity of the black treacley-looking fluid known as tar. This is collected in proper receptacles, and as it is of no use to the gas manufacturer, is sold to those whose special business is its preparation.

Until the last few years, the applications of coal-tar were very simple, and very limited: it was spread over a vast variety of substances which required its preserving influence to guard them from the weather; it was used as a rough varnish for gigantic ironwork; and it formed an important ingredient in various compositions used instead of stone for esplanade purposes.

Coal-tar is a union of a very considerable number of organic bodies, some being solid, and others fluid. It contains — if you desire a clear and satisfactory idea of its composition — ammonia, aniline, picoline, quinoline, pyridine, phenic acid, rosalic acid, brunolic acid, benzole, toluole, cumole, cymole, napthaline, paranapthaline, chrysene, and pyrene. As each of these sixteen substances is individually more or less complicated, we are not, we think, wrong in saying that the fluid formed by their union is somewhat remarkable.

The apparently simple business of the tar-worker is to take his tar to pieces; not to separate it into all the various components we have enumerated, for that would be a very difficult, and perhaps useless proceeding, but to extract from it a number of vastly different bodies, which have been put to a variety of uses in the manufacturing world.

In nearly the whole of his operations, the simple agent used by the tar-worker is *heat*. It is one of the fundamental laws of chemistry, that every fluid at a certain temperature shall assume a gaseous form; the temperature at which such change takes place being entirely dependent upon the nature of the fluid operated upon. The highly complex body, tar, is therefore placed in certain large stills, each containing from 2000 to 3000 gallons; and heat being applied, the tar in time begins to boil; and each of its fluid constituents, which assumes the form of vapor at a different temperature from the others, separately makes its appearance at the end of the still-worm.

The first of these is a quantity of ammonia and other gases, all of which are collected in cold water, which soon becomes strongly impregnated with them, and is used for the preparation of a rough description of sulphate of ammonia, which finds a ready sale as an important ingredient in certain artificial manures.

As the heat is increased, an oily fluid comes over, technically called "light oil," which is carefully collected apart from the other products. When as much of this light oil has made its appearance as about equals in bulk one-twentieth of the tar originally put into the still, it ceases to be produced, and is succeeded by a dense, dark-colored fluid, with a peculiarly offensive odor, known as "dead oil." The dead oil comes over in much larger quantity than the light oil, equalling fully one-fifth of the tar. When the dead oil has ceased to run, the distiller knows it is of no use to keep the pot boiling any longer; the fire is therefore put out, a huge tap at the bottom of the still is turned, and the thick, black residuum, still fluid in its heated state, being neither more nor less than common pitch, is allowed to run along certain channels, prepared for its transmission, into immense underground tanks in which it is stored.

By simple *boiling*, then, our manufacturer has split up his tar into four very different matters — pitch, dead oil, light oil, and ammoniacal liquor.

With the pitch he does very little. Shortly after running from the still, it is ladled out of the great tanks already mentioned into moulds formed of the halves of resin-casks, rubbed with chalk on the inside to prevent its adhering; and being sold in this state, it is used for a variety of well-known purposes.

The greater part of the dead oil, too, has no further process to undergo. The product is in reality a rough mineral creosote, and possesses in a high degree the antiseptic properties for which creosote is so celebrated. The dead oil is about the most important thing got out of the tar; thousands and thousands of gallons are every week sold to the different railway companies for the soaking of sleepers and other timber; for, once well impregnated with the fluid, every description of wood may bid defiance to both wet and dry rot. A good deal of the oil is, however, used for a very different purpose. It is exceedingly inflammable, and contains a large amount of carbon; and these two peculiarities are taken advantage of by slowly burning it in curious little lamp-furnaces connected with vast brick flues; the smoke from the burning oil is rapidly deposited on the sides of these flues in a form which washerwomen would recognize as "blacks;" and being periodically scraped off, it makes its appearance in the market as "lampblack."

The light oil is, however, a substance requiring a good deal more preparation, and serving a greater variety of purposes, than any of the other products. Light oil is impure *coal naphtha;* and to free it from its impurities, especially those affecting its color and smell, is the crowning object of the tar-distiller.

As it comes over, in the first instance, it is a dark-brown liquid, smelling most horribly. Being, in this state, all but useless, it is at once redistilled, and loses a large amount of smell and color. It is now ordinary "naphtha," and used for a variety of purposes, but it still contains a large quantity of a peculiar greasy matter, called "paranaphthaline," from which no amount of distilling would entirely free it. To separate it from this paranaphthaline, therefore, it is mixed with "oil of vitriol," in an iron reservoir, and the acid and naphtha are thoroughly shaken and stirred together. For some little understood reason, the fatty paranaphthaline leaves the naphtha, and attaches itself to the acid, carrying along with it a vast amount of impurity, and leaving the naphtha in a very commendable state of cleanliness. As the oil of vitriol is nearly three times as heavy as the naphtha, directly the stirring and mixing process is at an end, the two bodies separate, and are drawn off from the reservoir into proper receptacles.

The naphtha is now either sold in its present condition, or again distilled. For the most particular purposes, indeed, it is distilled or rectified three times, the whole operation being conducted by the steam of boiling water; and the fluid is known to the trade as once, twice, or thrice *run* naphtha, respectively.

Here the legitimate labors of the tar-distiller end. He has prepared from his black tar — pitch, creosote, lampblack, naphtha, and sulphate of ammonia. The first three are used, as we have already said, in their existing forms; while the fourth, the coal naphtha, has yet to undergo a greater variety of changes, and to fulfil a larger number of offices, than all the other products put together.

In the state in which the naphtha leaves the tar-worker's yard, it is used extensively for illumination, for which it is eminently fitted by the immense amount of carbon it contains; and if the lamp employed in burning it be only constructed so as to allow of the actual *combustion* of this carbon, the light emitted is probably greater than that obtained from the same bulk of any other known substance. It is also a solvent of caoutchouc, gutta-percha, and other gums, and therefore much in request by the varnish-maker; whilst purified and deprived of its smell, by some secret method it becomes the benzine liquid, extensively used as a valuable detergent of grease from wearing apparel, etc.

When coal-naphtha is submitted to the action of certain chemical bodies, totally different from itself in their nature, the most remarkable changes take place in it; certain of its principles unite with certain elements of its added body, and compounds are produced of the most unexpected nature.

Thus we have said that one of the constituents of tar is *benzole*. Now, when the tar is distilled, and separated into the dead oil and the light oil, this body, benzole, suffers no alteration in its nature; its affinity for some of the other ingredients of the naphtha is so great, that simple heat is altogether insufficient to produce a disunion; and the consequence is, that the benzole *goes over* with the light oil, and continues to form part of it.

By using rather more energetic chemical means, however, the benzole may be separated from the naphtha, about a pint being obtained from two gallons. It makes its appearance as a heavy, oily substance, with very little smell, and a pungent taste. When this apparently useless fluid is mixed with nitric acid or aquafortis, a singular phenomenon occurs, — the two substances, the benzole and the acid, unite, and produce what chemists call nitro-benzole, a fluid precisely resembling, in smell and taste, oil of bitter almonds, and extensively used in various ways, in place of the more expensive and poisonous substance which it represents.

Yet another strange transformation may be effected. *Phenic acid* we have enumerated as existing in tar; and phenic acid, like benzole, is not altered during the process of distillation, but passes over with the naphtha, and forms part of it. Phenic acid further resembles benzole in being of little use in its pure state. When, however, it is treated with nitric acid, already mentioned, and evaporated, long pale-yellow crystals, bright and clear, make their appearance, very beautiful to the eye, and intensely *bitter* to the tongue: these are crystals of carbazotic acid. Their color has caused a solution of them to be extensively used in dyeing silk; their taste has made them serviceable in adulterating beer.

Using only the multiform processes placed at his command by modern chemistry, the investigator into such matters has gone on experimenting upon all the compounds of this curious body, tar, and has baptized with fearfully hard names the substances produced therefrom, until he has given us binitrobenzol, hydrobenzamide, bi-bromide of chlorabronaphtese, and a dozen other no less mystifying substances. Those above mentioned are, however, the principal ones which have yet been put to any practical use.

Who will despise the nauseous, black coal-tar now? With substances obtained from it, we have rendered our timber impervious to rot, have painted our dwellings, paved our streets, made our varnishes and water-proof garments, taken grease from our Sunday clothes, manured our fields, dyed our silken fabrics, adulterated our beer, and flavored our soaps, sweetmeats, and confectionery. — *Chambers's Journal.*

ON SOME MODIFIED RESULTS ATTENDING THE DECOMPOSITION OF BITUMINOUS COALS BY HEAT.

The following paper has been communicated to us by Dr. A. A. Hayes, of Boston. When bituminous coal is exposed, in proper vessels, to a gradually increasing temperature, at a certain point decomposition commences and continues, while heavy hydrocarbon vapors, mixed with the vapors of water and salts of ammonia, escape, and may be condensed.

The proportion of permanent gases formed is small in comparison with the weight of the liquids produced, when the decomposition of the coal is carefully regulated. In the ordinary rapid breaking up of the composition of coal by heat suddenly applied in the manufacture of illuminating gas, the proportion of permanent gases is increased, but the heavy fluid hydrocarbons are also formed. This mode of decomposition is evidently a mixed one, partaking of the characters of a regulated distillation, while at the same moment a more complete destruction of the coal is proceeding in some parts of the mass. A further decomposition of the fluid products, condensed from either or both of these modes of operating, takes place when we again subject them to the influence of heat; and this well-known fact is the basis on which improvements in the manufacture of illuminating gas have been founded, — a secondary destruction of vapors being effected in appropriate apparatus, heated to a high temperature.

This character, which all the bituminous coals exhibit, of passing into carbon nearly free from vapors only when heavy fluid hydrocarbons are also formed, has, in a chemical view, been the strongest fact adduced in opposition to the generally received opinion that the anthracites and semi-anthracites have resulted from chemical changes of bituminous coal, through the agency of the heat of igneous rocks which have disturbed their beds. The heavy hydrocarbons, represented by ordinary coal-tar, are the most indestructible bodies known; and wherever anthracites exist, we should expect to find near by those products of the chemical changes effected in the coal. Such is the delicacy of the balance existing between the elements of the heavy hydrocarbons, that no second distillation of them can be effected; they always undergo decomposition by heat, with the separation of carbon, which, under any known natural conditions, would remain to attest their previous presence.

Considerations of this kind have led me to experiment on the changes which coals undergo by heat, where the influencing conditions were not the same as those usually seen; and the results of extended trials demonstrate that the bituminous coals may be broken up into permanent gases, vapors of water, and ammoniacal salts, while carbon remains as a fixed product. If we substitute, for the ordinary forms of apparatus used in decomposing coal by heat suddenly applied, any modification of form which compels the gas, as it forms, to escape from the more highly heated part of the mass of coal, through a small opening, or, better, a small eduction pipe, the heavy hydrocarbons do not form part of the products which escape. Generally the light, nearly colorless oils of the benzole series, appear with the aqueous solutions of the ammoniacal salts, while only an accidental quantity of carbon is deposited in the eduction pipe. The carbon left is more than usually compact and hard; and such coals as ordinarily produce much water, when they form heavy hydrocarbons, afford less than half the usual amount, when thus decomposed, under the influence of the constant presence of an atmosphere of permanent gases.

In following the observations at the earlier stage, it was found that the size of the eduction-tube leading the gas from the hotter part of the mass of coal undergoing changes, exerted a most marked effect on the composition of the products. It was established as a fact, that in an ordinary coal-gas retort, the size of the conduit might be varied so as to allow the tar-like bodies to form, or to prevent their appearance, at pleasure.

But a more remarkable result was obtained when, after having prevented the production of heavy hydrocarbon fluids, the influence of reduced size of tube was studied in its relation to the composition of the gas afforded by a peculiar kind of coal. To a certain extent, the chemical constitution of the gas formed was found to be under control, and the conclusion reached was, that dissimilar permanent gases may be thus obtained from the same parcel of coal without a modification of temperature.

Any explanation of the change of composition induced in the volatile parts of bituminous coals under the above-described conditions, should not include mechanical pressure, which is no greater than often exists in ordinary cases.

It seems probable that the presence of an atmosphere of nearly permanent gases in the decomposing vessel, and the regular continuous flow of them from the coal, prevent the formation of heavy vapors at the instant of change in the coal. In support of this point, we find the temperature necessary to convert coal into gas without the presence of heavy hydrocarbons much less high than when they were produced.

We may, therefore, observe the decomposition of coal without the simultaneous formation of tar, and beds of coal may be converted under existing natural conditions to anthracite, without secondary products being formed.

ON THE DECOLORIZATION OF ROSIN.

At a recent meeting of the Royal Institution, London, Mr. Mercer exhibited a specimen of purified and bleached rosin, a substance, he said, which at first might not appear to be of much interest or importance, but the bleaching of rosin was a subject which had occupied the attention of the most eminent chemists, and hitherto without success. Now, however, the problem had been solved, and a patent taken out by Messrs. Pochin and Hunt, of Manchester, by which common black rosin, worth only 4*s.* 6*d.* per cwt., was converted into a beautiful white article, worth 18s. per cwt. To obtain this result, the rosin to be purified was placed in a still with a receiver, and a steam-pipe in connection with a boiler was introduced into and reached to the bottom of the still, where it radiated with various smaller pipes, perforated so as to allow of the exit of steam. The steam was heated until the rosin melted, when steam was admitted and thoroughly permeated the entire contents, the temperature of the still being at the same time raised to 600°, at which it was maintained until all the contents of the still capable of being volatilized had passed into the receiver, the contents of which, at the close of the operation, would be found to consist of fluid and solid matter, the former being principally water, and the latter the bleached rosin, holding a quantity of moisture in suspension. After the water had been driven off by remelting, the rosin had the beautifully white and transparent appearance of the specimen on the table.

SAPONIFICATION OF FATS BY CHLORIDE OF ZINC.—BY LEON KRAFFT AND TESSIE DU MOTTAY.

When any neutral fatty matter is heated with anhydrous chloride of zinc, we see it melt and disappear gradually as the temperature rises. Between

300° and 400° Fahr. the mixture of the two bodies is complete. If the temperature be maintained for some time, and the mixture be then several times washed with warm water,—or better, with water acidulated with hydrochloric acid,—we obtain a fat which, when submitted to distillation, gives the fat acids which correspond to it, and with an insignificant production of acroleine. The wash-waters carry off almost the whole of the chloride employed, so that by evaporation this may be again used for another process. The fat acids are thus produced in as great quantities as by the common methods, and have the same appearance, the same qualities, and the same fusing point as those which are obtained after saponification by sulphuric acid. To operate well and quickly, the mixture should be heated rapidly, until by the reäction of the two bodies on each other, which is of considerable violence, the vapor of water is abundantly evolved.

In fact, the washing with acidulated water may be dispensed with; but the products then obtained by distillation are softer. If, however, the distillation be carried on by means of a current of superheated steam, this defect may be in a great measure cured. In all our experiments, the use of superheated steam produced the products more rapidly, more firm, and less colored.

The experiments were instituted with a view to allow the inhabitants of South America to convert their fats into stearic acid, without the danger and expense of transporting sulphuric acid to those countries. In an economical point of view this problem is resolved, since the chloride of zinc is sold at Marseilles never higher than two and one-fourth cents per pound, and, packed in cases or barrels, can be shipped without danger or inconvenience. — *Comptes Rendus de l'Academie des Sciences, Paris.*

CONDENSED LYE, OR PORTABLE ALKALI.

The hydrated oxides, soda and potassa, are known in commerce as the caustic, mineral, and vegetable alkalies. Being very deliquescent, it has not been found practicable, until quite recently, to put them up for sale in small parcels, so as to render them easily accessible to families, for soap-making and other useful purposes.

Various devices have been tried, at different times, to secure the caustic soda in air-tight packages. A patent was obtained October 1856; one mode for doing which was to wrap up the small blocks in paper impregnated with a resinous composition; but this was soon discovered to be inefficient, and abandoned, because the caustic soda, possessing a powerful affinity for all substances containing the elements of water,—namely, hydrogen and oxygen,—quickly corroded the resinous paper, and destroyed the wrapper and envelope.

The only mode which had heretofore proved measurably successful in securing the caustic soda from atmospheric air and moisture, was the putting it into metallic boxes; to this mode there are many serious objections, on account of the difficulty of getting it out of the boxes, being apt to burn the fingers and clothing, wherever it comes in contact with them.

Very recently, Dr. Chase, of Philadelphia, has succeeded, after various experiments, in rendering paper wrappers proof against the corrosive action of caustic alkali, by means of Paraffine. This being a hydro-carbon, is insusceptible to the corrosive action of the caustic soda, and is found in practice to be perfectly efficient.

The caustic soda is cast into cylindrical blocks, and, under the name of Condensed Lye, is sold in large quantities. — *Philadelphia Eclectic Medical Journal.*

GLYCERINE.

Under a process lately patented in England, this substance is stated to be obtained from spent soap-lees, by forcing dry steam of a temperature of 400° Fahr. through them. By this means the glycerine is evaporated and condensed in a separate vessel, upon the common principle of distillation. Glycerine has also been used lately in England, mixed with paper pulp, whereby the paper so made is rendered soft and pliable, and especially useful for some kinds of wrapping paper.

DEODORIZING ALCOHOL.

In trying to prepare a transparent soap, M. Kletzinsky has made a curious observation, which may be of value in the arts. He found that empyreumatic alcohols, distilled over properly selected soaps, lost their bad odor and their bad taste. A series of experiments, resulting from this first observation, lead to the following results:

1. Spirits of wine, brandy, or alcohol, distilled over soap, lose their empyreumatic odors and tastes entirely. About 212° the soap retains neither alcohol nor wood-spirit.
2. The empyreumatic oil which remains in combination with the soap which forms the residuum of the distillation, is carried off at a higher temperature by the vapor of water which is formed during a second distillation, the product of which is a soap free from empyreuma and fit to be used again for similar purposes.
3. The concentration of the alcohol increases in this operation more than when soap is not employed, because this compound retains the water, and the alcoholic vapors which pass over are richer.
4. Thirty-three pounds of soap is enough for one hundred gallons of empyreumatic brandy, and direct experiments have shown that under the most favorable circumstances, the soap can retain twenty per cent of empyreumatic oil.
5. The soap employed should contain no potassa; it must be a hard or soda soap, and ought to be completely free from any excess of fat acids or fluids; otherwise it may render the product rancid and impure. Common soap, made with oleine and soda, by the manufacturers of stearine candles, has satisfied all the conditions in practice. If this soap is employed, it will be better to add a little soda during the first distillation.

The hard soda soaps, as exempt as possible from fluid fat-acids, remove completely the empyreumatic odor, and act, for equal weights, much better than any of the other modes heretofore proposed, which disguise rather than correct the fault.

A new method has also been introduced by Prof. Breton, of Grenoble, which consists in passing the raw spirits through powdered pumice-stone, moistened with olive-oil. It had been found that the fusel-oil is taken up by the fat oil, even if held in solution by alcohol; and on this principle, filters of woollen cloth were constructed impregnated with olive-oil; but there was no means of cleaning them when once saturated with fusel-oil. The powdered pumice-stone is easily freed from that impurity by calcination.

NEW SOURCE OF AMMONIA.

Mr. Alexander Williams, of Neath, England, in a letter to the *Journal of the Society of Arts*, has suggested a means of economizing the waste nitrogen products escaping from the oil of vitriol chamber, by effecting their conversion into ammonia. This is done by passing the escaping gases, mixed with steam, over heated charcoal, and then into dilute sulphuric acid, by which sulphate of ammonia is obtained. The following is Mr. Williams' description of the arrangement he employs, and which has been tried on a large scale at the Pontardawe Vitriol Works.

"The apparatus fitted up was of the following description: A furnace was built above the exit-tube of one of their vitriol chambers, and a brick gas retort, about fourteen inches in diameter, eight feet long, and open at both ends, was passed through its whole length. This retort was filled with charcoal, and kept at a red heat; the exit-tube of the chamber and a steam-jet to supply the hydrogen were attached to one end, whilst at the other end was an upright leaden cylinder filled with coke, and moistened with diluted sulphuric acid. On passing the waste gases and steam through the retort containing hot charcoal, both were decomposed, the oxygen of each uniting with the charcoal to form carbonic acid, the nitrogen and hydrogen combining to form ammonia; then, together, probably forming carbonate of ammonia, which was again decomposed by the diluted sulphuric acid, the sulphate of ammonia being found remaining in solution. This solution was then evaporated, and in July 1857 I first had the pleasure of obtaining any quantity of crystals of sulphate of ammonia, by this process, from a vitriol chamber in actual work."

ARTIFICIAL INDIA-RUBBER.

The *Journal Franklin Institute*, April 1859, translates from the proceedings of the French Academy the following communications on the above subject:

On the Action of Chloride of Sulphur upon Oils — By M. Z. Roussin. — If a vegetable oil be mixed with about one-thirtieth of its bulk of chloride of sulphur, this latter substance will be entirely dissolved; in a little while the mixture heats, and assumes a viscous consistence, so that frequently the vessel may be inverted without spilling the contents.

If the chloride of sulphur is in the proportion of one-tenth, the preceding phenomena acquire greater intensity. The mixture soon attains a temperature of 120° or 140° Fah., some bubbles of hydrochloric acid are disengaged, and the whole mass solidifies instantaneously without losing its transparency, and acquires a consistence like caoutchouc. This product possesses some elasticity, and shrinks slightly after consolidation. Macerated in distilled water, it loses its transparency and becomes opaque white. In a few days it is transformed into a white, slightly friable, elastic mass, having no similarity to the original substance, and resembling rather an organic substance.

If we take a mixture of one part of chloride of sulphur, and nine of oil, and heat the mixture, we shall find that at about 140° a pretty strong reaction shows itself. Hydrochloric acid is disengaged, and the mass is transformed into an elastic cavernous substance like sponge, very closely resembling certain cryptogamic vegetations. Macerated in water, it becomes whiter, without changing its form.

All these products resist the action of boiling alkalies, whether dilute or concentrated. Ammonia and the concentrated acids have no action on them. Neither water, alcohol, ether, sulphuret of carbon, or the oils, appear to alter or dissolve them.

At the temperature of 300° Fah. they remain solid and unaltered. A few degrees above this point they begin to melt into a brown liquid, and emit whitish acid vapors. We have not had time to determine the composition of these substances. After long boiling in alkaline solutions, reiterated washings with dilute acid and boiling water, they still contain sulphur and chlorine in considerable quantities. In this state, the slightest shaking communicates to them a peculiar vermicular motion, which continues for some time.

Action of Chloride of Sulphur on Oils, or Vulcanization of Oils — By M. Perra. — The chloride of sulphur combines at ordinary temperatures with flaxseed oil, as well as with other oils.

If we take 100 parts of flaxseed oil and about 25 parts of chloride of sulphur, we obtain a compound which has the maximum hardness.

100 parts of the oil, and from 15 to 20 of the chloride, give a flexible compound.

From 5 to 10 parts of the chloride will thicken 100 parts of the oil very strongly, without hardening it. In this state it is soluble in all the solvents of common oils. This is not the case with the other combinations, which swell somewhat, and lose a little sulphur without dissolving in solvents.

If we dilute a given weight of flaxseed oil with 30 or forty times its weight of sulphuret of carbon, and introduce one-fourth of the weight of the oil of chloride of sulphur, we have a product which will remain liquid for some days. If in this condition it be applied upon glass or wood, etc., the sulphuret of carbon evaporates, and you have instantly a varnish.

The chloride of sulphur saturated with sulphur, is preferable, for these actions, to that which is not saturated.

In making these mixtures, proceed as follows: Introduce the chloride of sulphur quickly into the oil, which must be stirred so as to mix them intimately. Gradually the mass heats, the combination takes place, the oil thickens, and forms a compound more or less soft, according to the proportions of the chloride. But small quantities should be operated on at a time, and all elevation of temperature must be avoided, otherwise the chloride of sulphur will be volatilized, and will form bubbles in the mass, or carbonize and blacken the oil. As soon as these two substances are intimately mixed, pour the mixture on a plate of glass or other polished substance, smooth it, and in five or six minutes, according to the temperature of the air, you obtain the compound. With the point of a knife, detach one of the corners of this pellicle, which may be easily raised without breaking. One coat may be laid over another, and they will unite in one, provided the upper one be put on after the temperature of the lower has been reduced; moisture in the air must also be avoided, which decomposes the chloride and prevents the adherence.

By following this mode, I have succeeded in making little boxes, knife-handles, etc. By introducing wire gauze into the mixture, plates of considerable resistance may be procured. This is easily done by laying the wire gauze on the glass, and proceeding as above.

All the products thus made are completely transparent, if care be taken to keep the articles in a stove or other warm place, to drive out the vapors of chloride of sulphur, and prevent the dampness from decomposing this compound. These hard compounds of oil are not attacked by any atmospheric influences; I have left them for several years exposed to the external air.

These compounds are not, like vulcanized India-rubber, flexible when cold, but are brittle when handled carelessly, which is an inconvenience. A still greater one is the decided smell which they retain for a long time.

I have tried to make them as hard as hardened India-rubber, but in vain. Almost all substances introduced into them are altered by the chloride, and add nothing to the hardness.

They can, however, easily be colored. It requires but a little color mixed with the oil before the introduction of the chloride. Some colors, however, are altered by it.

These compounds resist very well the mineral acids and alkalies when moderately dilute. These alkalies concentrated saponify them finally. A heat of 250° browns them, a higher temperature melts them with a blackish color. This vulcanized oil may be well used for moulds, as it takes impressions very sharply. When rubbed, it always keeps a smooth and polished surface. It has electric properties in a high degree, and might be used for plates for electric machines.

I have not been able to apply this substance upon stuffs, in consequence of its acid reäction, which destroys them. I have plated wood with it, by first roughening the wood so as to cause it to adhere. It may be applied for floor-cloths, table-covers, imitation marbles, window panes, etc.

I will remark, in conclusion, that the bromide of sulphur has the same properties as the chloride, and it was, in fact, with the former that I made my first experiments at the College of France, in 1853.

ON THE VARIABLE ILLUMINATING POWER OF COAL-GAS.

The following paper, on a subject of general and popular interest, read before the American Association for the Promotion of Science, Baltimore meeting, 1858, by Prof. W. E. A. Aikin, of Baltimore, is published in *Silliman's Journal*, Vol. XXVII., No. 78:

In common with a large number of citizens of Baltimore, my attention was directed, some short time since, to a somewhat sudden, inexplicable, and enormous increase in the amount of our quarterly bills for gas consumed; an increase equal at times to an advance of a hundred per cent. over the corresponding quarter of the preceding year. As it would have been absurd to suppose a simultaneous derangement of all the meters over an extensive district, it was obvious that the difficulty could not lie in any error in the registry of the gas, but in its illuminating power, necessarily requiring the consumption of a greater bulk of gas to produce a given quantity of light. Feeling curious to know how this difference could have occurred, I set myself to work to ascertain, if possible, what causes could be acting to diminish the illuminating power of the gas.

It has long been known that the quality of the gas produced from the fat coals is very materially influenced by the circumstances of the decomposition. In the elaborate experiments made some years ago, on a most extended scale, by Hedley, the British engineer, as detailed in his report to a committee of the House of Commons, we find this subject most satisfactorily discussed. Below a cherry-red heat, the product obtained by heating coal in close vessels contains hardly any illuminating material. At that temperature it is furnished most freely, but after having been formed, is liable to decomposition, involving a loss of carbon by contact with any highly heated surface, in passing through the apparatus, — such decarbonization increasing with the degree of heat, with the extension of the red-hot surface, and with the time of contact. Again, the duration of heat is most important, the best gas coming over during the first hour, the quality rapidly deteriorating, until, at the expiration of four hours, the product is worth very little to the consumer, and after five hours may be considered as worthless. But the bulk of such worthless gas that can still be obtained by pushing the process to completion, is very considerable, equal sometimes to two-fifths of all that passes over.

How far any neglect in the observance of the precautions required to produce a proper illuminating gas, may explain the result, the public have no means of knowing. All that we know is, that the manufacturers furnish an article which they say is the right article, and prepared in the right way, and possessing an illuminating power varying from fourteen to seventeen candles. That is, their engineer reports, that on trial with a photometer, at stated times, the gas burning from a jet, consuming five cubic feet per hour, gives an amount of light equal in the average to that of fifteen patent candles, six to the pound, — the patent candle being ostensibly a mixture of spermaceti and wax. Assuming as true all that is claimed by the manufacturers, it can still be shown that the gas, even if properly made and correctly tested, may be, and is, furnished to the consumer in a condition of greatly diminished illuminating power, compelling the consumption of a greater bulk to obtain the required light, and consequently swelling the record of the meter and the sum-total of the quarterly bills. In my trials to determine the specific gravity of our gas by weighing a globe previously exhausted and then filled with it, I obtained a result ranging from ·570 to ·580, somewhat below that given as characterizing good gas. But in reality I attach very little importance to this result, since the mere specific gravity of such a complex mixture as coal-gas, can hardly be relied upon to determine its commercial value.

Although good gas certainly has a higher specific gravity than poor, yet the difference could not be taken to represent the true difference in value, since the principal components of the mixture — hydrogen, carbonic oxide, light carburretted hydrogen, olefiant gas, and other still heavier hydrocarbons having specific gravities widely different — might vary somewhat in their relative proportions, sufficient to affect the illuminating power, without at the same time, and to the same extent, affecting the specific gravity. The action of chlorine in removing the olefiant gas, and other more dense hydrocarbons, the principal light-giving materials of the coal-gas, showed a percentage of these substances never exceeding ten per cent. But, not having time at the moment to guard against all sources of error in the process, I laid it aside. My attention was principally directed to the simple inquiry, To what extent will the illuminating power of the gas be impaired by keeping it in contact with water for noted periods? That it does deteriorate when thus kept, or when kept in contact with oil, or even close vessels, has been long known.

Dr. Ure tells us that gas from oil, when first made, and with a specific gravity of 1·054, will give the light of one candle, when burned from jets consuming 200 cubic inches per hour. But keep the gas three weeks, and then, to get the same light from the same burner, you must supply 600 cubic inches per hour. He adds, that with coal-gas the deterioration appears to be more rapid. For if such gas, when first made, will give the light of 1 candle by the consumption of 400 cubic inches per hour, when kept four days it will require the consumption of 460 cubic inches per hour to give the same light. On my first attempt to obtain some definite results, I filled a large receiver from the street main, and placed it on the shelf of the pneumatic trough; the next evening I filled a second one, and put it alongside of the first; the following evening I filled a third receiver, and still the following evening, the 11th inst., I filled a fourth receiver. On the evening of the 12th I was thus provided with four jars of gas, one of which had been standing twenty-four hours, or one day, over the pneumatic trough; this I will call No. 1. Another, No. 2, had been standing two days; No. 3 had been standing three days, and No. 4 had been four days in contact with the water. The diminution in volume by such exposure was indicated by a receiver graduated to cubic inches, into which I introduced 130 cubic inches of gas on the evening of the 8th; on the evening of the 12th this had lost about ten and one-half cubic inches, indicating a loss of about eight per cent. of the original bulk.

The effect produced on the illuminating power of the gas by the loss of volume became at once apparent as I proceeded to contrast the value of the flames furnished by the contents of the several receivers, 1, 2, 3, and 4. I used for this purpose the ordinary photometer arrangement, taking the relative intensity of the shadows produced, as a measure of the relative intensity of the light. The candle employed for the comparison was the patent candle already referred to, and the burner was the kind known as fish-tail burner, which had been previously gauged, and known to consume a trifle more than five cubic feet per hour, with the average maximum pressure of the gas-works. I need hardly add, that the burner was the same in all the trials, and occupied exactly the same position. The burner and the screen on which the shadows fell were not moved at all during the experiments. The only adjustment wanted was to bring the candle nearer to or farther from the screen; and by beginning with the most luminous gas, the adjustment became simply a gradual withdrawal of the candle.

The capped receiver from which the gas was passed, floated freely in a large glass jar, supported in an erect position by the perpendicular sides of the jar, its own weight, with all attachments, making a difference of level between the water around it and that within, equal to three and one-half inches, a little exceeding the ordinary evening pressure in the gas-pipes. This difference of level, and consequently the pressure on the escaping gas, was kept uniform by the spontaneous sinking of the receiver as the gas was consumed, a flexible tube communicating between the stop of the receiver and the gas-burner. This arrangement gave me a steady, equable flame, which continued perfectly uniform long enough to enable me, after a few trials, to note very exactly its true value. The results as first obtained were too startling to be at once believed, but subsequent repeated trials satisfied me that they were very close approximations to the truth. The first trial was with the gas from the street main, which I found equal to 10·71 candles. The same gas, transferred from the pipe to the capped receiver, and burned immediately, gave exactly the same power, 10·71 candles. Gas No. 1 was next used, and found equal to only 3·50 candles; gas No. 2, after standing two days, gave the light of 3·20 candles; gas No. 3, three days old, was equal to 1·90 candles; and gas No. 4, four days old, gave the light of 1·75 candles, — the quantities representing the average of repeated trials.

It thus appears that the illuminating material of our coal-gas is so rapidly abstracted by suffering it to remain in contact with water, that the same volume of gas which to-day will give me the light of nearly 11 candles, by standing until to-morrow will give the light of only 3·50 candles; and if left standing four days, will give the light of only 1·75 candles; while the only means left to the consumer to get the light he requires from this deteriorated gas, is to burn more of it, as we have all been doing through the past winter. If we now take into account the well-known fact, that gas of less illuminating power has less density, and that gas of less density passes more rapidly through a given aperture than gas of greater density, we have another cause operating to increase the consumption. In Hedley's experiments, the Argand burner, which gave the light of 25 candles when supplied with three cubic feet per hour of gas from Welsh cannel coal, with a specific gravity of ·737, required no less than seven and one-half cubic feet per hour to give the same light, from the same burner, when the gas was made from the Newcastle coal, and had a specific gravity of only ·475.

Again, as we diminish the illuminating power of the gas, we increase its heating power, and this necessarily brings with it a higher temperature given to the burners, a higher temperature given to the gas passing through them, and again an increased rapidity in the flow. It is thus manifest that the public are placed in a peculiarly unfortunate position, since all the mistakes that are likely to occur in the process of manufacture, are mistakes that must inevitably increase the bills of the consumer and the profits of the manufacturer. If the workman fails to raise the heat with proper rapidity; if he overlooks a retort, and allows the heat to continue a little too long; if, towards the close, he allows the heat to rise a little too high, the result is inevitable, — the product is deficient in illuminating power. Or if, on any one day, a little more gas is produced than is legitimately required, the surplus remains in the gasometer to vitiate the supply of to-morrow. To what extent this vitiating action operates may be inferred from the fact, that I have never been able to obtain from the gas of our pipes an illuminating power equal to the minimum of that reported by the engineer of the gas company. In my trials, the power has varied from that of 13 candles down as low as that of 9 candles, instead of ranging from 14 to 17 candles.

This difference is perfectly intelligible, if we assume the last quantities to represent the value of the gas when first made, and my results to represent its value as delivered to the consumer.

In conclusion I would merely add that the difficulty suggests its own remedy; and that would be to have a standard of quality established by the proper authorities, taking the illuminating power as the basis of the calculation, and then to have the requirements of such standard insured by a nightly examination, if necessary, on the part of some one entirely disconnected with the manufacture. In other words, the photometer can be made as available and as valuable to the consumer of gas as the hydrometer is to the spirit merchant; as he distinguishes with his instrument in any mixture, between the spirit he wishes to buy and the water he is unwilling to pay for, so the consumer of gas can distinguish with the photometer between the true illuminating material and the worthless heat producing gases, hydrogen and light carburretted hydrogen, that make up the bulk of the ordinary coal-gas.

ESTIMATION OF ORGANIC MATTER IN THE AIR.

The following lecture was given before the Royal Institution, London (March 25th, 1859), by Robert Angus Smith. It furnishes more complete details of a process devised by Mr. Smith, than was given in the *Annual of Scientific Discovery* for 1859, pp. 262, 263.

After describing the opinions concerning matter in the air, and the attempts made to estimate the amount, the lecturer described a method of obtaining the relative quantity by means of mineral chameleon, permanganate of potash or soda. This mineral had been proposed by Forchammer, as a mode of estimating the organic matter in water, but it was capable of estimating quantities much more minute. At first, the air was passed through the solution of chameleon, but this was not found to cause complete action. It was necessary that the air should remain for some time in contact with the solution to be decomposed. It was then ascertained that the relative amount of organic and other oxidizable matter in air could be found by a simple metrical experiment in a few minutes. In working out this idea, it has been found that a vessel of the capacity of 80 to 100 cubic inches is the most convenient. This is equal to, or rather less than, a quart and a half. The solution used must be extremely weak; 600 grains of it are required to decompose 5 grains of a standard solution of oxalic acid. The standard solution of oxalic acid is so made that 1000 grains neutralize 1 grain of carbonate of soda. A thousand grains contain therefore 1·181 grains of crystallized oxalic acid. To prepare the solution a manganate was formed by heating nitrate and carbonate of soda and manganese, assisted by a little chlorate of potash. There was the most minute trace of nitrate remaining in the solution. A solution of this manganate was made in pure water, and carbonic acid passed through until a reddish purple shade was obtained. It was then tested by oxalic acid, adding three or four drops of pure sulphuric acid. Pure water was added, to dilute it. The solution is apt to change, even when it is hermetically sealed in a glass tube. It is found readily to change when exposed to air. The strength is extremely small. A few grains of the ordinary solutions of manganese used will make some thousand grains of the solution here employed. The reason of this lies in the extremely small amounts of organic matter found in even the worst air. The vessel used is simply a bottle, with a perforated stopper, through which pass two tubes. To one of these a stop-cock is attached, to the other a clasp or stop-cock. The standard size proposed is 100 cubic inches; and to this all the experiments have been reduced; the vessels actually used contain between 80 and 100 cubic inches of air. The stop-cock is of glass, or of hard caoutchouc, which is better. When the bottle is to be filled with the air to be tested, the stopper is to be removed, and the pipe of an exhausting pump is inserted, reaching to the bottom of the bottle. The pump is made like a cylindrical bellows of about 8 inches long when stretched out, and 4 in diameter, and is compressible into the thickness of about 2 inches. The sides are made of thin Mackintosh cloth. By the use of the pump the air of the vessel is removed, and the external air of course enters. A few strokes of the pump are sufficient, *i. e.*, from six to ten. The test-liquid is poured into a graduated tube or burette, containing somewhat more than will be required. A portion is then poured into the tube which passes through the stopper, and the stop-cock is opened to allow it to pass. Small quantities are used. When it has entered the bottle, the liquid is made to spread over the sides, and time given it to be exposed to the action of the air; it is found that in five or six minutes a decided epoch is attained from which to date the comparative action. In order to see the color, the liquid must be allowed to trickle down the sides of the vessel, and collect itself at one point of the circumference at either end of the cylindrical part of the bottle. This part must be raised up to the level of the eye, so that the longest axis may be presented to the sight, and thereby the deepest shade of color. It requires some time to accustom one's self to the sight of such a small amount of color; but when it is once well observed, it will be found to be a method which will admit of the greatest precision. The first few drops which are poured in will probably be decolorized at once; a few drops more must then be added; if they become decolorized a few more must be used, and so on, until there is a perceptible amount of color remaining. When this occurs the experiment is concluded. The amount of the reägent used is then read off from the graduated measure. If the liquid be of proper strength, and the bottle the required size, the number of grains gives the comparative quantity at once. Sometimes the amount of organic matter is so small that there is no appreciable action, or even the smallest amount of solution by one vessel of air. In this case it is necessary to fill the bottle several times. Some of the principal results obtained by this method were as follow:

Relative Quantities of Organic and other Oxidizable Matter in the Air of

Manchester (average of 131 experiments)	52·9
" All Saints, E. wind (37 experiments)	52·4
" " W. wind, less smoky (33 experiments)	49·1
" " E. wind, above 70° Fahr. (16 experiments)	58·4
" " " below, " (21 experiments)	48·0
" In a house kept rather close	60·7
In a pigstye uncovered	109·7
Thames at City, no odor perceived after the warmest weather of 1858	58·4
Thames at Lambeth	43·2
" Waterloo Bridge	43·2
London in warm weather (6 experiments)	29·2
" after a thunderstorm	12·3
In the fields S. of Manchester	13·7
" N. of Highgate, wind from London	12·3
Fields during warm weather in N. Italy	6·6
Moist fields near Milan	18·1
Open sea, calm (German Ocean, 60 miles from Yarmouth)	3·3
Hospice of St. Bernard, in a fog	2·8
N. Lancashire	about same.
Forest of Chamouni	2·8
Lake Lucerne	1·4

The first experiments undertaken were in Manchester, and the average amount obtained was in the city about 50, gradually diminishing in moving towards the country, until it was found in the fields at 13; on passing a sewer stream about a mile from the outskirts, the amount rose to 83. The atmosphere on the Thames was not measured whilst at its worst, but immediately afterwards; when, however, it had ceased to affect the senses of most persons at least, the amount was very high, viz., 58. Moisture itself does not produce any action on the test; one of the lowest numbers obtained was on the German Ocean, about 60 miles from land; the day was calm and clear. The influence of height was very decided; in the higher grounds of Lancashire, near Preston, the numbers being from 2 to 4. What is abundantly established and made clear to the eye is, that the air of our large cities is sufficiently impure to account for much of its unhealthiness, and the air of our hills and seas and lakes sufficiently pure to account for its salubrity.

ARTIFICIAL PRODUCTION OF TARTARIC ACID.

M. Pelouze recently informed the French Academy that he had, in connection with Baron Liebig, by the action of nitric acid on gums, etc., and the sugars analogous to the sugar of milk, etc., succeeded in converting these substances into tartaric acid, quite identical with the tartaric acid of nature. This transformation cannot be doubted, for it has been confirmed by a multitude of chemical and optical experiments; and with the aid of the artificial acid, Liebig has prepared tartrates of soda and potash, and even tartar emetic. The announcement of this great discovery was received with great enthusiasm. It has long been sought for by chemists, who have, however, generally experimented on grape and cane sugar, instead of sugar of milk, gums, etc.

RELATION BETWEEN FERMENTATION AND CRYSTALLIZATION.

In 1854 Mr. Schroeder, in connection with Mr. Dusch, published a paper on fermentation and putrefaction, and showed that putrescent and fermentable substances could be indefinitely preserved, if, instead of leaving such matter in common air, they were placed in vases filled with air that had been filtered through cotton. Flesh, soup, and all kinds of alimentary substances can thus be preserved, if the precaution has been taken previously to boil them in water.

Mr. Schroeder shows that what he has established concerning fermentation and putrefaction, is also true of crystallization. It is well known that a saturated solution of sulphate of soda remains liquid as long as it is in vacuo, but solidifies on access of air. Mr. Schroeder establishes the fact that crystallization does not take place if the air is made to pass through a tube filled with cotton.

Mr. S. explained the results of his experiments in 1854, by supposing that the air filtered through cotton is deprived of the spores of cryptogamic infusoria, which are the cause of putresence and fermentation. If the experiment on the sulphate of soda tends to establish a relation between fermentation and crystallization, it serves to prove also that these phenomena can take place without the presence of these cryptogamia or infusorial germs, suspended in unfiltered air. This question, which appeared to us finished by the earlier researches of Mr. Schroeder, comes up anew. — *Cor. Silliman's Journal.*

ON THE COMPOSITION OF VEGETABLE CELLS.

M. Fremy has been engaged in some researches on this subject, the results of which he has presented to the French Academy. The nature of the liquids which are found in the vegetable cell have been several times accurately determined, but our knowledge of the insoluble portion, or cell walls, is very imperfect. We know that solid matter is deposited on the interior of the cellular membrane, and increases its thickness; several reägents show that the chemical composition of these layers is often ternary and often nitrogenous, but the insolubility of these bodies in neutral liquids renders their separation at the present time impossible, and prevents their composition being properly established. The examination of the vegetable cellular membranes possesses, however, very great interest both to the chemist and the vegetable physiologist. We see, in fact, these membranes undergo, during vegetation, some remarkable modifications; in certain cases their thickness increases rapidly, while in other cases it diminishes in as notable a manner. The latter phenomena is presented during the ripening of almost all fruits. The cell walls of green fruit are at first very thick, and formed of several concentric membranes; at the period of maturation, however, these walls become rapidly thin, as indicated by the changes which take place in the hardness and transparency of the fruit. It can also be rigorously determined by analysis. The following are the results of the examination of the solid pericarp of two species of pears, taken at different periods of their development and maturation:

	Percentage of membraneous tissue.	
	Winter pear.	Summer pear.
June 16	17·7	13·4
" 24	17·4	13·4
July 1	14·8	11·0
" 9	14·0	11·0
" 17	12·5	11·0
" 26	9·2	6·7
August 4	5·8	6·0
" 12	4·8	5·1
" 20	3·8	5·4
" 28	3·4	3·5

Similar analyses to the preceding were made upon fruits, such as apples, which ripen after they are detached from the tree, and which do not alter in size during maturation. From these experiments it results that the cell walls in these fruits undergo a notable diminution of weight during the period of maturation; it therefore became interesting to know what were the membranes in the cell walls which were thus absorbed at a certain period of the growth. M. Fremy, several years back, showed that vegetable tissue contains an insoluble substance, which he named *pectose*, constantly accompanying the cellulose, and that under very slight influences this body becomes soluble, and is converted into *pectine*. This modification explained the origin of a gummy substance which appears in the juice of fruit which has ripened or has been decocted; and it appeared probable that the interior membranes of the cell, which become altered, are composed of pectose, whilst the exterior membrane is formed of cellulose, which is a very stable body. The solvent for cellulose, cuprate of ammonia, discovered by M. Schweitzer, and successfully employed by M. Peligot in determining the composition of the skin of silkworms, afforded the means for ascertaining the chemical nature of the walls of vegetable cells. The ammoniacal solution of copper may be prepared by the direct action of solution of ammonia and atmospheric air on metallic copper, or by dissolving hydrated oxide of copper in caustic ammonia. The solution prepared in either of the above ways is a perfect and immediate solvent for cellulose. To determine with this reägent the composition of the vegetable cells, thin slices of fruits or roots are cut up and left to digest for some hours in the solution. The cells assume a green color, swell out, and appear to disaggregate. After the action of the reägent, the tissue, examined under the microscope, had preserved its original form, but the outline of the cells was less distinct. In these experiments care was taken to employ tissues which contained no trace of starch, in order to avoid any secondary reäction. On examining the amoniaco-cupric solution which had reäcted on the cells, it was found to contain the traces of nitrogenous bodies, and all the cellulose which formed the primary membrane of the cells and fibrous tissue. The proportion of cellulose which has been dissolved may be readily determined by saturating the liquor with a weak acid, and washing the precipitate with a dilute solution of potash. The green insoluble matter, which has preserved exactly the form of the original cells, consists of the pectic substance modified by the action of the reägent. Analysis proves that it is formed of pectate of copper; it is decolorized by the action of acids, and leaves a residue of pectic acid which may be entirely dissolved by the alkalies, only imponderable traces of mineral matter remaining in the liquid. Thus, then, the new reägent dissolves the cellulose and the nitrogenous bodies, and it transforms the pectose into pectate of copper, without, however, at all affecting the shape or form which it had in the cell; the acids decompose the pectate of copper, leaving the pectic acid insoluble. Potash dissolves the pectic acid, precipitating the traces of lime salts. These facts leave no doubt of the important part which the pectic compounds play in vegetable organization. In certain cells these bodies are more abundant than the cellulose itself; they incrust the cells, and augment the thickness of their walls.

This new reägent does not attack all cellular membranes. Thus, the pith of certain trees, and the spongy tissues of champignons, resist its action. It may therefore be inferred, seeing that this body instantly dissolves the cellulose of roots and fruits, but exerts no action upon the cells which form the pith of trees, that several species of cellulose may exist, differing in their chemical properties.

In the course of his experiments, M. Fremy obtained from the cells of fruits a new and interesting body, which he terms *cellulic acid.* It is readily obtained by submitting the pulp of fruits or roots, from which all soluble matter has been removed by washing, to the action of lime. Cellulate of lime is produced, which remains dissolved in the water, and is precipitated by alcohol. This salt, decomposed by oxalic acid, gives the pure cellulic acid. This body is soluble in water. Its acidity is comparable to that of malic acid. It forms soluble compounds with all the bases, and reduces with great facility the salts of gold and silver. This acid is not derived from cellulose or from pectine, because these bodies, properly purified, do not yield it. M. Fremy is still engaged in the investigation of this body. It appears, however, to be of some importance, in a practical point of view. In one process, for preparing sugar from beetroot, the pulp is submitted to the action of lime before being pressed. The vegetable membrane is thus modified, it loses its elasticity, and is more easily expressed, the pectic compound being changed into pectate of lime. A juice is then obtained, which is very easily worked, but it retains an alkaline reäction, which carbonic acid does not remove, and retains in solution a notable proportion of lime salt, which prevents the crystallizing of the sugar, and gives it a disagreeable odor. This body proves to be cellulate of lime. From the foregoing experiments, M. Fremy concludes that the cell walls of fruits or roots are formed of different membranes, which microscopic observation cannot distinguish, the external membranes being formed essentially of cellulose, and the internal of pectic substances. This latter substance is associated in the cell to a new principle, which, under several influences, produces an energetic acid, which he terms cellulic acid.

CONSTITUTION OF FRUITS.

Fresenius (in Liebig's *Annalen*) gives the following table of the proportion of malic *acid* (I.), *sugar* (II.), and *pectin or gum* (III.) contained in the common domestic fruits:

	I.	II.	III.
Peaches,	67	1·57	3·78
Apricots,	1·09	1·80	5·82
Plums,	1·30	2·12	2·41
Reine Claudes,	91	3·12	1·30
Raspberries,	1·48	4·00	0·65
Blackberries,	1·19	4·44	1·01
Strawberries,	1·31	5·73	0·06
Whortleberries,	1·34	5·78	1·05
Currants,	2·04	6·10	0 03
Prunes,	89	6·26	4.88
Gooseberries,	1·45	7·15	0·05
Pears,	0·07	7·45	6·34
Apples,	0·75	8 37	7·47
Sour Cherries,	1·28	8·77	1·12
Sweet Cherries,	0·62	10·79	4·45
Mulberries,	1·86	7·19	0 59
Grapes,	0·74	14·93	2·74

CELLULOSE AND LIGNEOUS FIBRE.

In the French Academy, during the past year, an interesting discussion has been going on, concerning the probability of only one, or of several, kinds of cellulose, and which we find reported in M. Nickle's correspondence with *Silliman's Journal*, No. 82. Payen was an advocate of the first opinion, Fremy of the second. Judging from the action produced upon ligneous tissues by Schweitzer's reägent (ammoniacal oxide of copper), Fremy admits, at least, two species of cellulose; for he has seen paper, and textile fibres in general, dissolve in ammoniacal oxide of copper, while elder pith, and ligneous fibres in general, resist its action.

To Mr. Payen this difference seemed only an apparent one; he believed that in this latter case the cellulose is incrusted with gum and foreign matters, which hinder the solubility; also the pith of the elder, which is insoluble in Schweitzer's reägent, becomes soluble in it when it has been previously treated with a weak acid, such as dilute chlorohydric acid. Mr. Fremy supposed that the chlorohydric acid does not act as a solvent of foreign matters, but that it converts one variety of cellulose into the other variety, in the same way, for instance, as an acid converts cane sugar into glucose.

We need not speak of the different phases of this discussion, for it is not yet settled. According to Fremy, we must admit at least two kinds of cellulose, offering the same percentage composition, but differing from each other in their chemical properties, and capable of being brought into the same state by the most diverse reägents, such as mineral acids, organic acids, potassa, ammonia, etc. In order to prove that the differences in the properties of cellulose are due to the state of the organic substance itself, and not to the presence of mineral substances, Fremy has had recourse to the action of heat. In exposing vegetable pith, which is insoluble in the cupreous reägent, to the action of a temperature not exceeding 30°, and maintaining it at that point for several hours, he has seen that substance become soluble in the above reägent. He arrived at an analogous result by keeping the cellular tissue of pith for twenty-four hours in boiling water.

Furthermore, he has remarked that this change takes place only in the organic substance of the tissue; for the proportion of mineral matter remained the same in both cases, and the tissue which had become soluble in the cupreous reägent left, after its calcination, a mineral network, reproducing exactly the form of the vegetable cellules, which same thing happens to tissues not modified by either dry or humid heat.

In order to distinguish between these two kinds of cellulose, Fremy calls para-cellulose that which does not dissolve immediately in the cupreous reagent. He reserves the name cellulose for that which dissolves directly without previous treatment. Cellulose is found in cotton, fibres of bark, cellular tissue of fruits or of roots. Para-cellulose constitutes principally the pith of trees, ligneous fibre, the cellular tissue of the epidermis, etc.

This is not Payen's opinion. The experiment of Fremy, quoted above, does not appear to him to prove that the pith of the elder is of an isomeric composition with the cellulose of textile fibres; for, in Payen's view, it is not only the fact that foreign substances, in the form of incrustations, oppose the solution of the cellulose in Schweitzer's reägents, but infinitely minute bubbles of air, which are condensed there, have the same effect, to a certain point, in forming a protective envelope. According to him, the pith of the Æschynomene, insoluble in Schweitzer's reägent, becomes soluble in it by keeping it in a vacuum in the cold under an exhausted receiver, and afterwards plunging it under water; the liquid is then placed in a refrigerating mixture. After congealing, the pith has become to a great extent soluble; there remains a residue of forty-three per cent., containing fifteen per cent. of mineral substances. These mineral substances, according to Payen, prevent the complete solution of the cellulose. The same is the case with cortical fibres before their purification; so, also, hemp just obtained from the flax-plant, resisted solution for more than six hours, and the portions not dissolved preserved their fibrous form.

Incrusting Matter — Dead Cotton. — All these questions have recalled attention to an old paper by Mitscherlich, on the composition of vegetable cellules, cellules essentially formed of cellulose, and of a substance analogous to cork, a suberic material, capable of yielding suberic acid, and also succinic and nitric acids. The most delicate vegetable fibres are covered over with this slender coating of suberic matter; it is on this account that fresh cotton is with difficulty moistened with water, while it is at once decomposed if this coating of suberic matter is removed by the action of chlorine.

Such at least is the opinion of Mitscherlich. It seems, however, that an immersion in chlorine is not always sufficient to render this variety of cotton capable of receiving color, — the variety perfectly well known among dyers, who have named it "dead cotton." It was first described by Daniel Koechlin, of Mulhouse, and has since been carefully studied by Walter Crum, of Glasgow, whose results are published in the third volume of the *Proceedings of the Philosophical Society of Glasgow.*

In the opinion of Mr. Walter Crum, the dyeing of cotton depends upon a purely mechanical action. Chemistry is completely foreign to the subject of fixing dyes upon stuffs. Dead cotton is the proof of this; the fibres of this variety of cotton are flattened, while cotton which admits of being dyed is composed of cylindrical fibres; the coloring matter, hence, can penetrate within these, and fix itself there.

This is, as is seen, an opinion diametrically opposite to that of Runge, who is so strong an advocate of the chemical theory that he considers colored cottons as cottonates. In this view, a faint chamois tint, produced by oxide of iron, is called by him per-cottonate of iron; another, bi-cottonate; another still, basic cottonate of iron.

Mr. Walter Crum declares that the substance of dead cotton has been entirely bleached before becoming flattened; it contains, therefore, he says, neither fatty matter, nor any impurity capable of hindering the fixing of the coloring matter.

But let us return to the suberic matter, whose presence Mitscherlich recognized on leaves and about the exterior of plants. It is over thirty years since Payen showed that the epidermis of plants is covered over with a very thin envelope, containing a fatty matter, some nitrogen and silica. Ad. Brongniart has isolated this pellicle, on which Mitscherlich experimented, by submitting leaves to a prolonged maceration, and has described it under the name of cuticle; and Fremy, who has also just examined it, has recognized in it all the characteristics of a fatty substance which he calls cutine. In fact, in contact with boiling potassa, the cutine saponifies, and the acid which is produced presents, the characters of a fatty acid. This experiment has been repeated with success on the epidermic membranes of leaves, flowers, and fruits.

It is easy to develop, *ad libitum*, this epidermic membrane. It is sufficient, in fact, to experiment on superficial sections of living tissues of leaves, branches, tuberaceous roots, and subterranean stems; at the end of several days the denuded tissues afford characteristic reäctions of epidermic membranes.

Transformation of Woody Fibre into Sugar. — On the occasion of the above discussion, Pelouze announced the important results which follow. Cellulose, precipitated from its solution in the ammoniacal oxide of copper by a feeble acid, is soluble in dilute chlorohydric acid. Ordinary cellulose is soluble in concentrated chlorohydric acid; water forms with this solution a precipitate of dazzling whiteness; at the end of two days the precipitate ceases to form, and all the cellulose has been transformed into sugar affording the characteristics of glucose. The transformation of cellulose into glucose can be effected by a prolonged ebullition in water containing a small quantity of sulphuric or chlorohydric acid (some hundredths); paper, old linen, sawdust, and any cellulose, more or less pure, can be thus turned into sugar at the end of several hours' boiling. Pelouze thinks that this reäction will become the basis of a new branch of industry — one which has often been attempted since Braconnot succeeded, in 1819, in transferring lignine into glucose; he thinks that the transformation would be rendered much more active by operating in a close vessel at an elevated temperature. Lastly, Pelouze announces that, by treating the cellulose with caustic potassa in fusion at a temperature between 150° and 190° C., and dissolving the product in water, a substance can be separated from it by acids which has the composition of cellulose, but differs from it in that it is soluble in the cold in alkalies; it changes into sugar in the presence of chlorohydric acid.

ON THE PROPERTY OF AMMONIACAL OXIDE OF COPPER DISSOLVING CELLULOSE.

This property was made known some years since, by Schweitzer. Not only cellulose, but also silk, is soluble in this reägent. The ammoniacal sulphate of copper acts as a solvent only from the excess of oxide of copper present. Mr. Schlossberger finds that the solvent power increases with the proportion of copper, and that the hydrate of copper dissolved in ammonia acts better than the sulphate. The cupro-ammoniacal liquid does not dissolve gum, dextrine, starch, while it does dissolve filtering paper. The salts, and especially the alkaline salts, precipitate this solution of cellulose, and sulphate of copper has the same effect. The precipitate shows no trace of organization or crystallization; and it does not appear to differ in percentage composition from that of cellulose. These same alkaline salts do not precipitate the solution of silk, and the fact may be made the basis of a process for separating silk from cotton. The solution of cellulose is precipitated also by alcohol, a concentrated solution of honey, gum Arabic, or dextrine. The cupro-ammoniacal liquid has no action on pyroxilline or collodion. Inuline, chitine, conchyoline, are insoluble in it. Mr. Schlossberger has found that the ammoniacal hydrate of nickel, $NiO\ H^3N$, acts like the salt of copper. The solution of silk is, however, a fine blue in the latter, and a yellowish brown in the former. — *Correspondence of Silliman's Journal.*

The ammoniacal solution of oxide of copper and ligneous fibre, cotton, etc., is now coming into use as a substitute for collodion in photography. Most of the basic salts of copper, and its hydrated oxide, give blue solutions with ammonia, all possessing the remarkable property of dissolving the cellular tissue, the basic carbonate of copper in a higher degree than the rest. To prepare it, a solution of blue vitriol is precipitated with carbonate of soda, the precipitate transferred to a filter, on which it is washed and then dried in the water-bath, coarsely powdered and shaken in a well-stoppered flask, with aq. ammonia of spec. gravity $= 0{\cdot}945$, which is found to be the best strength for this purpose, the resulting solution being a better solvent than that of any other salt of copper. The portion of this liquid which acts as the dissolving medium for the ligneous membrane is undoubtedly the ammoniated oxide of copper, not the uncombined alkali or acid. This is proved by the very process used by the discoverer of this interesting phenomenon, Peligot, who employed the spirits of ammonia, agitated and digested with copper turnings. A small proportion of sal ammoniac hastens the solution of the metallic copper, which latter may be advantageously replaced by precipitated copper. According to Peligot, these ammoniacal solutions take up a quantity of cellulose equal to that of the copper held in solution. — SCHWEIZER, *Schweizer Zeitschr. fur Pharmacie.*

ON THE AMMONIACAL SOLUTION OF PROTOXIDE OF NICKEL, AS A MEANS OF DISTINGUISHING SILK AND COTTON. — BY PROF. SCHLOSSBERGER.

The violet-blue solution of freshly precipitated hydrate of protoxide of nickel, exerts an extremely remarkable action upon silk. If silk threads be brought in contact with a drop of this solution under the microscope, peculiar vermicular movements are observed in it, and at the same time they swell up considerably, and acquire a yellow color. Soon afterwards the outlines become pale, in part (with raw silk) accompanied by considerable inflations or ruptures of the external envelops of the fibres, and finally complete solution take place. If silk be thoroughly kneaded up in a test-glass by means of a glass rod with the blue solution of nickel, it soon becomes of a brownish-yellow color, resembling that of hydrated oxide of iron; it then becomes slippery and gelatinous, and at last furnishes a brownish-yellow solution.

If the silk fibres be washed with water in the first stage of their alteration by the author's new reägent, all further action ceases; in later stages of change, they are also fixed by washing. The same thing is effected by a drop of weak acid, by the addition of which the fibre also loses somewhat in volume, and becomes colorless.

Solutions of alkaline salts do not precipitate the solution of silk, nor do solutions of sugar and gum. It is remarkable that a solution of $Cl\ NH_4$ restores the original violet-blue color to a brownish-yellow solution of silk in $NiO\ NH_3$, without separating anything. The solution of silk and nickel is abundantly precipitated by acids, and this precipitate (in colorless flakes of the aspect of hydrate of alumina) is permanent, when the acids are not too strong. The fluid exhibits a greenish color.

Cellulose (cotton) is not at all altered, even by immersion for sevral days in the solution of $NiO\ NH_3$; after lying in it for three days, the fibres of cotton still presented their original form under the microscope, and there was no trace either of swelling or coloration. Potato-starch also did not swell up in it; inuline was gradually dissolved.

No analogous action has yet been produced upon silk by means of solutions of CoO, ZnO, and Al_2O_3 in NH_3. In the coloration, swelling, and solution of silk by NiO, it is essentially a matter of indifference whether the silk employed be raw silk, or silk deprived of its dressing by boiling. — *Chemical Gazette*, No. 383, p. 372.

REPORT ON VEGETABLE PARCHMENT.

The following report on the so-called "vegetable parchment,"* has been published by Prof. Hoffmann, of the Government School of Mines, London. Vegetable parchment, in appearance, greatly resembles animal parchment; the same peculiar tint, the same degree of translucency, the same transition from the fibrous to the hornlike condition. Vegetable, like animal parchment, possesses a high degree of cohesion, bearing frequently repeated bending and rebending, without showing any tendency to break in the folds; like the latter, it is highly hygroscopic, acquiring by the absorption of moisture increased flexibility and toughness. Immersed in water, vegetable parchment exhibits all the characters of animal membrane, becoming soft and slippery by the action of water, without, however, losing in any way its strength. Water does not percolate through vegetable parchment, although it slowly traverses this substance like animal membrane by endosmotic action.

In converting unsized paper into vegetable parchment or parchment paper by the process recommended by Mr. Gaine, viz., immersion for a few seconds into oil of vitriol, diluted with half its volume of water, I was struck by the observation, how narrow are the limits of dilution, between which the experiment is attended with success. By using an acid containing a trifle more of water than the proportion indicated, the resulting parchment is exceedingly imperfect; whilst too concentrated an acid either dissolves or chars the paper. Time, also, and temperature are very important elements in the successful execution of the process. If the acid bath be only slightly warmer

* See *Annual of Scientific Discovery*, 1858, pp. 324—326.

than the common temperature, 60° F. (15·5° C.) — such as may happen when the mixture of acid and water has not been allowed sufficiently to cool — the effect is very considerably modified. Nor do the relations usually observed between time, temperature, and concentration, appear to obtain with reference to this process; for an acid of inferior strength, when heated above the common temperature, or allowed to act for a longer time, entirely fails to produce the desired result. Altogether the transformation of ordinary paper into vegetable parchment is an operation of considerable delicacy, requiring a great deal of practice; in fact, it was not until repeated failures had pointed out to me the several conditions involved in this reäction, that I succeeded in producing the substance in question.

Mr. Barlow, in the discourse on woody fibre, records some experiments establishing that unsized paper, by its conversion into vegetable parchment, receives no appreciable increase of weight. These experiments rendered it very probable that the action of sulphuric acid in this case is essentially molecular, and that the chemical composition of the substance of the paper, by its conversion into parchment, is not altered. It remained to establish this point experimentally. For this purpose several of the specimens of commercial vegetable parchment, without any further purification, were submitted to analysis. The result showed that — with the exception of about 0·9 per cent. of mineral matter, a quantity, not much exceeding the amount which is present in the better varieties of ordinary paper — the substance of vegetable parchment is identical in composition with cellulose or woody fibre. The analytical experiment demonstrates — as might have been expected — that the extraordinary change which the properties of paper undergo during its transformation, depends solely and exclusively upon a molecular reärrangement of the constituents, and not upon any alteration in the composition of the paper. In this respect the action which sulphuric acid exerts upon woody fibre may be compared to the transformation of woody fibre, under the protracted influence of the same agent, into dextrin, a substance altogether different from fibre, but still identical with it in composition. Vegetable parchment may, in fact, be looked upon as the connecting link between cellulose on the one hand, and dextrin on the other.

Thus it is obvious that the transformation, under the influence of sulphuric acid, of paper into vegetable parchment, is altogether different from the changes which vegetable fibre suffers by the action of nitric acid; the cellulose receiving, during its transition into pyroxylin and gun-cotton, the elements of hyponitric acid in exchange for hydrogen, whereby its weight is raised, in some cases by forty, in others by as much as sixty per cent. As the nitro-compounds thus produced differ so essentially in composition from the original cellulose, we are not surprised to find them also endowed with properties altogether different, such as increased combustibility, change of electrical condition, altered deportment with solvents, etc.; whilst vegetable parchment, being the result of a molecular transposition only, in which the paper has lost nothing and gained nothing, retains all the leading characters of vegetable fibre, exhibiting only certain modifications which confer additional value upon the original substance.

The nature of the reäction which gives rise to the formation of vegetable parchment having been satisfactorily established, it became a matter of importance to ascertain whether the processes used for the mechanical removal of sulphuric acid from the paper had been sufficient to produce the desired effect. It is obvious that the valuable properties acquired by paper, by its conversion into vegetable parchment, can be permanently secured only by the entire absence or perfect neutralization of the agent which produced them. The presence of even traces of free sulphuric acid in the paper would rapidly loosen its texture, the paper would gradually fall to pieces, and one of the most important applications which suggest themselves, viz., the use of vegetable parchment in the place of animal parchment for legal documents, would thus at once be lost.

Examination of the vegetable parchment for the free sulphuric acid, was therefore one of the principal points to which I had to direct my attention. From the description of the process adopted in preparing the new material, viz., long-continued mechanical washing with cold water, immersion in a dilute solution of caustic ammonia, and, lastly, renewed washing with water, the absence in it of free sulphuric acid may be at once inferred on scientific grounds. For, supposing that the first process of washing had left any free sulphuric acid in the paper, this acid, after immersion of the paper in caustic ammonia, for which it has so strong an attraction, could have remained only in the form of sulphate of ammonia, a salt of perfectly neutral composition, in which the acid character of sulphuric acid is entirely lost. Now, sulphate of ammonia is a most stable compound, which begins to decompose only at about 536° F. (280° C.), a temperature at which paper is completely destroyed; and even then, no free sulphuric acid is to be found amongst the products of decomposition. But the paper is washed again after treatment with ammonia, and, obviously, only traces of sulphate of ammonia can remain in it.

The absence of free sulphuric acid in the parchment paper was, moreover, established by direct experiment. The most delicate test-papers, left for hours in contact with moistened vegetable parchment, did not exhibit the slightest change of color. There is reason, therefore, to believe that vegetable parchment, prepared as it is by one of the most powerful agents of decomposition, carries within itself the germ of its own destruction.

The absence of free sulphuric acid in vegetable parchment having been satisfactorily established, it remained only to perform a few experiments on the strengh of this material as compared with that of the animal parchment, with which it is likely to enter into competition. The result of these led to the result that paper, by exposure to the action of sulphuric acid in the manner described, acquires about five times the strength which it previously possessed, and that for equal weights, vegetable parchment possesses about three-fourths the strength of animal parchment. It was found, moreover, that bands of vegetable parchment taken from different sheets of the same kind of paper, exhibited a remarkable uniformity of strength, whilst in animal parchment — which, owing to its mode of manufacture, must always present considerable inequality of thickness — extraordinary variations were observed, even if the bands were taken from the same skin.

Vegetable parchment, then, as far as strength goes, is not quite equal to animal parchment. On the other hand, the new article greatly surpasses real parchment in its resistance to the action of chemical agents, and especially of water. As has been already stated, vegetable, like animal parchment, absorbs water, and becomes perfectly soft and pliable; but it may remain in contact, and even may be boiled with water for days, without being affected in the slightest degree, retaining its strength, and regaining its original appearance on drying; on the other hand, it is well known how rapidly animal parchment is altered by boiling water, by the protracted action of which it is converted into gelatine. Even at the common temperature, animal parchment, in the presence of moisture, is very prone to putrefactive decomposition; whilst parchment paper, in which nitrogen, this powerful disturber of chemical balance, is absent, may be exposed to moisture without the slightest change either in appearance or properties. It would, in fact, be difficult to find a paper-like material endowed with greater power of resistance to the disintegrating influences of water than vegetable parchment.

Taking into consideration the chemical composition of the new material, its cohesive power, and its deportment with chemical solvents, especially water, both at the common temperature, and at the temperature of its boiling-point, it is obvious that this substance unites in itself, in a most remarkable manner, the conditions of permanence and durability; and I have no hesitation in stating my belief that vegetable parchment, properly prepared, is capable of resisting the tooth of time for many centuries, and that under various circumstances it will even last longer than animal parchment.

The valuable properties of vegetable parchment suggest a great variety of applications for the new material.

There is no doubt that parchment paper may be adopted, with perfect security, for all legal documents, policies of insurance, foreign bills of exchange, bills of lading, scrip certificates, and other similar documents, as a substitute for the skins which are now generally used. On the other hand, its comparatively low price would appear to suggest its application in a variety of cases, in which, at present, paper is employed: for instance, for private ledgers of banking-houses, or other large establishments, as well as for registries of wills, marriages, baptisms, and deaths. Even for the manufacture of bank-notes it may be found useful; indeed, for all documents, the preservation of which is of importance. Many of the documents in question, in order to protect them from injury in case of fire, are generally kept in safes, the majority of which are now encased with solid water — the water of crystallization in alum, and other similar hydrated compounds. The interior of these safes, in case of exposure to heat, must, obviously, become filled with steam of a high temperature, and it cannot be doubted that documents written on vegetable parchment, owing to the extraordinary power with which this material resists the action of boiling water and of steam, will stand a much better chance of preservation under such circumstances, than those written on common paper or animal parchment.

As another advantage of vegetable parchment as compared with animal parchment, the experience may be quoted, that vegetable textures are much less attractive to insects than animal structures. Moreover, to increase the security of vegetable parchment in this respect, the paper, before conversion, may be incorporated with chemical agents, which, like salt of mercury, for instance, have been employed with such advantage in the manufacture of paper for public records.

In considering the applicability of vegetable parchment for legal documents, another property of this remarkable material, although perhaps of minor importance, deserves nevertheless to be noticed. This is the great difficulty with which words are erased from its surface, and others are substituted in their places. Deeds written on parchment paper acquire thereby a certain degree of security against falsification.

Its strength and resistance to water appear to recommend parchment paper in an eminent degree for engineers' and architects' plans, and especially for their working plans, which are often unavoidably subjected to rough usage and moisture. The thinner sheets of parchment paper, on account of their transparency, present the additional advantage of being useful as a most durable tracing paper.

In consequence of its strength and resistance to water, vegetable parchment would probably find many applications for military purposes; thus it promises to furnish an excellent material for water-proof cartridges.

Another field of considerable extent for the application of vegetable parchment appears to be in book-binding, and especially in ornamental book-binding. The books bound in parchment paper which accompanied your letter, are remarkable for the beauty and solidity of their binding. Experienced book-binders, to whom I submitted these books, believed them to be bound in real parchment. Even in the manufacture of books and maps which, like those used for educational purposes, like military plans and nautical charts, have to stand considerable wear and tear, parchment paper may find a very useful application. The printing on ordinary paper is not changed by the treatment with sulphuric acid, but owing to the shrinking of the paper during the process, it will, probably, be found more convenient for such purposes to print on the paper after it has undergone the transformation. Vegetable parchment is remarkable for the facility with which printer's ink, as well as writing ink, may be applied to it, and for its attraction for dyes generally, many of which it appears to take even more readily than calico. The specimens of dyed parchment paper which accompanied your letter, leave nothing that could be desired in this respect.

Among the numerous more or less important applications in which parchment paper is sure to be found useful as soon as it becomes accessible to the general public, its adaptation for household, and especially for culinary purposes, must not be left unmentioned.

In closing the orifices of vessels for preserves, etc., few housewives will hesitate to substitute an elegant material like vegetable parchment paper for the animal membrane, so frequently offensive, which is now generally in use.

Formed into bags, of which the seams are cemented with the white of eggs, parchment paper will be found very useful for the purposes of boiling and stewing, according to the principles of a refined and scientific *cuisine.*

Nor can the chemist fail to derive some benefit from so interesting an achievement of his own science as the transformation of paper into parchment.

In the laboratory, vegetable parchment will become a material of general use for connecting retorts and condensers, or other similar apparatus, and on account of its indestructibility by many of the fluids usually employed in electric batteries, it will probably find a further and even more important application in the construction of diaphragms for galvanic apparatus.

ESTIMATION OF ACETIC ACID IN VINEGAR.

Mr. Nicholson and Dr. Price have stated that the estimation of acetic acid, by means of carbonate of soda or caustic alkalies, gives results that are not accurate, because the acetate of soda has an alkaline reäction. Prof. Otto has recently made some experiments, with the view of ascertaining whether the error thus caused is constant, or whether it is sufficiently small to be disregarded; and has obtained results very different from the above-named chemists. The following numbers represent the percentage of acetic acid in vinegar, as estimated by different methods:

Acetometer.	Carbonate of soda.	Carbonate of baryta.
6·3	6·5	6·2
9·1	9·2	9·0

For testing with carbonate of soda, a solution was prepared, containing 10·1 grm. in a litre. Five cub. cent. of this solution indicated in 50 grm. of vinegar one per cent. of anhydrous acetic acid. The point of saturation was determined by means of pale-blue litmus paper.

For tasting with carbonate of baryta, a weighed quantity was digested with a weighed quantity of vinegar, with the aid of heat, until the liquid acquired an alkaline reäction. The undissolved carbonate of baryta was collected upon a filter, washed, dried, ignited, and weighed.

In order to remove the objection that the digestion with carbonate of baryta had not been continued long enough, the following experiment was made: A solution was prepared, containing in 100 grm. 27 grm. of crystallized acetate of soda. This solution contained 10 grm. or 10 per cent. of acetic acid. It had an alkaline reäction upon red litmus paper. When mixed with 2 cub. cent of vinegar, containing 4·5 per cent. acetic acid, it became perfectly natural, and another cubic centimeter of vinegar was sufficient to make it have a decided acid reäction upon blue litmus paper. The quantity of acetic acid in 2 cub. cent. of vinegar, containing 4·5 per cent. of acetic acid, is not quite 0·1 grm.; so that the error incurred by estimating the amount of acid in vinegar, containing 10 per cent. acetic acid, by means of carbonate of soda, would be only $\frac{1}{10}$ per cent. at the utmost, and is certainly much less, because in practice there is always a little excess of soda added.

A hot solution, containing 50 per cent. of acetate of soda, corresponding to 18·7 per cent. acetic acid, was rendered neutral by 2 cub. cent. of vinegar, containing 9 per cent. of acetic acid, and distinctly acid by 1 cub. cent. more vinegar.

Prof. Otto infers from these results that the estimation of the amount of acid in vinegar, by means of carbonated or caustic alkalies, may be adopted without the risk of any sensible error, inasmuch as the alkaline reäction of the alkaline acetates do not affect the results to such an extent as need be regarded in practice.

He also remarks, that a comparison of the relation between the density of ammonia solution and the amount of ammonia contained in it, as estimated by him some years since, with the results obtained recently by Carius in a very different manner, shows a very close correspondence.

NEW PROCESS OF PRESERVING MILK PERFECTLY PURE IN THE NATURAL STATE, WITHOUT ANY CHEMICAL AGENT.

At the Aberdeen meeting of the British Association, the Abbe Moigno stated, "that to preserve milk for an indefinite period, is an important problem, which in France has been solved in three different modes. M. de Villeneuve was the first to preserve milk, solidifying it by the addition of certain solid ingredients, but it was no longer, properly speaking, milk. M. de Signac preserved it by evaporating the milk till it became of the consistence of sirup, rendering it a solid mixture of milk and sugar; still it could not be called milk. M. Maben also preserved it by excluding the air, and exposing it to an atmosphere of steam about 100° Cent.—thus depriving it of all the gases which it contained, and then hermetically sealing the filled bottles in which it had been heated. When about to leave for Aberdeen, I opened a bottle which had been closed by M. Maben, in February 1851; and after the lapse of five and a half years, I found it as fresh as it was the first day. Since then, M. de Pierre has greatly improved the discovery. The means which he employs to effect the preservation is still heat; but heat applied in some peculiar way, by manual dexterity, first discovered by a Swiss shepherd. All that I am allowed to state is, that the effect of this new mode of applying heat is, to remove a sort of diaspore, or animal ferment, which exists in milk in very small quantity, and which is the real cause of its speedy decomposition. When this species of ferment is removed, milk can be preserved for an indefinite time in vessels not quite full, and consequently exposed to the contact of rarefied air, a result which was not effected by the process of M. Maben, as he completely expelled those gases which otherwise would have rendered it sour." M. Moigno then exhibited a five-gallon vessel containing milk, put up by M. Pierre's process, which he had brought from France to Aberdeen, and which was afterwards opened and passed round. It was found to be as natural, as pure, and as rich, as when first taken from the cow in Normandy.

ON THE USE OF SULPHATE OF BARYTES AS A PAINT.

M. Kuhlmann, who was the first to apply this substance to house-painting, has read a paper on the subject to the French Academy of Sciences. Sulphate of barytes is white, and is preferable both to white lead and to oxide of zinc, not only on account of its durability, but also because it produces no injurious effects upon the health of the workmen. To obtain it, M. Kuhlmann first deprives the natural carbonate of barytes, or witherite, of its carbonic acid, by putting it in contact with the vapors of hydrochloric acid issuing from the furnaces where sea-salt is decomposed for the purpose of obtaining soda; after which he transforms it into a sulphate by the addition of sulphuric acid. The sulphate is afterwards well washed, in order to deprive it of every trace of the acid. The excess of water is then expelled, either by pressure or swift rotation, and the paste which remains is put into barrels for sale. Sulphate of barytes might be reduced to the form of dry cakes like white lead, but it is preferable to keep it in the state of a paste, because, when once dry, it cannot be again reduced so easily to a fine powder, such as it was when first precipitated. It is used with great advantage in the manufacture of paper-hangings, and has been successfully applied to oil-painting, a coating of this paint being much more durable than any other known. In examining the rubbish remaining after the demolition of one of his furnaces for the transformation of chloride of barium, M. Kuhlmann observed a green and blue substance, strongly resembling ultramarine; and, in presenting a sample of it to the Academy, expressed his belief that it would not be impossible to obtain artificial ultramarine from barytes.

ACTION OF WATER ON GLASS.

Pelouze has made some experiments on the decomposition of glass by water. He finds, that while glass vessels in which water is boiled are but very slowly attacked, powdered glass is decomposed with remarkable ease. Thus, a pint flask, in which water was boiled for five days, lost scarcely a decigramme; but when the neck of this flask was powdered, and boiled for the same time with water, the decomposition extended to as much as one-third of the mass. Two specimens of glass, having the following composition:

Silica,	72·1	77·3
Soda,	12·4	16·3
Lime,	15·5	6·4
Alumina, Peroxide of iron,	traces.	traces.

were subjected to the same treatment.

The substance extracted from the first, amounted to 1.5 per cent.; that from the second, to 2 per cent.; and, judging from the quantity of lime dissolved, and the amount of this base in the glass, the decomposition amounted in the one instance to 10 per cent., and in the second to 33 per cent.; so that glass in which the amount of lime is large in proportion to that of soda, is less decomposed by water than glass in which the amount of lime is less than that of soda.

The experiments show that it is chiefly the basic constituents of glass that are extracted by water, and probably they might be entirely separated when the action was continued for a long time.

All ordinary kinds of glass undergo gradual decomposition, when exposed in fine powder to the atmosphere; they absorb carbonic acid, and after a time effervesce copiously.

When a mixture of powdered glass and water is exposed for some days to the air, it effervesces with acids, and the solution always contains sulphuric acid, originating from sulphate of soda, which Prof. Pelouze has found in most kinds of glass to the extent of from 0.001 or 1.002 to 2.0 per cent.

Powdered glass boiled with water, through which a current of carbonic acid is passed, yields a liquid that effervesces copiously with acids. When boiled with solution of sulphate of lime, a considerable amount of sulphate of soda is produced. This reäction accounts for the fact, that the walls and floor of the rooms in which plate-glass is polished, are covered with an efflorescence of sulphate of soda. The gypsum used for fixing the plates yields the sulphuric acid, and the glass yields the soda.

The extent to which powdered glass is decomposed by water is remarkable, when compared with the great durability of glass vessels under the same condition; and is probably owing to the greater extent of surface offered by the powdered glass to the decomposing influence of the water.

ON THE USE OF THE MAGNETIC CARBIDE OF IRON FOR THE PURIFICATION OF WATER.

The efficacy of oxygen gas in the destruction of every sort of impurity in water has long been known, but the means of readily availing ourselves of this property has been a great desideratum. Profs. Brande and Spencer, of England, recommend the use of the ferroso-ferric carbide of iron, or magnetic carbide of iron, as a peculiarly rapid and effective mechanical filter, which also possesses the additional valuable property of attracting oxygen to its surface in the form of ozone, which energetically manifests its presence by the exhibition of its wonderful chemical powers of purification. When water is passed through a filter made of this substance, it is deprived of all color, taste, and smell, and nearly all the deleterious gases it may contain (such as sulphuretted and phosphoretted hydrogen) are forced to combine with the oxygen, and are so rendered harmless, and the water so treated has little or no tendency to produce animal or vegetable organisms. These properties are so important that this filtering medium cannot fail to be speedily and extensively applied, with the best possible results.

ACTION OF WATER IN LEAD PIPES.

An essay has been published in the Edinburgh *New Philosophical Journal*, by Dr. Lauder Lindsay, in which he promulgates opinions totally opposed to those generally entertained by chemists regarding the action of water on lead pipes. It is generally taught and believed that pure soft water acts rapidly on lead, and converts it into an oxide when exposed to the atmosphere. On the other hand, it is as generally taught and believed that hard water, which contains neutral salts in solution, does not become impregnated with lead in passing through pipes — the pure water is held to be dangerous to use with lead pipes, while the impure water is considered safe. It is believed that the neutral salts in the water prevent it acting upon the lead, while the oxygen of the pure water has such an affinity for the metal that it leaves its hydrogen, and acts chemically upon it. Dr. Lindsay asserts that observation and experiment have led him to conclude that certain pure soft waters do not act upon lead; while certain hard waters, which are regarded as most protective, do act chemically upon it, and therefore it must be dangerous to use for conveying such water for domestic purposes. He has tried experiments on a large scale, and from these he has drawn his conclusions. He asserts that those before him who have made investigations on a small scale have been deceived as to the results, and that water containing a small portion of lead will affect some members of a family, or of a community, and not others, and that the *rationale* of this is not well understood. From what he says, the only safe course to pursue in the matter is not to use such pipes at all.

ON THE REMOVAL OF GYPSUM (SULPHATE OF LIME) FROM WATERS USED FOR GENERATING STEAM.

The following suggestions by Henry Wurtz, Esq., on the removal of gypsum from waters used in steam boilers, are found in *Silliman's Journal*, Vol. XXVI., No. 78:

When we call to mind that the crystallization of the gypsum from its hot solution is the principal, and usually the only cause of the formation of the destructive boiler-crusts; and that, leaving out of view the injury sustained by the boiler, the actual loss of heat through the non-conducting power of the crust, and other causes connected with it, has been shown to amount, in the case of locomotive boilers (in France), in many cases, to forty per cent. of the fuel consumed, — the subject may be considered worthy of further attention; and I shall, therefore, present some brief calculations bearing upon it.

In a saturated solution of gypsum, then (say, in round numbers, 1 part in 400), each 800 lbs. = 800 pints = 100 gallons, will contain 2 lbs., and each 1000 gallons 20 lbs. of sulphate of lime; which is equivalent to 24 lbs. of pure carbonate of baryta, or a little over 31 lbs. of pure carbonate of lead. But water used for steam purposes, sea-water for instance, is seldom or never a saturated solution of gypsum. Let us take von Bibra's analyses of the waters of the Atlantic Ocean (*Liebig & Kopp's Jahresb.* für 1850, 621), collected at four different times, at as many widely distant places. These give in 100 parts 0·205, 0·156, 0·16, and 0·19 parts, of sulphate of lime. For the sake of simplicity, take 0·2: then 1000 gallons = 8000 lbs. contain 16 lbs. of gypsum. The quantity of carbonate of baryta equivalent to this is 19·2 lbs., and of carbonate of lead 25 lbs. Thus one ton (2000 lbs.) of carbonate of baryta, which some years since sold in England (in the form of ground witherite) for $20, is theoretically sufficient to separate the gypsum from 100,000 gallons of the water of the Atlantic. On referring now to the evaporative power of different coals, as determined by Walter R. Johnson, for the United States Navy Department (*Taylor's Statistics of Coal*, introduction, p. lvii; *Knapp's Chem. Technology*, Am. Ed. i. 43), we there find that 1 lb., for instance, of Lackawanna anthracite (considered in New York superior for steam purposes) produces $8\frac{1}{2}$ lbs. of steam from cold water; so that to evaporate 100,000 gallons would require $\frac{8 \times 100{,}000}{8\frac{1}{2}} = 94{,}000$ lbs., or 47 tons. Forty per cent. of such a quantity is over 18 tons.

I do not, however, by any means recommend the application of this principle to ocean steamers, on account of practical difficulties, which I see no way to overcome. But on land the application is a matter of perfect simplicity. It is only necessary to have the tanks from which the boiler is supplied, larger, and to have more of them. While the process of mixture and agitation with the carbonate, and precipitation by standing, is going on in one tank, water may be used from another which has undergone the process. The idea seems to me to be especially adapted to locomotives, for which even sea-water may then be used.

IMPURITIES IN DRINKING-WATERS.

From a report by Edwin Lankester, F. R. S., on the drinking-waters of London, published in the *London Mechanics' Magazine*, July 1858, we obtain the following memoranda.

Phosphates and silica exist in all London well-waters, in small quantities, sulphate of lime, in the proportion of one to fifteen grains to the gallon. It decomposes, in contact with organic matters, and produces sulphuretted hydrogen. Very small quantities of organic matter serve to produce this effect.

Ammonia exists in Thames water in small quantities; in much larger and more appreciable quantities in the surface wells. This substance is the result of the decomposition of animal matter, and in the surface wells is undoubtedly derived from human excretions.

Nitrates were found in one well-water to the extent of fifty grains to the gallon.

The organic matters are not injurious when fresh or recent, but they assume certain conditions of decomposition which occasionally render them deadly. Their influence may be estimated by the case of the Lambeth and Vauxhall Water Company's supply, during the years 1848 and 1854, — two years in which cholera visited London. In 1848, both companies derived their supply of water from the Thames at Battersea, and both supplied the same district with water, and the houses supplied were equally visited with cholera.

But in 1854, the Lambeth Company obtained an improved supply high up the Thames, at Ditton. The consequence was, according to Dr. Snow's calculations, that the deaths amongst the population supplied by the Vauxhall

Company, as compared with the Lambeth, was as seven to one; according to the most favorable view of the case, as given by Mr. Swain, it was three and one-half to one. There is nothing to account for this difference but the larger quantity of organic impurity in the water supplied by the Vauxhall Company, which still obtains water from the more impure source. The outbreak of cholera in the Golden-square district, in September 1854, was traced to the pump in Broad Street, which was subsequently found to have communicated with the drain of a neighboring house.

Organic matters in standing water undergo a kind of fermentation, by which carbonic acid, sulphuretted hydrogen, and other gases, are got rid of, and nitric acid is formed The water thus undergoes a process of self-purification. This occurred in Thames water, and accounts for the fact that ships were often supplied with water from the Thames below London Bridge. This water is dangerous to drink before or during the fermenting process.

The appreciation of small quantities of organic matters by chemical processes is a difficult process. During the evaporation of water, the organic matters are dissipated, and not all left in the evaporating basin.

The microscope is an important aid. It detects the nature of organic impurities. These consist of dead and living animal and vegetable matters. The dead consist of the tissues of animals and plants. The source of these impurities can in some instances be made manifest. Such impurities are very manifest in the Thames and surface-well waters, scarcely to be detected in the deep-well waters. The living matters consist of plants and animals. The filaments of microscopic Fungi have been found in impure well-water. They have been detected in several waters known to be productive of disease. Amongst the living animals, the forms of Infusoria are most abundant. These are frequently indicative of the impure condition of water. Eggs of the higher animals are not unfrequently found in the Thames water; and some of these undoubtedly belong to those forms of Annulosa, which find their highest development in the human body.

Many of these forms of animal and vegetable life are not injurious in themselves; but they are most numerous where there is the greatest amount of impurity, and are a measure of the greater or less objectionable nature of a water for drinking purposes.

PURIFICATION OF WATER CONTAMINATED WITH LEAD.

Professor Faraday, writing to the *London Times*, on the danger of drinking rain-water contaminated with lead (dissolved from the lead of roofs), states, that if some powdered chalk or whiting be put into the cistern in which such water is collected, and be stirred immediately after rain, the water may, with the greatest facility, be obtained in a perfectly fit state for all culinary and domestic purposes. The lead is rendered insoluble, and the water may be filtered or left to settle.

EFFECTS OF THE PREPARATION OF LEAD UPON THE INFERIOR ANIMALS.

A. M. Pécart-Taschereau, a litharge manufacturer (*Deutsche Klinik*), has investigated, with some care, the effects of the preparations of lead upon the inferior animals. Strange as it may seem, he soon noticed that the Dog is never affected with symptoms of lead poisoning. He has seen this animal roll in litharge and white lead, and afterwards lick itself clean; but no evil consequences ever attracted his attention.

The Cat, on the contrary, is soon killed. This animal dies in convulsions, not only in establishments where litharge and white lead are prepared, but even in those places where minute quantities of lead chance to be present, in the compositor's rooms, and where newly printed books have been stored. New ink, it is well known, always contains a certain quantity of this metal.

M. Pécart-Taschereau tried a very decisive experiment. He hung several cages, in each of which a cat was confined, in his factory, and in a short time, one after another, all died.

Mice — and the lead manufactories are infested by them — play in the litharge and white lead without any apparent evil consequences.

M. Rouart, white lead manufacturer in Clichy, remarks that Rats, which multiply most rapidly in his establishment, are very apt to suffer from paralysis of the lower extremities.

The Horse, exposed to the poisonous atmosphere of lead factories, appears to be liable to a paralysis of the muscles of the larynx. The recurrent laryngeal nerve (which conveys the motory impulses to the muscles of the larynx) appears unable to perform its proper functions, whilst the remainder of the pneumo-gastric nerve is totally unaffected. The veterinary surgeon, Delanay, has performed, in these cases, tracheotomy, with the result of preserving the valuable animal, notwithstanding the local paralysis.

Birds soon succumb to the poison. It has been observed that Sheep and Goats that feed near lead factories frequently suffer from hæmaturia, and are also liable to miscarry. It is also asserted that in such neighborhoods women are peculiarly apt to have premature labor. — *Medical and Surgical Reporter.*

It is stated by Dr. A. S. Taylor, in his work on "Poisons," a new edition of which has recently been published in London, that lead paralysis may result from articles of food, from snuff, tobacco, etc., sold in what is denominated "tinfoil," which is, in truth, almost pure lead. This statement may cause some surprise; but he furnishes another statement that is yet more remarkable, from which it appears that vegetables are capable of taking up lead from the soil, and incorporating it with other materials in their organisms. Cattle-poisoning by lead, so alleged, became the subject of a chemical investigation, and the question was, whether the cattle were injured by the fumes from the chimney of the lead works, or from the lead in the soil. Earth was brought to London from the field in which the cattle fed. "Mustard and cress seeds were sown in these four samples of the Mendip leaden soil, and, for a comparative experiment, in a sample of ordinary garden mould. In about eight days the crops were carefully cut, without interfering with the earth, and submitted by Mr. Brande and myself to chemical examination. We first satisfied ourselves that there was no lead on the outside of the plants, by washing them in pure diluted acetic acid, and testing the washings. The vegetable matter was then dried and burnt, and lead, in well-marked quantity, was found in the ashes." — P. 512.

AGRICULTURAL CHEMISTRY.

The following views in relation to the demands of agriculture upon science, were expressed by Professor Vöelcker, of the Cirencester College, England, in a recent address before the Royal Agricultural Society:

He believes that among the landed proprietors, their agents, and the larger farmers, especially the rising generation, a more extensive knowledge of the sciences applicable to agriculture is needed. All these want better instruction. But to teach the small farmer or the laborer chemistry, is simply absurd. To either, the pursuit would be waste of time. So chemistry should never be made the direct guide to the agriculturist. Science is, after all, only the systematic arrangement of well-authenticated facts, and the rising generation should be taught its general principles. But many professers of chemistry have over-estimated their own powers, and instead of explaining the experience of practical men, they set themselves up as guides to the farmers; they have over-estimated the powers of the new science, and in consequence stumbled. Again he says: "Agricultural chemistry, in its application to farming, is altogether a new science; and hitherto it has been like every new knowledge, too vague and too general in its doctrines, as well as in its researches. What is required at the time are, experiments made for a special purpose, researches carried on in the field as well as in the laboratory. We have no need of the joint labors of practical men and men of science. There are questions which can only be properly investigated if the man of science heartily joins with the practical man, working cheerfully together, each in his own department, — a nearer approach between agriculture and science, in short, is what is required at the present time. A general knowledge of the principles of farming, however useful to the practical farmer, never will help him to grow a large crop of turnips; he must have special training in practical matters in order to be a successful farmer. So it is with chemical knowledge. Men may have excellent general chemical knowledge, but if they have not special chemical knowledge in relation to farming, their labors will be of little direct utility to the agriculturist."

In reference to the culture of root-crops, he says that, generally, ammoniacal manures, such as guano, are thrown away on roots; and phosphates are more profitable. Guano and super-phosphate of lime both rather retard the germination of the seeds, but they push forward the young plant in its early growth. This we believe to form the true value of such manures, though perhaps this is over-estimated.

SUBSTANCES EXTRACTED FROM ARABLE LAND BY RAIN-WATER.

Dr. Fraas, of Munich, has some time been making experiments to ascertain the nature and quantity of the constituents of soils that are removed by rain-water within a given time. The instrument used by him for this purpose is called a lysimeter, and the substances obtained have been analyzed by Hr. Zoeller. They were separated from rain-water that penetrated a square foot of earth, six inches deep, during the summer of 1857, from April to October. Five different extracts were analyzed:

No. 1, from cultivated and manured calcareous soil.

No. 2, from cultivated and unmanured clay soil.

No. 3, from uncultivated and unmanured clay soil.

No. 4, from uncultivated and manured clay soil.

No. 5, from cultivated and manured clay soil.

The manure applied to Nos. 1, 4, and 5, consisted, in each instance, of one pound of cattle manure without straw.

The residues left by evaporation were yellowish or blackish-brown, and very hygroscopic. They all contained the same constituents, with the exception of manganese, which could be detected only in Nos. 3 and 4. The bases were potash, soda, lime, magnesia, and peroxide of iron; the acids, carbonic, silicic, nitric, sulphuric, phosphoric, and chlorine. Besides these substances, there were also organic substance, clay and sand.

In none of these residues could the presence of a soluble compound of alumina or of ammonia be recognized. It was only by boiling for a long time with concentrated caustic potash, that an ammoniacal reäction became perceptible, and that was probably due to the decomposition of a nitrogenous organic substance. There is, however, so large an amount of nitric acid present, that when the residues of evaporation are heated upon platinum foil, they deflagrate; and when the solution is heated with sulphuric acid, it decolorizes indigo solution.

This nitric acid has most likely originated chiefly from ammonia by oxidation; for, although nitric acid may be produced directly by the combination of atmospheric nitrogen with the oxygen condensed by the soil, ammonia would always be oxidized first, and converted into nitrate of ammonia.

However, since the nitric acid in the solution from soils exists in the state of a lime or magnesia salt, this is a further proof of the powerful attraction of the soil for ammonia. So that while, on the one hand, the capability of the soils to condense ordinary oxygen and ozonize it, may cause the production of nitrate of ammonia, its powerful attraction for ammonia causes the decomposition of the nitrate of ammonia, the base being retained by the soil, while the nitric acid combines with lime or magnesia.

The analyses show that one million parts of the water passing through soil six inches deep contained:

Solid residue dried at 212°,....	472·32	254.62	292·64	305·20	291·50
Fixed portion,................	317·62	176·74	194·75	214·50	212·16
Potash,........................	6·50	2·37	2·03	5·46	3·82
Soda,..........................	7·11	5·60	7·43	23·74	6·02
Lime, ...	145·86	57·60	70·80	68·41	92·34
Magnesia,.....................	20·52	8 88	1·32	2 93	5·12
Peroxide of iron,.............	1·32	6·35	8·26	5·76	4·30
Chlorine,.....................	57·49	9·52	20·87	39·46	35·27
Phosphoric acid, ...	2·23	——	——	——	——
Sulphuric acid, ...	17·47	27·13	27·82	29·30	33·49
Silica (soluble),...............	10·46	11·35	17·46	9·50	9·34

These analyses illustrated the absorptive power of soils, first pointed out by Mr. Way as so important in its influence upon the nutrition of plants. With one exception only, neither phosphoric acid nor ammonia were present in sensible amount; the quantity of potash is in all instances small, and principally referable to the organic substance in the solution. Chlorine, sulphuric acid, and nitric acid salts are not retained by the soil.

If these analyses show the substances that are dissolved from the soil, the opinion that plants derive their nutriment from solutions must be given up. The soils experimented upon gave good crops of corn and straw, and the quantities of potash and phosphoric acid required by these crops much exceed those which would be furnished by solutions of the above composition. Moreover, the comparison of the ash of cereals, and the substance dissolved from the soil, is inconsistent with the opinion that the food of plants is supplied in solution, unless they are supposed to possess a very considerable selective power. — *Annalen der Chemie und Pharmacie*, cvii. 27.

ON THE VALUE OF WOOLLEN RAGS AS A MANURE.

Prof. Way, chemist of the Royal Agricultural Society, England, in recently investigating the value of woollen rags as a manure, felt that it would hardly be satisfactory to content himself with the analysis of wool, since, as he observes (*Jour. Royal Ag. Soc.*, vol. x. p. 617), to reason from the composition of a raw material of any kind upon that of the manufactured article, which has passed through perhaps half a dozen processes, is often to lay one's self open to much error; and nothing short of the direct analysis of the rags themselves, would enable any person to form a correct notion of their manuring value. Wool, in a state of purity, contains upwards of seventeen per cent. of nitrogen. Were woollen rags, therefore, of the same strength as the wool itself, they should produce *ultimately* a larger amount of ammonia than even Peruvian guano. It will be valuable, then, to examine the chemical compositions of some of the commonly sold refuse woollen rags. These rags are well known, and extensively employed as a manure in some parts of the country.

Owing, as the Professor remarks, to their slow decomposition in the soil, they are not well fitted for root culture — turnips and other plants of this kind requiring active and readily soluble manures to produce a rapid growth. Still, this must not be taken as an undoubted fact, since, in the experiments of the late Mr. Pusey on the growth of beet-root (*ibid.*, vol. vi., p. 530), when thirteen tons of farm-yard manure per acre produced twenty-seven and a half tons of clean roots, the *addition* to the dung of seven cwt. of rags raised the produce to thirty-six tons. This increase he attributed to the large proportion of azote or nitrogen present in the rags.

Woollen rags were formerly, as Professor Way adds, to be purchased of good quality, and unmixed with any less valuable substance; but of late years rags, of a size that used to be sold to the farmer, are bought up to be reconverted into an inferior kind of cloth. The supply being in this way in part cut off, is frequently made good by the admixture of such linen or cotton rags as may not be worth the paper-maker's attention.

Three specimens of these refuse rags were examined by the Professor. Specimen No. 1, consisting of the seams and other uselesss parts of old cloth, which had apparently been cut up to be remanufactured into cloth. No. 2, called "premings," and No. 3, "cuttings," appeared to be much of the same character, but totally different from the rags, — they both consisted essentially of colored wool less than an eighth of an inch in length. These all contained, in their ordinary state, a certain proportion of water. In the three specimens above referred to, the

	Per cent.
Rags contained of water,	7·87
Premings,	7
Cuttings,	8·70

In this state, the proportion per cent. of nitrogen which they contained, and the proportion of *ammonia*, which, by the decomposition of the animal matter, will be eventually produced from them, and from a specimen of "shoddy," is given in the following little table:

	Nitrogen.	Ammonia.
Rags,	10·47	12·71
Premings,	9 92	12·05
Cuttings.	11·84	14·31
Shoddy,	4·55	5·52

It appears, then, says Way, that it is quite incorrect to estimate the value of the different kinds of woollen refuse by the known composition of the wool itself; for, to whatever cause the inferiority may be due, it is plain that they do not, on an average, contain two-thirds of the nitrogen found in the raw material.

The mineral substances found in wool refuse are of small fertilizing value. In 100 parts of inferior wool refuse were found

Water,	7·15
Animal matter and oil,	58·52
Phosphate of lime,	1·48
Oxide of iron and alumina,	2·10
Carbonate of lime,	9·42
Sand, etc.,	21·23
Loss, etc.,	·10

This specimen contained about 2·5 per cent. of nitrogen.

Professor Vöelcker has explained the chief reasons for the considerable difference of opinion, which exists in different places, with regard to the fertilizing value of woollen substances (*ibid.*, vol. xvi., p. 94). These, he considers, are to be best understood by a reference to their analysis, and the time of their application, and the physical composition of the soil. Shoddy, for instance, often contains from twenty to twenty-five per cent. of oil, which, by excluding moisture, and the atmospheric air from the interior of the wool hairs which compose this refuse, prevents its decomposition, as effectually as the oil in sardines, or a cover of grease the potted meat. And thus the decomposition of the shoddy is retarded for a considerable period, so that no effect is produced if it is applied to the land when the young wheat has already made its appearance, or even if applied two or three months previously. But if the same refuse is applied to the land a considerable period before the sowing of the crop which it is intended to benefit, or if it is previously brought into a state in which it will readily ferment (and then it may be applied at once to the young wheat), a very marked and early good effect will be produced by its use, since ammonia is then gradually formed from the nitrogen of the shoddy. In light and porous soils, this necessary preparation proceeds much more rapidly than in stiff, heavy lands.

The farmer, by his practice, confirms these chemical conclusions. The Kentish hop-growers, we are told by Mr. S. Rutley, in his prize essay (*ibid.*, vol. ix., p. 562), deem woollen rags, shoddy, and refuse seal-skins, to be very lasting manures, but much more valuable and early in their effect on dry than on wet soils. On the Kentish hop-grounds they apply from twelve to twenty cwts. per acre of woollen rags, twenty to thirty cwts. of shoddy, and about 160 bushels per acre of seal-skin. For corn-crops on light, chalky land, or for grass, about ten or twelve cwts. per acre of woollen refuse were used. — *Extracted from an article on wool, communicated by Cuthbert Johnson to the (English) Farmer's Magazine.*

SURFACE MANURING.

Agriculturists are very much exercised, at the present moment, whether it is better to apply manures in a partially rotted state upon the surface of the earth, weeks or months before they are required for crops, or to decompose them in heaps, and plough them in as soon as applied, at planting-time. The best writers, both practical and theoretical, in England and America, seem to incline to the first-mentioned practice, in reference particularly to grass and grain; and the best effects are shown to have resulted from this method of the application of surface-manure.

The practice of top-dressing, or of surface-manuring, has long been the favorite method employed by all intelligent gardeners within the circle of my acquaintance. We have long ago learned that masses of rich, nitrogenous manures are not what plants require about their roots; but that manures are applied much more successfully (and less injuriously) by top-dressing, either in solid or liquid form. Nature never manures her plants with crude masses of concentrated fertilizing substances; but imparts her stimulating and mineral food in a state of the most minute division (almost infinitesimal), chiefly from the surface of the earth. No wonder so many fruit-trees have been killed, so many grape-vines destroyed or rendered barren by excess of wood, in consequence of the heavy manuring at the roots so universally recommended by writers on gardening and horticulture.

The great objection to surface-manuring is founded upon the probable loss of ammonia, caused by the exposure of decaying manures upon the surface of the earth. But this loss has been shown, by sound reasoning and by facts deduced from practical experience, to be much less than is commonly apprehended; while the benefits arising from surface-manuring, in other respects, more than counterbalance any possible loss of ammonia from this practice.

In the first place, when manures are exposed upon the surface of the earth, even in hot weather, decomposition no longer goes on so rapidly as when the same manures are kept in a heap, and the ammonia that is produced is gradually carried into the soil by rains. The other soluble substances, as potash, lime, the phosphates, etc., are, of course, not lost, because they are not volatile.

Nor are these soluble and valuable substances lost to plants by being carried into the soil before they are needed by growing plants. It has been conclusively shown by eminent scientific authorities, that any good soil, containing a fair proportion of clay and carbon, is capable of taking up and retaining effectually, ammonia, lime, potash, soda, etc., in a soluble form, so that little, if any, passes off in the underdrainage water of such soils. These substances, it is true, may wash from the surface, but they cannot pass through a good soil, and go off in the drainage water.

By surface-manuring, we mulch the ground, and render it cooler in summer and warmer in winter. Mere shade is an important element in culture, so important, that some writers have thought shade alone to be equivalent to manure. A piece of soil heavily shaded by surface-manuring, actually decomposes like a manure heap; that is, it undergoes a sort of putrefaction or chemical change, which sets free its chemical constituents, unlocks, as it were, its locked-up manurial treasures, and fits its natural elements to become the food of plants. Darkness, moisture, and air, are the conditions required for vegetable and mineral decomposition. These conditions are produced in the soil by surface-manuring.

Then, again, when the surface-manure decomposes, its elements are washed into the soil, in a state of solution precisely fitted to meet the wants of plants, and they become themselves active agents in promoting further decomposition and chemical changes in the entire body of the soil.

Manure then, I say, chiefly upon the surface. Do not waste your manures by mixing them deeply with the soil. Plant shallow. Keep roots of all trees, plants, and vines, as near the surface as possible. There are weighty reasons for the position assumed in the last sentence, which I have not space now to enumerate. I say again, plant shallow. Let your soil be deep and dry, but plant near the surface. To farmers I would say, manure upon the surface as much as possible. Top-dress your grass, after mowing in July or August, under a burning summer sun; top-dress in the fall, before and during the autumn rains; manure the surface while snow is on the ground, while the March winds blow, and while the April rains fall. Manure your grass, instead of your corn and wheat, broadcast, at any time when you have manure and leisure, and I will guarantee that you will be abundantly satisfied with the result.

To fruit-growers I would say, do not fill your soil with manure before you plant trees, grape-vines, etc. Plant in good natural soil, and manure from the surface, spring and fall, liberally and properly, and I will guarantee you success far greater than if you plant in holes and trenches filled with manure, as the custom is. Surface-manuring and mulching are the true doctrines. I am sure of it. — *Mr. Bright, Gardener's Monthly.*

ON THE ESSENTIAL MANURING CONSTITUENTS OF CERTAIN CROPS.

At the Aberdeen meeting of the British Association, Prof. Vöelcker detailed the results of certain field experiments, having special reference to the turnip-crop, which had extended over a period of four years. These are the most important points cited: — 1. That fertilizers destitute of phosphoric acid do not increase the yield of this crop. 2. That phosphate of lime applied to the soil in the shape of soluble phosphate (super-phosphate) increases this crop in an especial manner, and that the practical value of artificial manures for root-crops, chiefly depends on the relative amount of available phosphates which they contain. Thus it was shown that three cwt. of super-phosphate per acre, produced as large an increase of turnips as fifteen tons of farm-yard manure. 3. That ammoniacal salts and nitrogenized constituents yielding ammonia on decomposition, have no beneficial effect upon turnips, but rather the reverse. 4 That ammoniacal salts applied alone do not promote, as maintained erroneously, the luxuriant development of leaves; but that they produce this effect to a certain extent when salts of ammonia are applied to the land in conjunction with the mineral constituents found in the ashes of turnips. The report likewise states that numerous analyses of turnips have been made, from which it appears that the more nutritious and least ripened roots invariably contain less nitrogen than half-ripened roots, or turnips of low feeding qualities. In the latter, the proportion of nitrogen was found in several instances two to two-and-a-half times as high as in roots distinguished for their good feeding qualities.

Similar experiments upon wheat showed that nitrogenized ammoniacal matters, which proved inefficacious in relation to turnips, increase the yield in corn and straw very materially, and that the increase of wheat was largest when the ammoniacal constituents were associated with mineral matters.

ACTION OF THE SOIL ON VEGETATION.

The late Professor Gregory left the following summary of recent views relative to the action of soil on vegetation:

1. Way, and, after him, Liebig, have shown that every soil absorbs ammonia, and also potash, from solutions containing them or their salts, generally leaving the acid, which takes up lime, etc., from the soil in solution. The ammonia and potash, which are absorbed in very large proportion by arable soils, are rendered thereby quite insoluble.

2. Arable soils absorb also silicic acid in very considerable proportion, and it also becomes insoluble.

3. Arable soils also absorb the phosphoric acid of phosphate of lime, or of ammoniaco-magnesian phosphate, apparently soluting the acid, which also becomes insoluble.

4. Hence the soluble ingredients of manures cannot be conveyed to the plants in the form of a solution percolating the soil (such as liquid manure, or a solution formed by rain-water with the aid of carbonic acid), since such a solution is deprived of its dissolved ingredients by filtering through a very moderate amount of soil.

5. Hence, also, as the food of plants must thus be fixed in the soil in an insoluble form, it is plain that it can only enter the plant in virtue of some power or agency in the roots, which decomposes the insoluble compounds in the soil, and thus renders soluble the necessary matter.

6. The absorbent power of soils is partly chemical, and partly mechanical, as is the case with charcoal.

7. The quantities of alkalies, of phosphates of ammonia, etc., capable of being supplied to plants by rain-water, after it has been percolated through the soil, even supposing the whole to be assimilated, does not amount to more than a mere fraction of what the plants contain.

8 The theory of the transference of ammonia, potash, silica, phosphates, etc., from the soil to the plant, is not yet understood; but the old theory, that the rain conveys food to the plant directly, is certainly not the true one. —*Edin. New Phil. Journal.*

ON THE PRESENCE OF ARSENIC IN PLANTS USED FOR FOOD.

The following is the substance of a paper on the above subject, recently read before the Natural History Society, Dublin, by Prof. John Davy:

His attention was first attracted to the subject by the difficulty of obtaining pure sulphuric acid, that sold in shops commonly containing more or less arsenic, derived from the pyrites from which it is manufactured. Superphosphate of lime is extensively used as a manure, and is more and more employed every day, and this manure is made by the addition of sulphuric acid to crushed bones; and, in order to produce it at the lowest cost, an inferior description of acid is used, containing, among other impurities, an increased quantity of arsenious acid or white arsenic. With a view to ascertain whether plants had the power of absorbing this arsenic from the earth, Professor Davy transplanted three small pea-plants, and when they had recovered from the removal, he watered them every other day for about a week. The plants did not appear to be injured by the treatment, but grew up, flowered, and produced seed as usual. Having collected the stalks, leaves, and pods, they were carefully put aside for examination. The means most commonly employed for the detection of minute quantities of arsenic are Reinsch's and Marsh's. On trying the plants by these tests united, it was found that not only the stalks and leaves, but even the seeds had absorbed the poison, which was thus found to have penetrated the entire plant.

Having ascertained that arsenic could be absorbed by plants without destroying their vitality, Professor Davy next proceeded to experiment on the super-phosphate, by planting a small cabbage-plant in a pot containing one part of the manure to three of mould. At the end of three weeks the top was cut off, and appeared green and healthy; and on testing one hundred and thirteen grains of the cabbage, very distinct indications of the poison were observed. But, as the amount of super-phosphate used in this experiment was much more than would have been used in ordinary cases, Professor Davy procured some turnips to which six cwt. of the manure had been used per Irish acre, and from two lbs. weight of the roots which had been carefully washed and boiled for three hours in thirty-six ounces of distilled water and three ounces of hydrochloric acid, striking evidence was afforded of the presence of arsenic in the turnips. On testing the brown acid used by the manure-makers, as much as one grain of white arsenic was discovered per ounce of vitriol. It is necessary to state, that the utmost caution had been taken to ascertain that no arsenic existed in any of the reägents employed in the experiments. These facts show the extreme caution which is necessary in the formation of conclusions based on the presence of a minute quantity of arsenic in the body of a person suspected to have died from poisoning, as the small amount discovered in the liver, or stomach and viscera, might have been received into the system with the vegetable or even animal food taken by the individual.

ATMOSPHERIC DUST.

This subject has been recently brought before the French Academy by M. Pouchet, in a paper entitled "Etude des corpuscles en suspension dans l'atmosphere." The atmosphere which surrounds us holds in suspension a mass of corpuscles, the detritus of the mineral crust of our globe, animal and vegetable particles, and the debris of all that is used for man's purposes. These diverse corpuscles are proportionably more numerous and voluminous as the atmosphere is more or less agitated by the wind, and it is to these that the term dust has been applied.

The author enumerates the various corpuscles of mineral, animal, and vegetable origin with which the air is loaded. Under the latter — the vegetable products — he mentions especially particles of wheat, which are always found mixed with dust, be it recent or old, as well as those of barley, rye, potatoes, which have been discovered in rare instances. "Astonished at the proportional abundance of flour which I have found among the atmospheric corpuscles," says M. Pouchet, "I undertook the task to examine the dust of all centuries and of all localities. I have explored the monuments of our large cities; those of the shore and those of the desert; and in the midst of the immense variety of corpuscles that universally float in the air, almost always have I found the dust of grain, in greater or lesser abundance. Endowed with an extraordinary power of preservation, years seem scarcely to have altered it.

"Whatever may be the antiquity of atmospheric corpuscles, we find among them the dust of grain yet recognizable. I have discovered it in the most inaccessible retreats of our old Gothic churches, mixed with their blackened dust of eight centuries; I have met it in the palaces and hypogèes of Thebes, where it dates back perhaps to the epoch of the Pharaohs. I have found it even in the interior of the tympanal cavity of the head of a mummified dog, which I have recovered from a subterranean temple of Upper Egypt." — *Druggists' Circular.*

INFLUENCE OF FOODS.

Dr. Edward Smith, of the Hospital for Consumptives, Brompton, England, contributes to the Proc. Royal-Medico-Chirurgical Society a paper entitled "Practical Deductions from an Experimental Inquiry into the Influence of Foods." He considers the use of arrow-root and other fashionable foods (consisting merely of starch and water) in preference to the cereals (wheat, etc.), as utterly indefensible, even in cases of exhaustion. He draws the distinction between the action of that diet which increases the vital power, and that which merely tends to prevent the loss of it; and considers that beef-tea, wines, and brandy, can act only in the latter mode, while the cereals act in the first-named manner. Milk and the cereals he asserts to be the most perfect form of food, and approves of the use of skimmed rather than new milk in cases of fever. The great value of animal substances in diet, as increasing the respiratory process in addition to the supply of plastic material, is dwelt on. In cases of debility, with lessened appetite and a soft, perspiring skin, Dr. Smith recommends fat to be applied to the skin rather than taken internally. He approves of sugar and water (the French *eau sucrée*) as an innocuous and refreshing beverage, and thinks that the ill effects of sugar on the healthy system have been greatly exaggerated. Tea causes waste, and is thus injurious to persons under fed. It differs from coffee, chiefly by increasing the action of the skin, and thereby tending to cool the body. He thinks tea and coffee ought to be more commonly used as medicinal agents. The latter he believes to be a valuable febrifuge, and one particularly fitted for cases of nervous excitability. He considers all alcohols to have their chief influence in sustaining the action of the heart.

NEW DISINFECTING COMPOUND.

M. Corne and Demeaux, two French surgeons, have recently discovered and introduced a new disinfecting compound of a most simple and efficacious character. Its composition and preparation is as follows: — To one hundred parts of plaster of Paris, finely powdered, add from one to three parts of coal-tar, then mix these two ingredients well into a mortar. To the above add olive-oil in sufficient quantity, so as to reduce the mixture to the consistence of ointment, after which it is to be placed in close vessels for use. The mixture is of a dark-brown color, and has, owing to the presence of the coal-tar, a bituminous smell. The olive-oil employed serves the purpose of binding the powder without dissolving it, so that the preparation retains its absorbing quality when it is placed in contact with a suppurating sore, while at the same time it never dries sufficiently to become in any way inconvenient to the patient from becoming hard, and without creating at the same time any irritation; while its application destroys immediately any bad odor which may exist, and which is as disagreeable to the patient as to the attending physician. As this composition forms a kind of paste or ointment, it admits of being spread upon linen, and then placed upon the wound. The application may be immediate, or mediate, according to circumstances; if applied immediately to the sore it does not cause pain and has a detersive action, while at the same time, as it cleanses the wound, it favors cisatrisation. By dressing wounds in this manner with this preparation, Dr. Corne states that the twofold advantage is obtained of disinfecting any diseased part, and also of absorbing any liquid which may be present, thereby doing away entirely, or in a great measure, with the necessity of employing lint or rags.

For preventing the disagreeable odor of sinks, privies, etc., it is also exceedingly efficacious, and, being much cheaper, can be used with advantage in the place of chloride of lime. Two pounds of the powder is sufficient to dissolve in twenty-two gallons of water; or a table-spoonful dissolved in one and three-fourths pints of water is sufficient per day to render inodorous the refuse of a household of four or five persons. A morsel, the size of a pin's head, will render limpid and fit for use a pint and a half of water, which is beginning to become putrescent. The value of such a discovery for those who travel in the East, and especially for ships at sea, cannot well be overstated.

But it also has an important relation to agriculture. One-half pound of the powder, dissolved in five or six gallons of water and sprinkled on the litter of a stable, will deprive one cubic yard of manure of all odor, and prevent the loss of its fertilizing qualities.

M. Velpeau, in a report to the French Academy, highly recommended its use to the faculty, and gave numerous examples of its application. This report was succeeded by a discussion, which is thus reported by M. Nickles for *Silliman's Journal*, Nov. 1859.

M. Bussy recalled the fact that charcoal powder, the Boghead coke, creosote, and alkaline hypochlorites, have for a long time been used as disinfectants. M. Chevreul next called attention to the fact that, in the last century, Dr. George Berkeley, Bishop of Cloyne, had published a work on the virtues of tar-water, in which he speaks of this agent with enthusiasm. It was esteemed by him as a specific also, particularly against ulcers, virus, and the scurvy. More than twelve years ago, Dr. Herpin of Metz proposed a disinfecting mixture of plaster and carbon. Dumas reminded the Academy that one of its prizes was a few years since awarded to Mr. Sizet, who showed all the metallic salts which could be used with advantage in disinfection — who also added that the properties of these disinfectants were much exalted by the addition of a small proportion of coal-tar. These experiments have also been confirmed elsewhere by Mr. Boussingault, without, it is true, a special reference to sores and ulcers. Coal-tar has been used in England for disinfecting dead animals for the uses of rural economy. The use of coal-tar has also been advised for the dead on the battle-field.

Dumas added, that, having often sought an explanation of these facts, he had found it in the fact illustrated by Schonbein, that the vapor of turpentine, when mixed with air, produced an abundance of ozone. He thought that the vapor of coal-tar might equally ozonize the air. In this case, the odorous mixtures would be immediately burned by the ozonized oxygen, and the putrid odor rapidly destroyed.

If coal-tar really produces this action, it is necessary, according to Dumas, to distinguish three effects. 1st, the destruction of the infectious vapor or gas by means of ozone arising from coal-tar. 2d, the action of the plaster in preventing the production of new infectious gases by the solidification of the liquids present. 3d, the point of arrest set to the development of putrefactive process by any of the products contained in coal-tar, and especially the phenic acid, which in the smallest traces, in the form of phenate of soda, secures the preservation of animal matters in free air.

ON THE ALLEGED PRESENCE OF SAND IN SUGAR.

At the American Association for the Promotion of Science, August 1859, Prof. Horsford, in a paper on the above subject, remarked, that there was, perhaps, no adulteration more unhesitatingly charged upon grocers than that of mixing sand with sugar. The granular condition of sand, and its clean look, and its cheapness, were supposed to confer upon it such admirable adaptation, that the temptation to use it could scarcely be resisted. His attention was called to this subject by a gentleman who had received from a friend a present of a cask of maple sirup, who exhibited to him what he regarded as a quantity of very bright and glistening quartz sand. Although the circumstances rendered such a thing exceedingly improbable, still he regarded it as an instance of adulteration, at first, on account of the resemblance of the impurity to bright, clean sand.

A few months since, he received a specimen of deposit from maple sirup, which, on examination with the microscope, was found to be composed of minute, well-defined crystals; and on further examination, the crystals were found to be soluble in hydro-chloric acid, and when heated on platinum, before the blow-pipe, first to blacken, and after conversion into a coal, with prolonged heat, to become white. The residue effervesced with acid, and the solution gave a precipitate with ammonia and acetate of ammonia, insoluble in acetic acid. The sand was evidently a lime salt. Organic analysis and determination of the lime showed it to be a tartrate of lime. This fact shows that tartrate of lime has been sometimes mistaken for a much less legitimate adulteration of maple sugar, and the burden of proof against the dealers is much lessened.

ACTION OF MORDANTS.

O. L. Erdmann and Mittentzwey have published highly interesting experiments on the action of mordants, especially of alum on cotton, and have proved, almost to a certainty, that no chemical triple-combination takes place between cellulose, alumina, and coloring matter; but that the vegetable fibre takes up mechanically a minute portion of the earth, which then combines with the coloring matter, and that only minute portions can fasten a color, since an excess of the mordant will act as resolvent.

IMPROVEMENT IN THE MANUFACTURE OF STRAW-PAPER.

The following are the main points of an improved process for the manufacture of straw-paper, recently patented in England, by R. H. Collyer. The straw is first soaked or boiled in water to render it soft, then it is subjected to a cutting action, and also to a grinding-machine. This latter operation seems to be the improved feature. The straw is rubbed between grinding surfaces until every knot is crushed and made into impalpable pulp. In this finely subdivided state, the pulp is boiled in a strong caustic alkali, which dissolves all the silica (hard specks), and reduces it to a fine condition. It is then bleached, and treated in the usual way.

HOW TO RESTORE THE WRITING OF DAMAGED LETTERS.

Alfred Smee, of London, F. R. S., publishes the following directions for restoring the legibility of letters, etc., that have become damaged by the action of sea-water.

"The letter should be lightly once brushed over with diluted muriatic acid. As soon as the paper is thoroughly damped, it must be again brushed over with a saturated solution of yellow prussiate of potash, when the writing immediately reäppears in blue. In this latter operation, plenty of the liquid should be employed, and care must be taken that the brush is not used so roughly as to tear the surface of the paper. This result is obtained by simple chemical laws, as the iron which exists in the writing-ink is retained in the fibre of the paper, and by the action of the ferrocyanide of potash, Prussian blue is formed — the acid being used simply to place the iron under favorable conditions for uniting with the ferrocyanide. The letter should then be washed in a basin of clean water, and dried first between the folds of blotting-paper, and subsequently by holding it before the fire, when the letter is fit for the counting-house. If the letter should be of much permanent value, I recommend it to be carefully sized with a solution of isinglass before being filed; but if the paper has been much rotted, the operation requires care, and should not be done until a notarial copy, or photograph, has been taken."

WAX AND ROSIN FOR PAINTING.

To oil-coats there is this objection, that they require a comparatively long time to dry. When oil of turpentine is used, though it evaporates fast enough, it leaves the painting soft; and although, by the addition of some other substances the drying may be hastened, it even then takes up too much time, and leads to the substitution of white-wash and other water-colors. Mr. Alluys now proposes a mixture which yields a coat of paint that will dry as fast as white-wash, but leave as durable and elastic a coat as that of oil. To prepare it, instead of more linseed oil, as usually, he adds to the paint, ground in oil, a solution of wax and rosin in spirits of turpentine. The mixture thus prepared has the appearance of common oil-paint, and acts like such: on the evaporation of the turpentine, it leaves a coat sufficiently hard to bear gentle rubbing without coming off. Barreswil has reported some experiments with this mixture, and finds that, although it becomes sufficiently dry and hard after a time, it does not equal a good oil-coating in this respect; but he has no doubt that for some purposes Alluy's mixture will be found quite desirable. He gives the following formula for its preparation: Ten parts of pure yellow wax are dissolved in the same quantity of linseed oil, and five parts of rosin in eight of spirits of turpentine, at a slow heat, in separate vessels, until quite liquid, when they are taken from the fire and mixed, with constant stirring until they thicken. In this condition the mixture serves for out-door and store-work. If to be applied with ground paints, it is thinned with spirits of turpentine as required. — *Dingler's Journal.*

ON THE COMPOSITION AND PREPARATION OF ARTIFICIAL FRUIT ESSENCES.

Amyl Alcohol, Fusel Oil, $C_{10}H_{12}O_2$. — This alcohol, which has been referred to as an impurity of alcohol, is contained in the products of fermentation of potatoes, grain, and grape husks. To obtain it in a state of purity from the ordinary grain fusel oil, which may be obtained at distilleries, the crude fusel oil is agitated with an equal bulk of water, the water removed, and the oil distilled with about its own weight of dry carbonate of potassa. The potato fusel oil, distilling at first, still contains some alcohol, and the receiver is therefore changed as soon as the temperature in the retort has risen to 268°, when it remains stationary. This part of the distillate is the pure amylic alcohol.

It may also be obtained sufficiently pure for all purposes, if the crude oil is at once distilled over a slow fire, and the receiver changed when the temperature has attained 298°; a rectification of this product is necessary, and the first portion of all the distillates may be preserved for future use, when it may be added to other portions of crude fusel oil.

Fusel oil, thus purified, is a thin, oily liquid, crystallizing at —3° F. It has a penetrating, disagreeable odor, and a hot, acrid taste. The inhalation of its vapor and its internal administration are poisonous, producing coughing, nausea, vomiting, vertigo, fainting, prostration of the lower extremities, convulsions, asphyxia, and death. Ammonia has been recommended to counteract these deleterious effects.

It is not used in medicine, but has attained considerable importance in the arts, chiefly for the artificial production of perfume and fruit essences, and by oxidizing agents for the preparation of valerianic acid.

Jargonelle Pear Oil is an alcoholic solution of acetate of oxide of amyle, which may be obtained by digesting fusel oil with strong acetic acid for several days, but more satisfactorily by the following process: — one part of fusel oil, two parts of acetate of potassa, and one part of sulphuric acid, are mixed and distilled. The distillate is washed with a weak solution of potassa, then dried by chloride of calcium, and rectified over oxide of lead to abstract the last quantities of free acetic acid. This ether is a light, volatile liquid, boiling at about 270°. Its constitution is expressed by $C_{10}H_{11}O$, $C_4H^3O_3$.

Bergamot Pear Oil is similar to the former: five parts of acetate of oxide of amyle mixed with one and one-half parts of acetic ether, are dissolved in from one hundred to one hundred and twenty parts of alcohol.

Apple Oil. — In the preparation of valerianic acid from fusel oil, the distillate separates into two layers, the upper stratum of which is an oily liquid, consisting principally of valerianate of oxide of amyle. It is washed with a weak solution of carbonate of soda, then with water, afterwards dried with chloride of calcium, and distilled, preserving that portion which comes over at 270° to 274°; it consists of $C_{10}H_{11}O$, $C_{10}H_9O_3$. One part of this ether dissolved in six or eight parts of alcohol, furnishes apple oil.

Oil of Pineapples. — For the preparation of this essence, the making of butyric acid is necessary. As obtained by the saponification of butter, some difficulties are presented in freeing it of caprylic, caprinic, and vaccinic acids; it is therefore best to prepare it artificially by butyric fermentation, for which purpose, one hundred parts of starch sugar, or cane or milk sugar, are dissolved in water, and set aside in a warm place, with ten parts of old cheese; or a mixture of one hundred parts of sugar, one hundred and fifty parts milk, and fifty parts of powdered chalk, are allowed to ferment in a warm place; if diluted with water, fermentation takes place quicker. After the cessation of the evolution of gas, the liquid, on evaporation, furnishes butyrate of lime, ten parts of which are to be dissolved in forty parts of water, and distilled with three or four parts of muriatic acid; from the distillate the acid is separated by saturating it with chloride of calcium, the oily liquid is rectified, and that portion coming over at 327° is preserved as pure concentrated butyric acid.

Two parts of this acid are mixed in a tubulated retort, with two parts by weight of alcohol, and one part of sulphuric acid; after the reäction has taken place, the mixture separates into two strata, the upper of which is washed with water, dried with chloride of calcium, and rectified: it is then butyric ether, has a specific gravity of ·9, and boils above 230°; it is composed of C_4H_5O, $C_8H_7O_3$.

To avoid the preparation of free butyric acid, the ether may be prepared by heating the powdered butyrate of lime with a mixture of alcohol and sulphuric acid, skimming of the ether and treating it as above. The essence of pineapples is made by dissolving one part of this ether in eight or ten parts of alcohol.

Banana Essence is prepared from a mixture of acetate of oxide of amyle and some butyric ether, by dissolving it in alcohol.

Essence of Raspberries is usually made by mixing acetic ether with an alcoholic essence of orris root.

Quince Essence. — In making this essence, pelargonic acid has to be prepared as a first step. This acid is contained in the oil of pelargonium roseum, from which it may be obtained by combining it with potassa; but more advantageously it is made from oil of rue, by heating it in a retort with nitric acid previously diluted with an equal measure of water, removing from the fire as soon as the reäction commences, afterwards boiling with cohobation until nitrous acid vapors cease to be evolved; the oily acid is then removed, washed with water, combined with potassa, and a neutral, strong-smelling oil separated, after which the solution of pelargonate of potassa is decomposed by sulphuric acid.

Pelargonate acid is now sufficiently pure for the preparation of the ether; it still contains a resinous substance, from which it may be purified by rectification, combining with caustic baryta, and decomposing the crystallized salt with diluted sulphuric acid. Pelargonic acid, by a continued digestion of alcohol, is converted into pelargonic ether, which is obtained purer and in a shorter time by saturating an alcoholic solution of pelargonic acid with muriatic acid gas, washing the separated ether with water, and drying it over chloride of calcium. If the pure ether is sought, this may be rectified; it consists of C_4H_5O, $C_{18}H_{17}O_3$.

The pelargonic, also called œnanthic ether, dissolved in alcohol, constitutes the essence of quince.

Fusel Oil of Wine. — Though pelargonic ether is generally called œnanthic ether, many chemists apply the latter name to the pure fusel oil of wine, which, though closely analogous to the former, they assert to be a different compound. This fusel oil is the cause of the persistent smell of all or most wines, and is quite distinct from their bouquet, which in some wines is wanting altogether. It is obtained by careful distillation of the ferment of wines mixed with half its measure of water; a little œnanthic acid may be removed by agitation of the distillate with some carbonate of soda; the liquid is then heated, the ether rises to the surface, and is obtained free of water by standing over chloride of calcium. — *Parrish's Practical Pharmacy.*

ON THE ODORS OF PERFUMES.

At a late meeting of the French Academy, M. Chevreul presented a communication upon the mode of action of odoriferous substances. This discussion was intended to recall the publications which this distinguished chemist has made during the past thirty years — researches made specially to trace odors to their material causes. He reviews in the following manner the action by which bodies exert their odors when properly mixed with other odoriferous materials. 1st. Bodies, themselves odorant, disguise the odors of other substances, as a strong light overpowers a feeble one. 2d. Bodies, being themselves odoriferous, act in the manner of an acid in neutralizing a base. 3d. Solid bodies may act by capillary affinity to absorb odors, as is the case, for example, with charcoal. 4th. Other bodies act by altering the constitution of the odorant substance, producing new compounds either odorless or nearly so. Such is the action of moist chlorine or oxygenated water. 5th. Lastly, the action may be twofold, as in the case of chlorine and ammonia, decomposing one portion and neutralizing the other, without decomposition.

Neutralization includes the largest class of cases; thus the volatile odorous acids are neutralized by alkalies to form odorless salts. Ammonia loses its odor when united to an acid. The odors in such cases are truly neutralized, since displacing the acids liberates again the odors, each in its own character. Examples of the destruction of odors are numerous and well known to chemists. Sulphydric acid, for instance, is at once decomposed by chlorine, and consequently disinfected. Ammonia, by the action of chlorine, offers an example of both neutralization and destruction of odors, because at the same time we have decomposition of one part of the base and the neutralization of another part by the chlorohydric acid formed.

M. Chevreul proposes to define odors by means of a scale, analogous to our notation of sounds, or for gradations of color by the chromatic diagram (which last device we also owe to this savant). The great obstacle to this plan is, the difficulty of employing the sense of smell as we employ that of sight or hearing, a difficulty much increased by the toleration which the smell soon acquires to odors — becoming "blasé."

In 1830 he endeavored to take account of the changing odors exhaled by the woad-vats during evaporation, if possible to define exactly the kind of odor appropriate to each condition of the vat. He reached no positive results, although he detected in the dye-stuff bath five perfectly distinct odors: the odor of ammonia, a sulphurous odor, a metallic odor, an aromatic odor, clinging for many months to the woollen stuffs which had passed through the woad-vat; and lastly, the odor of a volatile acid analogous to that of animal matters in decomposition. M. Chevreul hoped to detect in these odors of the dye-vats symptoms to guide the dyer in his art, as the physician finds new indications in his knowledge of symptoms depending on the chemical nature of organic solids and liquids, if these symptoms can be certainly recognized by their odor. Thus he did not shrink from exposing himself to the most repulsive odors of the organism to reach his results. Having often heard the odor of a cancer spoken of as characteristic, he examined it, and recognized it as a compond of — 1st, an ammoniacal odor, turning blue a reddened test-paper. 2d, a feeble butyric odor. 3d, a heavy odor which is familiar in the "trying out" of suet or lard. No specific odor exists, then, in cancers, since the three odors recognized coëxist in non-cancerous matters which the disease alters. He recognized these matters in the odor of pus, and other products of animal origin, and he also detected in them a sulphurous odor and a smell of fish, due probably to a compound ammonia.

To all these odors he adds what he calls the stale-nauseous (*fade nausea-*

bonde), which appears in well-water that has stood some days in a vessel in which have been placed egg-shells impregnated with albumen.

We may be permitted to add to these interesting facts some others which we submit to the distinguished author of the chromatic circle and researches on the fatty bodies.

1. If an odorous substance can be neutralized or destroyed by another odorant body, there are others destitute of odor, which, by union, produce odorant substances.

(To this class of odorless bodies belong O, S, Se, Te, C, H, As, N, and we might add P, which is odorless unless combined.)

2. Likewise there are odorless bodies which have become odorant by union with others endowed with odor.

It is thus with oxalic, malic, butyric, racenic, citric, sorbic (the acid recently discovered by Hoffman), boric, silicic acids, all odorless, which however produce, with the elements of alcohol, ethers more or less aromatic.

3. It is necessary to distinguish those bodies which act mechanically on the olfactory membranes (for example, ClH, FlH, BrH, IH, and the vapors of NO_3+HO, SO_2 HO) from those which exert a physiological influence (for example, Cl, Br, I, NO_4, So_2, the hydrocarbons, the essential oils, etc).

4. It is necessary also to distinguish bodies having an odor proper, that is, an odor which exists when they form compounds with other bodies (for example, arsenic). The arsenical odor is recognized in AsH_3, $AsBr_3$, and in the cacodyl series. Tin is another example. The odor of tin characterizes a large number of stannic compounds. Sulphur: thus SO_2SH, S^2C, SNH_3, SCl, etc., are distinguished by a more or less sulphurous odor.

We might also mention naphthaline, benzine, and other hydrocarbons and organic radicals.

We see that this group of bodies, characterized by a peculiar odor, embraces those elements which, like sulphur, arsenic and phosphorus, are destitute of odor; that is, their odor is manifest only in combination. If we examine this phenomenon, we observe (*a*) that elementary bodies are usually destitute of odor; (*b*) that in general the least odorant compounds are generally oxygen compounds; (*c*) highly odorant compounds are usually those containing hydrogen. These seemingly singular facts may to a certain extent be explained, when we remember that, in general, chemical compounds become less volatile as they fix oxygen, while by union with hydrogen they become more volatile. But these considerations do not explain all; they do not tell us why CO and CO_2 are odorless gases, while $C_{12}H$, $C_{26}H_8$,$C_{12}H_6$, etc., are odorant.

Moreover, the perfumes, properly so called, as musk and the aromatic essences, rose, lemon, orange, bergamot, lavender, etc., are eminently hydrogen compounds. They are not at all volatile; and some of them may be exposed to the air for years, exhaling odor all the time, with no sensible loss of weight. Among these are the perfumes isolated by Milon in 1856. The cause of odors is not referable exclusively to the phenomenon of volatility, although, as a general thing, the odor of most bodies is developed when they are volatilized.

Hydrogen must be considered, *par excellence*, the exciting cause of odors. This element possesses, above all other substances, the peculiar property of developing odors, even with odorless bodies, as nitrogen, carbon, selenium, tellurium, phosphorus, etc., and a great number of compounds of these and other elements. Oxygen, on the other hand, appears to act the chief part in the perception of odors; it seems indeed proved that odors are not recognizable where there is not oxygen in the air to bathe the olfactory membranes. — *Correspondence of M. Nickles, Silliman's Journal, November*, 1859.

ON THE DETECTION OF STRYCHNIA.

It has long been a general opinion that strychnine was evanescent, and difficult, if not impossible, to detect after death; and hence this poison has been chosen for the perpetration of the most odious of crimes. Since the celebrated trial of Palmer for the murder of Cook, chemists have directed their researches to the means of detecting this poison in animal tissues, even in the most minute quantities. Their success has been most complete. Messrs. Rogers and Girdwood have obtained strychnine from bony tissue long after the death and putrefaction of the victim who had been poisoned by repeated small doses of this drug. A writer in the *London Medical Review*, who has employed strychnine for more than twenty years in the extermination of vermin, after describing its effects on various animals, mentions the following important fact: "I once knew a greyhound bitch poisoned in consequence of having picked up the leg-bone of a hare, completely bare of flesh, it having been eaten off by hoddie crows for whom it had been originally laid three months previously, poisoned with strychnine, and which had destroyed hundreds of them." From this we perceive in how remarkable a manner this, among other vegetable poisons, penetrates every part of the body, and remains ready for reproduction by the chemist with such a degree of certainty that the most inexperienced experimentalist can bring forward unfailing proofs of its existence. Thus, in this as in other cases, punishment follows inevitably upon guilt, and the skill to detect crime keeps full pace with the iniquity which imagines it. Next in importance to the prevention of crime, the discovery of an antidote engages our attention; and on this point also marked progress has been made. In November 1856, the Rev. Professor Haughton called the attention of the Royal Irish Academy to his experiments on the poisoning of frogs by nicotine and strychnia, and the mutual counteraction of these poisons, which he believed to be important, as the action of the antidote depended on its physiological and not on its chemical properties. Nicotine has been more than once used with success to counteract strychnine. We shall instance the case of a Mr. Johnson, of St. Louis, who took six grains of this drug, with the intention of committing suicide, but immediately afterwards, repenting of his act, he procured an emetic, which acted freely, but did not prevent violent symptoms of poisoning setting in. A Dr. Byrne was therefore called in, who, acting on Mr. Haughton's suggestion, made an infusion of tobacco, and administered it in table-spoonful doses at intervals of five minutes, until a favorable change was perceived. An hour and a quarter elapsed from the time of the poison being taken until the antidote was administered, but this delay in its action is accounted for by the emetic so promptly taken. The spasms disappeared after twelve hours, and in the course of a few days the patient was recovered. It is possible that other sedative poisons may act as antidotes to strychnia also, in evidence of which we may mention that, more than thirty years ago, Dr. Bewley wishing to kill a mangy cur, and having read in Magendie's "Report on Strychnia" that the sixteenth of a grain will kill the largest dog, determined to make sure of this very little animal by giving it about half a grain. But either Magendie's statement was incorrect, or the drug was adulterated; for at the end of ten minutes, the dog, though suffering frightfully, was not dead. Dr. Bewley resolved to put him out of his misery at once, and accordingly mixed half a drachm of prussic acid with a little milk, and put it under the dog's snout. He lapped the milk with avidity, and in less than a minute vomited, got upon his legs, ran away, and recovered. It must be observed that Mr. Haughton's proposal involves the principle of employing a physiological antidote to neutralize the *poisoning*, instead of merely rendering the poison inert by chemical means, which is the plan that has hitherto been universally adopted.—*London Lancet.*

ON "MARSH'S" TEST FOR ARSENIC.

At the Aberdeen meeting of the British Association, Dr. Odling read a paper, the object of which was to show that Marsh's test for the detection of arsenic was not reliable to the extent generally supposed. He stated that numerous and varied bodies, including the organic substance contained in ordinary earth, vegetable tissue, animal tissue, salts of copper, and ordinary salts, prevented the formation of arseniated hydrogen, and thereby defeated the action desired. As a mode of separating the arsenic from these interfering substances, the author recommended the process of distillation with muriatic acid, whereby arsenic in the form of chloride of arsenic is isolated in a form suitable for testing.

PECULIAR EFFECTS OF PHOSPHORUS.

At a session of the Cercle de la Presse Scientifique, in Paris, the Abbé Moigno directed attention to two facts, novel, and fit to figure in the pathogenesia of a poison, already charged with so many mischievous properties. Females, being *enceinte*, breathing air filled with phosphoric emanations in the establishments where matches are made, are sure to abort; and this result is so common and well known, that, in localities where the manufacture of matches engages a large number of workmen, the women profit by it to rid themselves of the product of conception. The abbé made this statement on the authority of a pious ecclesiastic, who guaranteed its authenticity. In men submitted to the same conditions, phosphorus vapors induce, after a little while, a vehement excitation of the generative functions.—*Journal de Chemi. Medicale.*

METAMORPHISM OF ROCKS.

Deville impregnated a piece of chalk with chloride of magnesium, and then heated it for a long time in a platinum crucible in a sand-bath. By a temperature of about 100° C., six to seven per cent. of lime were replaced by magnesia. Washing, and repeating this eight times, the ratio of magnesia to the lime was 1 : 2, or nearly that of a true dolomite (which is 1 : 1½).

In this reäction, however, some carbonic acid was given off, and oxychloride formed. But, on exposing the piece in water to the atmosphere, a little pure carbonate of lime formed, and separated with the chloride, and left a neutral dolomite. It was an unexpected result to find the carbonic acid of the atmosphere promoting this result, while a saturated solution of carbonic acid leads to the formation of bicarbonates.

Deville impregnated a sandstone which contained no lime with a mixed solution of chloride of calcium and magnesium, and submitted it to the action of a good red heat. After several repetitions of the process, the mass became spongy and more absorbent. Pulverized, and raised to a white heat, it fused to a milk-white mass, consisting of interlaced chrystalline fibres. Its specific gravity was 3·0; it was not attacked by acids; it contained no chlorine, but consisted of

$\ddot{Si}$ 56·0 $\dot{Ca}$ 26·3 $\dot{Mg}$ 17·7

equivalent to $(\dot{Ca}, \dot{Mg})^3 \ddot{Si}_2$, or a variety of pyroxene.— *L'Institute, No.* 1282.

RESEARCHES IN LIME, SALTS OF LIME, AND MAGNESIA, AND ON THE FORMATION OF GYPSUMS, MAGNESITES, AND DOLOMITES.—BY T. STERRY HUNT, F. R. S.

In these researches, undertaken to clear up several obscure points in Chemical Geology, the author shows, among other things—

1°. The action of dilute solutions of bicarbonate of soda, added by degrees to liquids which, like sea-water, contain both salts of lime and magnesia, determines at first the separation of all the lime as a nearly pure carbonate, after which there is found a very soluble bicarbonate of magnesia, which separates from concentrated solutions as a hydrous carbonate.

2°. Carbonate of lime, as is well known, requires for its solution about 1000 parts of water, saturated at the ordinary pressure with carbonic acid; but its solubility is much augmented by the presence of sulphates of soda or magnesia: in which case there is formed a bicarbonate of soda or magnesia, together with sulphate of lime, which may be precipitated by alcohol. When a solution of bicarbonate of lime, mingled with sulphate of magnesia, is evaporated at a gentle heat, crystalline gypsum is first deposited, while bicarbonate of magnesia remains in solution, and is separated, as the liquid is concentrated by evaporation, in the form of hydrous carbonate.

3°. When heated under pressure to 300° or 400° F., the hydrous carbonate of magnesia is converted into a sparingly soluble crystalline, anhydrous carbonate, which is magnesite; but if the amorphous hydrated carbonate is mingled with carbonate of lime and then heated, the two combine to form a double carbonate, which is dolomite.

In Haidinger's famous experiment, which was supposed to prove the formation of dolomite by the reäction, at 400° F., of a mixture of sulphate of magnesia and carbonate of lime, no double salt is formed; but a mixture of carbonate of lime and magnesia is readily separated by dilute acids. In Marignac's process, where chloride of magnesium replaces the sulphate, a portion of double carbonate is, however, formed, and remains mingled with magnesite and carbonate of lime.

4°. Besides the gypsums of epigenic origin, there are probably others which have been formed by the simple evaporation of liquids like sea-water, but the greater number of stratified gypsums are associated with magnesian rocks,—a fact which is readily explained by the reäctions indicated above.

Mr. Hunt considers attentively the various facts presented in the history of magnesian limestones, and rejecting entirely the theory which ascribes their formation to a metamorphism of sedimentary limestones, maintains that they have been produced by the chemical union of carbonates of lime and magnesia, which were deposited in a state of mixture from the waters of seas and lakes. The carbonate of magnesia has either been produced by the action of bicarbonate of lime with simultaneous formation of gypsum, or by bicarbonate of soda producing at the same time chloride of sodium. In this way have been formed those magnesian limestones which are not associated with gypsums. The intervention in this process of the waters of alkaline metalliferous springs, will explain the metalliferous character of many magnesian rocks. The source of the bicarbonate of soda has been the decomposition of feldspathic rocks, which have formed clays and clay slates; and the action of this alkaline carbonate upon the lime and magnesian salts of the primitive sea, has given rise to limestones and dolomites, as well as of the sea-salt which we find in the ocean. At the same time, the removal of the carbonic acid of the atmosphere, which was absorbed by the soda and then fixed in the form of carbonate of lime and magnesia, has served to purify the air, and fit it for the support of the higher orders of plants and animals. In this relation between the atmosphere, the argillaceous rocks, the limestones and the salt of the sea, we have a remarkable instance of the balance of chemical forces in inorganic nature. — *Silliman's Journal*, Vol. xxviii. pp. 170—365.

ON THE NUMERICAL RELATIONS EXISTING BETWEEN THE ELEMENTS.

The *American Journal of Science* for January 1859, contains the first part of a paper on the above subject, by M. Carey Lea, Esq., of Philadelphia, in which certain numerical relations between the elementary bodies, before unnoticed, or only partially noticed, are developed in a remarkable and exceedingly interesting manner.

Few of the so-called elements present more directly marked analogies than nitrogen, phosphorus, arsenic, and antimony ; while Cahours and Hofmann have shown that phosphorus stands in every respect intermediate between nitrogen and arsenic, forming compounds of the type $3(C_4H_5)PHCl$, etc., like the nitrogen compounds, as well as those of the type $3(C_4H_5)PO^2$, etc., like those of the arsenic and antimony groups. These authors further observe, that the equivalents of phosphorus, arsenic, and antimony, differ by nearly the same number (44 to 45), but that nitrogen does not exhibit this relation. Beyond the fact of the approximate equality of these two differences, the analogy has never been extended. Mr. Lea, however, shows that this relation may be extended not only to nitrogen, but, with exactness, to many other elements.

Thus, if we form a descending arithmetical series, beginning with antimony = 120·3, and diminishing by a common difference of 45 (45·3 in one instance, 44 in several), we shall find that such a series does not cease with the third term, P = 31, but gives for a fourth — 14, the exact equivalent of nitrogen with a negative sign. The fifth term will be — 59, the exact equivalent of tin (with a negative sign). The sixth will be — 104, or very nearly the equivalent of lead (also with a negative sign). The seventh — 149, very nearly double the equivalent of arsenic, a previons term in the same series. These results exhibit themselves more strikingly when tabulated, as follows:

It will be seen presently that the number 164, the eleventh term in the following table, occurs also in the ascending positive series, and may represent the equivalent of a metal existing, but as yet unknown.

If we examine the position occupied by antimony, arsenic, phosphorus, and nitrogen, in the electro-chemical scale of Berzelius, we shall find that in

Differences.	Calculated equivalents.	Received equivalents.	Differences.	Calculated equivalents.	Received equivalents.
	120 . .	Sb = 120·3			
45 .			45 .		
	75 . .	As = 75		— 194 . .	—— ——
44 .			45 .		
	31 . .	P = 31		— 239 . .	2 Sb = 240.6
45 .			45 .		
	— 14 . .	N = 14		— 284 . .	—— ——
45 .			44 .		
	— 59 . .	Sn = 59		— 328 . .	= 2 + 164
45 .			44 .		
	— 104 . .	Pb = 103·5		— 372 . .	—— ——
45 .			44 .		
	— 149 . .	2 As = 150		— 416 . .	2 Bi = 416

proportion as their equivalent numbers diminish, their properties become more and more electro-negative; a corresponding change is also visible in the organic radicals which these elements are capable of forming by their union with carbon and hydrogen. The passage from the positive to the negative sign in the interval between phosphorus and nitrogen, is accompanied by a marked change in the nature of the organic radicals into which these elements enter; — $3(C_4 H_5) N$ does not possess the power of combining directly with oxygen, chlorine and sulphur which $3(C_4 H_5)P$, $3(C_4 H_5)As$, $3 (C_4H_5)Sb$ exhibit in so high a degree. The methyl compounds show the same differences as the ethyl.

Again, if we begin with phosphorus, and form an ascending series with a common difference of 44 (except in one instance), we shall find both the number 164, the double of which constituted the eleventh term of the preceding table, and also the equivalent of bismuth, the double of which formed the thirteenth term of the same table.

Differences.	Calculated equivalent.	Received equivalent.
	. . . . 31	. . . . P = 31
44 . .		
	. . . . 75	. . . . As = 75
45 . .		
	. . . . 120	. . . . Sb = 120·3
44 . .		
	. . . . 164	. . . . — ——
44 . .		
	. . . . 208	. . . . Bi = 208

These four elements exhibit strong analogies and are all isomorphous with each other.

If, taking mercury as a starting-point, we subtract the number 44 from each term to find the following one, we shall obtain the series —

Differences.		Calculated equivalents.	Received equivalents.
		100	. . . . Hg = 100
44 . .	. . . .		
		56	. . . . Cd = 56
44 . .	. . . .		
		12	. . . . Mg = 12
44 . .	. . . .		
		−32	. . . . Zn = 36·2

The salts of the protoxides of the three last of these metals are isomorphous, and the metals themselves are all volatile.

It is not a little curious that the numerically negative members of this series lead into the positive members of the foregoing. If we continue the subtraction of 44, we find for the fifth number 76, or nearly the equivalent for arsenic; for the sixth 120, very nearly that of antimony; for the seventh 164, corresponding, as before remarked, with a possible undiscovered metal; and for the eighth 208, or exactly the equivalent of bismuth. The two series thus naturally lead to each other.

The members of these two analogous series are further united by the fact that all of them, eleven in number, are capable of uniting with the hydrocarbons of the methyl, ethyl, etc., type to form powerful organic metals, and that this capacity appears to be limited to these elements alone.

The magnesia group includes a well-marked natural family of metals, whose oxides having the constitution RO are related with each other by isomorphism. The equivalents of these metals, according to the most recent determinations, are as follows :

Magnesium,................	12	Chromium,.................	26·7
Manganese,.................	27·5	Zinc,.......................	32·6
Iron,.......................	28	Cadmium, ...	56·
Cobalt,......	29·5	Copper,.....................	31·7
Nickel,................... ..	29·6	Lead, ...	103·5
Uranium,..................	60		

They are furthermore related in the following manner by 44:

Thus, with Cu and Mg, Zn and Mg, the sum of each pair is 44 nearly.

With Cd and Mg, Pb and Ur, the difference of each pair is 44 or nearly.

With U and Mg, U and Fe, U and Co, U and Ni, U and Cr, Cd and Zn, the mean term is 44 or nearly.

With Pb and Mn, Pb and Fe, Pb and Ni, Pb and Co, Pb and Cr, the sum of each pair is three times 44 nearly.

The strong analogy existing between Mg, Cd and Zn, extends to their equivalents, that of Mg being added to that of Zn gives the number of 44 nearly, subtracted from that of Cd, 44 exactly.

Mr. Lea also shows, in a like manner, that relations depending upon the number 44, exist between the equivalents of the following metals, which may be classed together as tending to form acids; viz., tin, titanium, tantalum, tungsten, vanadiam, molybedenum, tellurium, niobium.

If commencing with gold, Au = 197, we form a diminishing series with a common difference of 44·5, we shall find for its terms —

Differences.	Calculated equivalents.	Received equivalents.
	197	. . . Au = 197
44 5 . .		
	152·5	. . . — ——
44·5 . .		
	108	. . . Ag = 108
44·5 . .		
	63.5	. . . Cu = 63·4

The equivalent of Cu has been here taken at double that usually employed, or that which results from taking the first oxide of copper as CuO, a view formerly entertained by Berzelius, L. Gmelin, and other distinguished chemists.*

The second number in the above series, 152·5, does not correspond with the equivalent of any known element, and, like the number 164, which occurs twice in the nitrogen series, may represent the equivalent of some elementary body as yet unknown.

The same relation may also be extended, with more or less approximation to the platinum group, which naturally divides itself into two families; rodium, ruthenium, and palladium; and platinum, iridium, and osmium; and the difference between the equivalents of the two groups approaches to 45.

So, also, if we take Gerhardt's equivalent of carbon = 12, the sum of the equivalents of carbon, boron, and silicium, amounts to 44 exactly.

From these and other examples, which Mr. Lea develops at considerable length, it is evident that the number 44 — 45 plays an important part in the science of Stoichiometry; and the relations which depend upon it are supported, in some cases at least, in a remarkable manner, by analogies of atomic volume. That such analogies are a support, becomes evident from the following considerations.

Solids and liquids are very far from being governed by the laws which determine the combinations of gases, in volumes either equal or having some simple relation to one another. Therefore, if we find that in some few instances such a relation does hold good with solid substances, we may naturally expect to find a close relationship existing between those substances thus united. We may even be permitted, by way of hypothesis, to advance a step further, and finding that a given volume of silver unites with a given volume of oxygen, and that the same volume of gold unites with precisely the same volume of oxygen, to conjecture that gold may differ from silver only by a third substance, which unites with the silver without increasing its volume, or affecting the amount of oxygen which it is capable of saturating, but which, on the other hand, alters its chemical equivalent, its specific gravity, and other physical characters.

Moreover, if we find that by subtracting from the chemical equivalent of silver half the difference between the equivalents of silver and gold we obtain the equivalent of a third metal, copper (Cu = 63·4), which also, under equal volumes, combines with a quantity of oxygen expressed by a very simple relation with that capable of saturating gold and silver, we may at

* In the cases of nitrogen, tin, and lead, the equivalents are taken with a negative sign, as before explained.

least speculate that the three may form a series consisting of two substances combined in different proportions. It is true that we must be extremely cautious about venturing upon hypotheses involving a compound constitution of bodies which all our efforts have hitherto proved ineffectual to decompose; but, on the other hand, it must be admitted, that when we find so-called elements arranging themselves into a series of terms having a common difference, and when we find the terms of these series united by equality or simple relation of atomic volume, we cannot grant that their elementary nature has been absolutely established.

The following substances combine relations of chemical equivalents already pointed out, with analogies of atomic volume:

Differences of Equivalents.		Atomic* volume.	Relation of At. vol.
	Nitrogen, ...	14·42	2
45* . .	Phosphorus (vapor), . .	7·01	1
44 . . .	Arsenic (vapor), . . .	7·07	1
	Lead, ...	9·09	1
44·5* . .	Tin, ...	8·09	1
45* . .	Nitrogen, ...		
45 . . .	Phosphorus, ...	17·7	2
44 . . .	Arsenic, ...	12·58	$\frac{3}{2}$
45·3 . .	Antimony, ...	18·—	2
87·7 . . or twice 43·85 . .	Bismuth, ...	21·18	$\frac{7}{3}$

(Where phosphorus, arsenic, etc., are compared in the solid state, the unit of relation is of course different.) It has been already remarked, that, in point of chemical relations generally, lead and tin are less closely united with the series than the other members composing it; but the relation between the atomic volumes of lead and antimony — the latter almost the last term at the other end of the series — is almost absolutely exact. Nitrogen is of course omitted in the second table, as we do not know what would be its atomic volume in the solid state.

For the further details of this paper, we must refer our readers to the journal to which they were originally contributed. In conclusion, however, Mr. Lea remarks, that the relation developed by him, depending upon the same, or approximately the same number, extends to no less than forty-eight of the elementary bodies, — the differences rarely exceeding the possible errors in the determination of the chemical equivalents; or to all the elements except those as yet imperfectly understood, most of which may yet range themselves under the same law, and except the oxygen group, — oxygen, sulphur, selenium and tellurium, substances which stand alone and unmistakably apart from the other elements.

* The numbers here given for the atomic volumes are calculated from the specific gravities adopted in Gmelin's Handbook, and the latest and most reliable determinations of chemical equivalent.

GEOLOGY.

ON THE CONDITIONS OF GEOLOGICAL TIME.

The successive modifications which the views of physical geologists have undergone since the infancy of their science, with regard to the amount and the nature of the changes which the crust of the globe has suffered, have all tended towards the establishment of the belief, that throughout that vast series of ages which was occupied by the deposition of the stratified rocks, and which may be called "geological time" (to distinguish it from the "historical time" which followed, and the "pre-geological time" which preceded it), the intensity and character of the physical forces which have been in operation have varied within but narrow limits; so that, even in Silurian or Cambrian epochs, the aspect of physical nature must have been much what it is now. This view of the condition of the earth, so far as geological time is concerned, is, however, perfectly consistent with the notion of a totally different state of things in antecedent epochs, and the strongest advocate of such "physical uniformity," during the time of which we have a record, might, with perfect consistency, hold the so-called "nebular hypothesis," or any other view involving the conception of a long series of states very different from that which we now know, and whose succession occupied pre-geological time. The doctrine of physical uniformity, and that of physical progression, are therefore perfectly consistent, if we regard geological time as having the same relation to pre-geological time as historical time has to it. The accepted doctrines of palæontology are by no means in harmony with these tendencies of physical geology. It is generally believed that there is a vast contrast between the ancient and the modern organic worlds — it is incessantly assumed that we are acquainted with the beginning of life, and with the original manifestation of each of its typical forms; nor does the fact that the discoveries of every year oblige the holders of these views to change their ground, appear sensibly to affect the tenacity of their adhesion. Without at all denying the considerable positive differences which really exist between the ancient and the modern forms of life, and leaving the negative ones to be met by the other lines of argument, an impartial examination of the facts revealed by palæontology seems to show that these differences and contrasts have been greatly exaggerated. Thus, of some two hundred known orders of plants, not one is exclusively fossil. Among animals, there is not a single totally extinct class; and of the orders, not more than seven per cent., at the outside, are unrepresented in the existing creation. Again, certain well-marked forms of living beings have existed through enormous epochs, surviving not only the changes of physical conditions, but persisting comparatively unaltered, while other forms of life have appeared and disappeared. Such forms may be termed "persistent types" of life; and examples of them are abundant enough in both the animal and the vegetable worlds. Among plants, for instance, ferns, club mosses, and *Coniferæ*, some of them apparently generically identical with those now living, are met with as far back as the carboniferous epoch; the cone of the oolitic *Araucaria* is hardly distinguishable from that of existing species; a species of *Pinus* has been discovered in the Purbecks, and a walnut in the cretaceous rocks. All these are types of vegetable structure, abounding at the present day; and surely it is a most remarkable fact to find them persisting with so little change through such vast epochs. Every sub-kingdom of animals yields instances of the same kind, which are known to have persisted from at least the middle of the Palæozoic epoch to our own times, without exhibiting a greater amount of deviation from the typical characters of these orders than may be found within their limits at the present day. It is difficult to comprehend the meaning of such facts as these, if we suppose that each species of animal and plant, or each great type of organization, was formed and placed upon the surface of the globe at long intervals by a distinct act of creative power. If, on the other hand, we view "Persistent Types" in relation to that hypothesis which supposes the species of animals living at any time to be the result of the gradual modification of preëxisting species, — an hypothesis which is supported entirely on negative evidence, and therefore wholly untenable in the present state of the science, — their existence would seem to show that the amount of modification which living beings have undergone during geological times, is but very small in relation to the whole series of changes which they have suffered. In fact, palæontology and physical geology coincide in indicating that all we know of the condition in our world during geological time, is but the last term of a vast and, so far as our present knowledge reaches, unrecorded series of changes in the condition of the earth. — *London Literary Gazette.*

ON DEEP-SEA EXPLORATIONS. — BY PROF. W. P. TROWBRIDGE.

The following is an abstract of a paper on this subject, communicated to *Silliman's Journal*, Vol. xxvi., No. 78, by Lieut. W. P. Trowbridge:

The first systematic deep-sea explorations were undoubtedly made by Commander C. H. Davis, U. S. N. This officer, in 1845, while running a line of deep-sea soundings across the Gulf Stream, obtained one cast of 1350 fathoms, and brought a specimen of the bottom, in the so-called "Stellwagen Cup." In the succeeding year, in the same explorations, soundings were made to the depth of 1500 and 2160 fathoms, without finding bottom; but, in the latter case, the temperature of the water was recorded at the depth named. In 1848, in the explorations off Cape Hatteras, the officer engaged in the explorations lost his instrument, with 3300 fathoms of line out. In these explorations of Commander Davis, 95 specimens of the bottom, and 25 specimens of water, at various depths, were brought up and preserved.*

* These specimens from the ocean bottom were submitted to the late Prof. Bailey, of West Point, for examination, who reported on them as follows: All the specimens are of the highest interest, being filled with organisms, particularly the calcareous Polythalamia, to an amount that is really amazing — hundreds of millions existing in every cubic inch of these green muds. The most interesting specimen

Our principal object, however, is to notice those great depths where *no bottom was found*, and to examine whether the failure *to find the bottom* was, under the circumstances, any proof that it did not exist at much less depths than those reported, or whether any conclusion whatever can be derived from the results.

When we reflect that two-thirds of the earth's surface is covered with water, while the remaining third is dry land, and that the figure of the solid part can only be known when we can trace with certainty the mountain-ranges and valleys along the bottom of the sea, it becomes important to scrutinize those reported measurements which give such enormous depressions in different parts of the sea, compared with which the highest mountain-ranges are insignificant elevations. Numerous instances have been reported in which soundings have been made to the depth of five, six, seven, eight, and nine miles, without finding bottom; and again over large areas the bottom of the sea is represented as a comparatively level plain, submerged to the depth of two, three, or four miles. Supposing these reported measurements to have been correct, we would have, still, very insufficient data for arriving at any correct conclusions with regard to the elevations and depressions of the ocean bed. What idea could be formed, for instance, of the topography of our country, if our knowledge of its surface consisted in knowing the height, above the level of the sea, of only one point in every State of the Union? Such points, selected at random, might be the highest or lowest points within an area of some thousands of square miles; and, after all, we would only know that it was possible to measure those heights, without being able to conjecture, even, their relation to each other. In the case of deep-sea soundings, we only know that bottom has been reached — in some instances at depths which show that our ideas concerning the unfathomable abysses of the ocean have been erroneous, and to sustain the belief that the mean depth is less than has been supposed. With regard to the uncertainties of the measurements, it is not sufficient to say that, compared with the immense area over which they are spread, the depths are very small. It might as well be argued that the height of the Alps is insignificant compared with the distance around the earth, and therefore an error in height of one or two miles is unimportant ; or that the elevations of ordinary mountain-ranges need not be noticed when compared with the area of a continent. We are dealing with finite quantities, not with the infinite with which they may be compared; and an error of several thousand feet in two or three miles is hardly within the limits of scientific accuracy.

Prominent among the instances of these reported unfathomable depths, stands the sounding of Captain Denham of the British navy, in H. M. S. *Herald*, made in October 1852, on a voyage from Rio de Janeiro to the Cape of Good Hope. This is an extreme case; but since it is reported among the greatest deep-sea casts, it will serve best for illustration.* All other great casts of the lead which have been reported are subject to the same causes of error which are to be found in this, some in a greater and some in a less degree ; so that it is not necessary for us to believe, yet, anything with

is the one labelled No. 1, latitude 38° 04′ 40″, longitude 73° 56′ 47″, 90 fathoms. This is crowded with Polythalamian forms, mostly large enough to be recognized by a practised eye without the aid of a magnifier.

* Lieutenant Maury discusses these deep casts in his sailing directions, but his rules for arriving at the depth, do not seem to me to be entirely satisfactory.

regard to them, except that they gave no result. The sounding of Captain Denham was made with a lead weighing nine pounds, attached to a line one-tenth of an inch in diameter: and it is reported that this lead descended to the depth of nearly nine miles in the sea without touching bottom.

In accordance with a plan which originated with the lamented G. M. Bache, U. S. N., in 1846, in the explorations of the Gulf Stream, and which has constantly been followed since, Captain Denham noted the time of running out of the successive portions of the sounding-line during the nine hours of its supposed descent. According to these observed times of descent, the nine-pound lead communicated to the descending line, at the depth of 3000 fathoms, or 18,000 feet, a velocity of two feet per second, — a result which is *philosophically impossible*, since the resistance of the water acting upon a line of this diameter, moving with a velocity of two feet per second, at the depth mentioned, amounts to more than three times the weight of the lead or shot used. It will hardly be necessary to enter into any argument to show that there can be no motion of descent, when the resistance to that motion is three times the weight of the moving mass. Further, the observations show that the nine-pound shot and line were running with a velocity of two feet and a half per second, at the depth of 2000 fathoms or 12,000 feet. Here the result contradicts, in quite as strong a manner, the mechanical laws of the descent; and in fact, below 1000 fathoms, or 6000 feet, if we credit the observations, a velocity was observed in the running out of the line which it was impossible for the lead to communicate to it. In fact, but a small part of that velocity could have been produced by the descent of the lead. Here we have a reliable result to the depth of 1000 fathoms only. The difference between this result and the conclusions of Captain Denham is simply the difference between *one mile* and *nine miles*.

In measuring the distance to the sun, an error of eight miles would hardly be worth noticing, perhaps; but what conclusions can be drawn from a measurement in which the probable error amounts to eight times the whole distance?

Popular ideas with regard to the sinking of bodies in the sea have heretofore been vague; for the reason, perhaps, that the laws which govern this descent, and which are derived from the well-known laws of fluids, have never been fully defined in their application to the depths of the ocean. Some imagine that ships which founder at sea sink to a certain depth and then float about until broken to pieces, or thrown upon some bank beneath the sea; and, indeed, a recent writer in England has published a book sustaining this absurd notion. Others, again, believe that the buoyant force of the water at great depths is enormous, and due to the whole pressure of the column of water above, and that all bodies which are lighter than water at the surface, will, if sunk to the bottom and detached from the sinker, shoot upward with a great velocity; or, in other words, that the *density* of the water increases directly with the depth. These views are erroneous. It is true the pressure increases with the depth, to the amount of fifteen pounds upon every square inch for every thirty-four feet in depth; but the density is not thereby sensibly increased, owing to the incompressibility of the water; so that neither the buoyant force nor the resistance to the motion of any body are sensibly increased from the surface to the bottom. At the depth of 3000 fathoms, for instance, the pressure upon a square inch is nearly 8000 pounds; but the column of 18,000 feet of water is only shortened about 60 feet. The density is thus but slightly increased; but the effect of this enormous pressure upon compressible bodies, as air, wood, etc., is to condense them into a smaller bulk, by which they may be rendered *heavier than water*, and will sink of their own weight. A piece of wood cannot float at the bottom of the sea, but a very slight extraneous force will bring it to the surface.

Now, how is it with the sounding-lead and line? The lead, if allowed to descend alone, will fall with a uniform and rapid velocity to the bottom. This velocity will be attained within a few feet of the surface, and will be due to the opposing forces of gravity and the resistance of the water, which will be balanced, when the uniform velocity is reached. But if a line be attached to the lead, a few hundred feet of the line will offer a resistance to the motion nearly equal to the whole weight of the lead; and as successive lengths of line are drawn into the water, the resistance is constantly increased; so that at 2000 or 3000 fathoms depth, the weight will be almost entirely suspended in the sea by the resistance of the water along the sides of the line.

Some idea of the resistance which opposes the motion of a sounding-line may be formed from the fact, that upon 1000 fathoms of a line one-tenth of an inch in diameter, moving with a velocity of three feet per second, the resistance is between twenty-five and thirty pounds; and if the velocity be increased to six feet per second, the resistance upon the line becomes a hundred pounds, nearly. Or, if the length of the line be doubled, with the same velocity, the resistance is doubled; and it is also directly proportional to the diameter of the line.

These are some of the reasons why an improvement in the mode of measuring the depths of the sea is not only desirable, but necessary, before a certain knowledge of those depths can be obtained.

THE GEOLOGY ON NEW ZEALAND.

It will probably be remembered, that a scientific expedition round the world, in the frigate *Novara*, was organized and despatched, about a year ago, by the Austrian government. Among the scientific officers appointed was Dr. Ferdinand Hochstetter, a geologist of great eminence; and it appears that when the *Novara* touched and remained for a few days at New Zealand, Dr. Hochstetter was so much struck by the peculiarities and interesting geological features of that country, that he applied for and obtained permission to remain six months in that island, in order that he might investigate its geology at his leisure, and especially that of the province of Auckland. The general result of Dr. Hochstetter's explorations, communicated to the New Zealand government, is as follows:

The first striking characteristic of the geology of Auckland, according to Dr. Hochstetter, is the absence of the primitive, plutonic, and metamorphic formations. The oldest rock that he met with belongs to the primary formation. It is of very variable character, sometimes being more argillaceous, and of a dark color, more or less distinctly stratified, like clay-slate; at other times, the siliceous element preponderates, and from the admixture of oxide of iron, the rock has a red, jasper-like appearance. No fossils have hitherto been found in this formation in New Zealand, and therefore it is impossible to state the exact age; it is possible, however, that these argillaceous, siliceous rocks correspond to the oldest Silurian strata of Europe. The existence and great area of this formation are of great importance, as all the metalliferous veins hitherto discovered in Auckland, or likely to be found, occur in rocks of this formation. To these rocks belong the copper pyrites, which have been worked for some years, the manganese, and the gold-bearing quartz at Coromandel. The gold which is washed out from beds of quartz-gravel, on both sides of the Coromandel range, is derived from quartz-veins of crystalline character and considerable thickness, running in a general direction, from north to south, through the old primary rocks which form the foundation of the Coromandel range. The coal-beds at Coromandel, occurring between strata of trachytic breccia, are too thin to be of any value, and there is no reason to suppose that a workable seam exists. Nearly all the primary ranges are covered with dense virgin forests, rendering them extremely difficult of access; but there is every reason to believe that they will yield considerable mineral riches. It is remarkable, that while one of the oldest members of the primary formation is found so extensively in New Zealand, the later strata of the Devonian, Carboniferous, and Permian systems, appear to be altogeter wanting; while, on the other hand, in the neighboring continent of Australia, these members of the primary period, together with plutonic and metamorphic rocks, constitute, so far as we know, almost the principal part of the continent. A very wide interval occurs between the primary rocks of the northern island, and the next sedimentary strata. Not only the upper members of the primary series are absent, but also nearly the whole of the secondary formations. The only instance of secondary strata met with by Dr. Hochstetter, consists of a very regular and highly-inclined bed of marl, alternating with micaceous sandstone, extending to a thickness of more than one thousand feet. These rocks contain remarkable specimens of marine fossils, which belong exclusively to the secondary period. The tertiary period must be divided into two distinct formations, which may, perhaps, correspond to the European eocene and miocene. The older of these formations contains the brown-coal seams, on the skilful working of which much of the future welfare of the province depends.

Dr. Hochstetter explored the remarkable limestone caverns at Hangatiki, near the sources of the Waipa, the former haunts of the gigantic Moa. He expected to meet with a rich harvest of Moa skeletons, but only found a few bones. The natives, according to his account, have long since carefully collected and stowed away, in safe hiding-places, all the Moa bones, in consequence of the value attached to them by Europeans; but they are willing to exchange them for money.

The volcanic formations in New Zealand are on a vast scale. Lofty trachytic peaks, covered with perpetual snow; a great variety of smaller volcanic cones, presenting all the characteristics of volcanic systems; and long lines of boiling-springs, fumaroles, and solfataras, — present an almost unbounded field of interest, and, at the same time, a succession of magnificent scenery.

The first volcanic eruptions were submarine, consisting of vast quantities of lava, breccia, tuff, obsidian, and pumice-stone, which, flowing over the bottom of the sea, formed an extensive submarine volcanic plateau. Subsequent eruptions formed lofty cones of trachytic and phonolithic lava. Thus, in the central part of the northern island, an extensive volcanic plateau exists, two thousand feet high, from which rise the two gigantic mountains, Tongariro and Ruapahu. From the former, smoke constantly issues, and the shape of the cone is changing, thus showing continual volcanic activity. A grand impression is made upon the traveller by these two magnificent volcanic cones, — Ruapahu shining with the brilliancy of perpetual snow; Tongariro with its black cinder cone capped with a cloud of white vapor; — the two majestic mountains standing side by side upon a barren desert of pumice, and reflected in the waters of Lake Taupo.

In immediate connection with the volcanoes are the hot-springs, solfataras, and fumaroles. In Iceland only are such a number of hot-springs found as exist in New Zealand. Although there may be no single intermittent spring in New Zealand of equal magnitude with the great Geyser in Iceland, yet in the extent of country in which such springs occur, in their great number, and in the beauty and variety of the siliceous incrustations and deposits, New Zealand far exceeds Iceland. All the New Zealand hot-springs, like those of Iceland, abound in silica, and may be divided into two distinct classes — alkaline and acid. To the latter belong the solfataras, characterized by deposits of sulphur, and never forming intermittent fountains. All the intermittent springs belong to the alkaline class, in which are also included most of the ordinary boiling-springs. Sulphurets of sodium and potassium, and carbonates of potash and soda are the solvents of the silica, which, on the cooling and evaporation of the water, is deposited in such quantities as to form a striking characteristic in the appearance of these springs.

Dr. Hochstetter's geological map of the Auckland district contains no less than sixty points of volcanic eruption within a radius of ten miles. The isthmus of Auckland is, in fact, completely perforated by volcanic action, and presents a large number of true volcanic hills, which, although extinct, and of small size, are perfect models of volcanic mountains. These hills — once the funnels out of which torrents of burning lava were vomitted forth, and afterwards the strongholds of savage cannibals — are now picturesque and pleasing features, being the homes of peaceful and prosperous settlers, whose fruitful gardens and smiling fields derive their fertility from the substances long ago thrown up from the fiery bowels of the earth. Volcanic action in New Zealand, according to Dr. Hochstetter, is dying out; and numerous facts prove that the action of the hot-springs is diminishing.

NOTES ON SPITZBERGEN.

The following is an abstract of a paper on the geological and physical features of Spitzbergen, communicated to the London Geological Society, by I. Lamont, Esq.

Mr. L. cruised about Spitzbergen, in his yacht, in the summer of 1858, and went up the Stour Fiord, which, he remarks, is a sound, dividing the island, not a gulf. The first thirty miles of coast along which he sailed on this Fiord, consisted almost entirely of the faces of two or three enormous glaciers; the water is shallow, seldom as much as sixteen fathoms, and such appears to be the case all around Spitzbergen; and hence icebergs of very large size are not formed. The shores are mostly formed of a muddy flat, from half a mile to three miles broad, with ice or hard ground, at from twelve to eighteen inches under the surface; this is intersected with muddy rivulets, and bears saxifrages, mosses, and lichens, on which the reindeer fattens. Protruding trap-rocks appear at many spots on these flats. A steep slope of mud, snow, and *débris* succeeds the flats, and reaches up to perpendicular crags of schistose rock, above which extend the great glaciers. Above these, peaks, probably of granite, appear, when free of mist. The upper part of the sound has much drift-wood, chiefly small pine trees, weather-worn and water-logged, and some wreck-wood. Bones and skeletons of whales are numerous. Drift-wood and bones of whales were observed several miles inland, and high above high-water mark — at least thirty feet. Whales' skeletons were also seen high up on the Thousand Islands. These circumstances, connected with the fact that seal-fishers and whalers state their belief in the shallowing of these seas, led the author to think that Spitzbergen and the adjacent islands are emerging from the sea at a rate even more rapid than that at which some parts of Norway have been shown to be rising.

THE MAELSTROM.

Of late years, even the existence of the Maelstrom on the coast of Norway has been doubted. The ancient accounts of its terrible power were doubtless fabulous; but the Maelstrom actually exists, and is sometimes dangerous. M. Hagerup, minister of the Norwegian marine, has recently given a reliable account of it, in reply to some questions from a correspondent of the *Boston Recorder*. The vast whirl is caused by the setting in and out of the tides between Lofoden and Mosken, and is most violent half way between ebb and flood tide. At flood and ebb tide it disappears for about half an hour, but begins again with the moving of the waters. Large vessels may pass over it safely in serene weather, but in a storm it is perilous to the largest craft. Small boats are not safe near it, at the time of its strongest action, in any weather. The whirls in the Maelstrom do not, as was once supposed draw vessels under the water, but by their violence they fill them with water, or dash them upon the neighboring shoals. M. Hagerup says:

"In winter, it not unfrequently happens that, at sea, a bank of clouds shows a west storm, with heavy sea, to be prevailing there, while further in, on the coast, the clear air shows that on the inside of the West-tjord (east side of Lofoden), the wind blows from the land, and sets out through the tjord from the east. In such cases, especially, an approach to the Maelstrom is in the highest degree dangerous; for the stream and under-current, from opposite directions, work there together to make the whole passage one single boiling cauldron. At such times appear the mighty whirls which have given it the name of Maelstrom (that is, the whirling or grinding stream), and in which no craft whatever can hold its course. For a steamer, it is, then, quite inadvisable to attempt the passage of the Maelstrom during a winter storm; and for a sailing vessel, it may be also bad enough in time of summer, should there fall a calm or a light wind, whereby the power of the stream becomes greater than that of the wind, leaving the vessel no longer under command."

GEOLOGICAL REVOLUTIONS.

The following is an abstract of a paper on the above subject, recently read before the Boston Society of Natural History, by Dr. C. F. Winslow:

"The general idea set forth in the communication is, that the earth, in falling to the sun, and following the same law of gravitation that governs any spheroidal or irregular body in falling to the ground, must change the inclination of its poles to the plane of the ecliptic with every translation of matter from one part of the mass to the other; that is to say, that its present equilibrium would be disturbed, and materially modified, by such changes as have, from time to time, transpired in producing the formation of mountain-chains, and continents, and broad oceanic depressions. This principle can be illustrated by experiments. The earth may be represented by a marble or small balloon falling in a vacuum. Modify the form of these, however slightly, or add particles of matter to one hemisphere or the other, and a partial rotation or change of equipoise is produced, turning the heaviest diameter towards the earth. If this principle holds with a marble, it will hold with the moon, and with the earth, and all planetary masses moving toward the great central mass.

"The second deduction is, that the earth was many miles larger in all its diameters, when organic life first appeared in its shallow seas; and the *modus agendi* of physical causes was illustrated, by which have been produced the profound geological revolutions that have divided the creative epochs. These causes lie in the play of the primal and central forces of the planet — attraction and repulsion — by which periodic condensation and expansion are effected (see 'Central Relations of the Sun and Earth,' *Annual of Scientific Discovery*, 1858, p. 361); and all geological revolutions are direct results of the locomotion of the planet (a rocky, irregular shell, with a plastic nucleus) in an orbit having *radii vectores* of unequal lengths. The igneous constitution of the globe, and its contraction in consequence of the radiation of heat, as first suggested by Leibnitz, is sustained; but the idea of slow and gradual puckering of the surface, maintained by Cordier and modern geologists, is discarded. The permanent contraction of the *nucleus* is produced by the escape of lava and heat from fissures and volcanic orifices, and by the conversion of heat into magnetism and electricity, during its transmission through the crust, thus originating metamorphosis and crystallization of primitive and superimposed rocks, in its diffusion and passage to the surface. These local processes, together with the periodic condensations arising from cosmical laws already referred to, produce atmospheric or gaseous voids between the nucleus and the mundane arch, which present possibilities, or absolute necessities, after long intervals, for general convulsions of the globe, attended by sudden engulfments, or subsidences of vast areas of its crust. Thus have the minor and greater delineations of surface now observable been brought about. When these catastrophes happen to the globe, the law of gravitation, as fundamentally stated above, immediately sways the planet into new polar relations to the plane of the ecliptic, and universal mutations of land, sea, climate, isothermals, life, and of every other terrestrial and geographical condition, follow. The facts on which were based these deductions were traced from small to greater at length, and the geological sequences noted, whatever the processes may have been which caused condensations of the nucleus. Kilanea, a pit 800 feet deep and nine miles in circumference, on the slope of Mauna Roa in Hawaii, is a geological fact of remarkable significance. Its walls are perpendicular; and Dr. Winslow, in his personal explorations, has observed the debris of the roof projecting in a line of ridges, from 50 to 150 feet high, above the sea of lava by which it had been swallowed up. Thingvalla, in Iceland, graphically described of late by Lord Dufferin, is another remarkable instance of engulfment; appearances all indicating a sudden catastrophe, — an area many miles in extent being partially submerged beneath the sea. Various sudden submergencies of small areas, within recent epochs, — for instance, that of the site of old

Callao, on the 28th of October, 1746; of the Quay of Lisbon, on November 1, 1755; and of New Madrid, on the 16th of December, 1811, and many other well-known facts of the same kind on record, — illustrate still more fully the *modus agendi* of these physical changes, and demonstrate the existence of subterranean voids to receive falling areas. From this series of facts, Dr. Winslow ascends to others of greater magnitude, like Seneca Lake, the chain of great North American lakes, the German Ocean, British Channel, and Gulf of Mexico, where identity of strata and fossil forms observable in opposite coasts and headlands clearly show former continuity, which can only have been destroyed by sudden and more or less complete engulfments of immense areas of surface. The existence of intervening islands, as of Cuba and Hayti in the Gulf of Mexico, and of Aru between Australia and New Guinea, is additional evidence of this position, — they bearing the same relation to surrounding coasts that the ridges of debris in the pit of Kilanea hold to their former connection with the level of the general surface of Mauna Roa. Carrying these observations still further, St. Paul's in the Indian Ocean, which Dr. Winslow personally explored, is found to be the vestige of a sunken continent, the extinct crater of some ancient Cotopaxi or Popocatapetl shattered and split, and opened to the incursion of the sea, by the great catastrophe which revolutionized the Southern Hemisphere during a former epoch. The Atoll formations, ingeniously divined by Darwin to betoken the earlier existence of mountain-ranges and chains of craters, not only strengthen this conclusion respecting a former continent in the Indian Ocean, as represented in the Maldives, Lacadives, and other islands; but their prodigious development in the Pacific Ocean, with evidences and logical deductions drawn from other geographical and geological data, settles the fact relative to the submergence of a continent in that part of the globe now occupied by the Polynesian Islands. Sudden changes of so stupendous a character would profoundly alter the equipoise of the globe, and produce such movements of the ocean as to overwhelm all lands, and give rise to drift phenomena as extensive as those which can be traced in the last geological ages.

"These deductions, extended into their astronomical developments, explain the unique relation of the moon to the earth, the longest diameter of the former being held steadfastly to the planet, while the sun controls the celestial movements of both; the various inclinations of the axles of the different planets to the planes of their respective orbits; and even the anomalous conditions of Uranus, whose retrograde rotation may be readily accounted for when the fact is recognized that successive revolutions of surface may have been so numerous or profound as to completely invert the planet from its primitive relation to the sun." — *Comm.*

ON THE THEORY OF GLACIERS.

It is only within a comparatively recent period that the attention of the modern scientific world has been especially directed to the very interesting and complicated phenomena of glacier action. Attempts had indeed been made by earlier observers to frame theories by which these phenomena could be explained; but further examination proved that the hypotheses thus proposed were not only insufficient to account for, but were in many cases inconsistent with, the results of observation. The more accurate researches of the last few years have, however, been attended with better success; and the main credit of attaining to this result is unquestionably due to Professor J. D. Forbes. In the course of several successive journeys to Switzerland, extending from 1841 to 1850, he instituted a series of minute observations on the phenomena of glacier action, from which he was at length enabled to elaborate a theory by which these phenomena were adequately explained. Until very recently, Professor Forbes's hypothesis met with all but universal acceptance; but early in 1857 it was controverted by Professor Tyndall, whose objections to it have not been removed by the result of observations and experiments made by him chiefly during the last two summers. The question being thus reöpened, it became a matter of interest to the public generally to ascertain more exactly the details of Professor Forbes's theory, and the grounds on which it rests; and with a view of supplying full information on this subject, the scattered papers of Prof. F. have been collected and published during the past year, by Messrs. Black, of Edinburgh. The appearance of this book furnishes a fitting opportunity for an attempt to estimate the contributions made by its author to our knowledge of the laws of glacier action; for which purpose it is necessary to state briefly the opinions which, before his time, were entertained on the subject.

The most striking and obvious phenomenon connected with glaciers is unquestionably their continuous motion. That they do move, is a fact which must have been evident to the earliest observers, from the barest consideration of the circumstances of the case. A glacier being a stream of ice, issuing from, and serving as an outlet to, the reservoirs of eternal snow, and extending thousands of feet below the line of perpetual frost, it is obvious that its lower extremity must be constantly thawing; so that, unless the glacier were as constantly advancing, its permanent existence below the snow-line would be an impossibility. Motion, therefore, being the one necessary condition of the existence of a glacier, the first task of the glacier theorist was plainly to assign a cause for this motion. The earliest theory on this subject was that known as the *Gravitation Theory*, originally proposed by Gruner, in a work published at Berne in 1760, but more generally associated with the name of De Saussure, its most illustrious exponent. According to this theory, the masses of ice which comprise the glacier, slide bodily over their rocky bed, urged by their own weight, — the motion being facilitated by the melting of the ice at the bottom of the glacier by contact with the warmer earth. The fatal objection to this theory is, that a sliding motion of this kind, when once commenced, must be accelerated by gravity, and the glacier must slide from its bed in an avalanche. Other valid objections are also found in the small slope of most glacier-beds, and their frequent contractions and changes of form through which it would be impossible that a rigid, unyielding mass of ice could be urged. The second hypothesis, known as De Charpentier's, or the *Dilatation Theory*, ascribes the moving force to the well-known expansion which water undergoes when converted into ice. A glacier is traversed by innumerable minute fissures, which, during summer, are filled with water, during the daytime; and this water, being frozen during the night, by its expansion thrusts forward the whole mass of the glacier in the direction of its slope. The same opinion was adopted by Agassiz, with the modification that the water freezes, not in minute fissures in the glacier, but in the capillary ducts by which its granular masses are traversed. According to this theory, the motion of a glacier must take place by fits and starts; it must be accelerated by cold weather and retarded by hot; and must cease altogether in the winter; — all conditions which are totally at variance with the now known nature of glacier motion. Further objections are, that in the height of summer, those parts of a glacier which move fastest are never reduced below the freezing-point; and that the congelation produced by nocturnal radiation cannot possibly extend more than a few inches below the surface of the glacier.

Such was the state of glacier theories at the time when Prof. Forbes approached the subject. He at once perceived that it was hopeless to attempt any explanation of the phenomena of glacier motion, without previously obtaining precise numerical data as to the nature and extent of that motion. Accordingly, in the summer of 1842, he commenced a series of observations on the Mer de Glace, which were continued, principally on the same glacier, during the following years, by which he was enabled to determine the daily, and even the hourly, motion of the glacier at different parts of its course, as well as that of different surface-points of the same portion of the glacier. By means of similar observations carried on under his direction by Auguste Balmat in 1844–5, the mean annual motion was determined, together with the effect produced on its velocity by changes of temperature. The result of these observations was the establishment of the following facts: The glacier moves *continuously*, day and night, winter and summer; the motion, however, is not *uniform*, being accelerated by heat and retarded by cold. It moves with varying velocity in different parts of its course, according to variations in the slope, width, and other physical peculiarities of its bed. The ice in the centre moves faster than that at the sides, and that at the surface faster than that at the bottom; the variation in velocity from the sides to the centre is always gradual, and is greater or less according to the actual velocity of the glacier at the time when, and the point where, the observation is made. Now, these are precisely the laws by which the motions of any viscous fluid (of which a river may be taken as the most familiar example) are governed; and, according to Prof. Forbes, they can only be expressed by the following theory, to which the name of the *Viscous* or *Plastic Theory* is commonly given : A glacier is an imperfect fluid, or viscous body, which is urged down slopes of certain inclination by the mutual pressure of its parts. The ice of which a glacier is composed is not perfectly coherent, but is traversed in all directions by capillary fissures, which are always more or less charged with water, derived from the surface-melting of the glacier itself, and of the snow-fields by which it is fed; and as the fluidity, and consequently the velocity, of the glacier varies with the amount of water which it contains, the retardation of its motion in the winter, and its acceleration in the summer are fully accounted for. The lowering of the surface of the glacier, which takes place during the summer, arising partly from superficial melting, partly from the attenuation and collapse of the parts which move most rapidly, is repaired during the winter, when the velocity of the whole glacier is diminished, and, the higher regions of the glacier moving relatively faster than the lower, the yielding mass of ice is pressed upwards in a vertical direction.

The above theory expresses so completely all the observed facts of glacier motion, that it gradually acquired all but universal acceptance, notwithstanding the startling nature of its assertion of the plasticity of a body which we have always been accustomed to regard as one of the most brittle of known substances. Professor Tyndall, however, while fully admitting that the motion of a glacier was that of a viscous fluid, was never able to reconcile himself to the notion of the viscosity of ice ; and accordingly, in a lecture delivered before the Royal Institution, in January 1857, he proposed another theory, by which the viscous motion of glaciers might be explained. This theory is based upon a fact announced by Mr. Faraday in 1850, that two pieces of ice at 32° will freeze together when brought into contact, either with or without pressure, — a phenomenon which Dr. Hooker has named "Regelation." By experiments with small masses, he showed that ice can be moulded by pressure into any given form; and he asserted that the plasticity of ice, whether upon the large or small scale, was owing, not to its viscosity, but to fracture and regelation.

Without pretending to arbitrate on a question disputed by such eminent authorities, we may observe, that we are not disposed to attach so much importance to the difficulty based upon the brittleness of small masses of ice. That ice is not perfectly rigid is shown by its frequent bending beneath the weight of the skater. Other bodies, scarcely less brittle than ice, will flow down slopes with precisely the motion of treacle, or any other viscous fluid: as is proved by an instance quoted in Professor Forbes's volume, in which Stockholm pitch was observed to flow very slowly out of a barrel, when it was sufficiently hard to break into fragments under the blow of a hammer. It would seem, therefore, that the properties of hardness and brittleness are not incompatible with that of viscosity, or quasi-fluidity. But, after all, the difference between the two theories is only one of degree. If we discard the term *viscous* altogether, and substitute for it the alias *plastic*,— which, indeed, Professor Forbes seems to prefer, — the same designation may be applied to both theories. Both agree in asserting that, by the subjection of glacier-ice to a peculiarly violent strain, solution of continuity is produced, which is afterwards repaired when the disjoined surfaces are brought into contact by pressure; but, according to Forbes, the solution of continuity is only partial; while, according to Tyndall, it is complete. Professor Tyndall may deny the viscosity of ice, but he will hardly deny its plasticity, since he has himself succeeded in moulding it by pressure into a variety of forms; and, whether solution of continuity which it undergoes in the process be partial or complete, is a circumstance by which the ultimate fact of its plasticity is not affected.

Hitherto we have considered the different glacier theories with reference to the one point of glacier motion; there are, however, several other phenomena connected with glaciers, whose explanation must be included in any complete theory on the subject, all of which, according to Professor Forbes, are fully accounted for by his hypothesis. We have not space to enter into a detailed enumeration of these phenomena, the explanation of which may, in most cases, be deduced with facility from the plastic theory; but we must dwell briefly upon two points, which appear to be closely connected with each other, and of which, in one case at least, the theoretical explanation is certainly less clear. We allude to the mode in which glacier ice is formed, and to the peculiar structure which it exhibits. We have already seen that the glacier proper issues from, and is, in fact, fed by, the vast snow-fields which occupy the higher plateaux of the mountains. It is to these snow-fields that the term *névé* or *firn* is applied. In the mass of névé a succession of strata of more and less crystalline snow is observed, which is generally admitted to be owing to the successive falls of snow by which it is formed. The question, therefore, arises, What is the process by which the granular snow of the névé is converted into the compact ice of the glacier proper? For some time Professor Forbes, sharing the then universal opinion that snow could not pass into pellucid ice without being first melted and then frozen, was inclined to attribute the conversion to the liquefaction and subsequent congelation of the névé snow. This view is plainly open to the same objection that is urged against the dilatation theory of De Charpentier; viz., that there is every reason to believe that the cold of the most prolonged winter penetrates to a comparatively small extent into the interior of the glacier. Accordingly we find that, in 1846, Professor Forbes abandoned this opinion, and expressed his belief that the snow is converted into ice by intense pressure exerted upon it when it is softened by the imminent approach of the thawing state; "the very first effect of which is to annihilate the strata of the névé, the most rapid glacification being effected by the kneading and working of the parts upon one another, by the differential motions which the semi-fluid law of glacier progression occasions, and which also necessarily takes place under intense pressure." Professor Tyndall, who verifies his conclusion by actual experiment, also holds that the phenomenon is caused solely by intense pressure; though, of course, he does not admit to any share in it that differential motion of particles which, according to Professor Forbes, constitutes the glacier a viscous fluid. We may, therefore, assume it to be established that the glacification of the névé is effected by pressure. We now come to the second point, the structure of glacier ice. In all glaciers whose ice is well consolidated, more especially in their middle and lower portions, the ice is found to be composed of alternate veins or laminæ of white, porous, and blue compact ice. These veins are of very varying width; they are most distinct in those parts of the glacier which are subjected to the greatest pressure. Their direction also varies considerably; but they appear generally to traverse the whole width of the glacier, in a curve bending down from the sides to the centre, and dipping forward in the direction of the glacier's motion. This *veined* or *ribboned structure* was first observed by M. Guyot, in 1838; but the first to attach to it a theoretical significance was Professor Forbes, who noticed it in the Aar glacier in 1841. He ascribes its formation to the differential motion of the glacier particles, occasioned by the friction of the glacier on its sides and bed, and by the pressure of the upper regions on those below; the result of such motion being the separation of the ice into a multitude of fissures, which constitute the blue veins, being filled up, not, as he at first believed, by the congelation of infiltered water, but simply by the effects of time and cohesion. Professor Tyndall, on the other hand, conceives that these veins are the result solely of external pressure (as opposed to differential motion of particles); and he states that they are always developed in directions perpendicular to the direction of pressure. Observing that the veined ice may be generally split in the direction of its laminæ, he traces an analogy between the veined structure and the lines of cleavage in slate; and he proves by experiment that wax, or any body not strictly homogeneous in its structure, may be endowed, by pressure, with the property of cleaving in lines perpendicular to the direction of the pressure. He further proves by experiment that ice, when subjected to pressure, is liquefied in lines perpendicular to the direction of pressure.

Notwithstanding the extreme beauty and ingenuity of Professor Tyndall's experiments, we cannot think that they are capable of affording a complete explanation of the veined structure of ice. As far as the development of perpendicular lines of cleavage goes, the analogy between slate and ice is perfect; but it fails in the point that in ice distinct laminæ are formed, varying in compactness; which, as far as we know, is not the case with slate. Prof. Tyndall's last-named experiment would seem to show that the blue veins are formed by the liquefaction of the ice in lines perpendicular to the direction of pressure. But, in this case, how is the freezing of this water effected? Not by the winter's cold, which could only affect the surface; nor by regelation, so long at least as the laminæ of ice and water are subjected to the pressure which causes the liquefaction. And yet parallel veins of ice and water are never found in any part of a glacier. The difficulty will be removed when it is proved that pressure will develop in porous ice perpendicular veins of compact ice, *without previous liquefaction.* — *Lit. Gazette.*

ON THE MARKS OF ANCIENT GLACIERS ON THE GREEN-MOUNTAIN RANGE IN MASSACHUSETTS AND VERMONT.

At the meeting of the A. A. for the Promotion of Science, 1859, Mr. C. H. Hitchcock, of Amherst, presented a communication on the above subject, which embodied in itself the results of investigations undertaken under the direction of Professor Edward Hitchcock, upon the mountains west of the Connecticut River, in Massachusetts and Vermont. The following, according to Mr. H., are the chief distinctions between the marks of the ordinary drift and the marks of glaciers:

1. Glacier striæ differ often widely in direction from drift striæ. The drift striæ may be referred to three general directions, — to the south, to the southeast, and to the southwest, — while the glacier directions are exceedingly various, sometimes coinciding with, and often crossing those left by the drift.

2. Glacier striæ occur only in valleys radiating outwardly from the crests of mountains, or in valleys tributary to a main valley, in which was the principal glacier, while the drift striæ overtop the mountains; or, when found in valleys, cross them obliquely.

3. Glacier striæ descend from higher to lower levels, except in limited spots, where they may be horizontal. Drift striæ as frequently ascend mountains hundreds of feet.

4. Drift is spread promiscuously over the surface, and the blocks are a good deal rounded. The detritus of glaciers more or less blocks up the valleys, and the fragments are frequently quite angular. These, however, are in part covered with other materials, which have descended from the mountains.

Mr. H. then carefully described the marks of an ancient glacier, to be seen in the west part of Hancock, in a valley through which Middlebury River commences to run, and within half a mile of the crest of the Green Mountains. Here several ledges of gneissoid rocks have two sets of striæ on them, — the one running south 50° east, the other set pointing west 30° south, down the valley. The glacier set are the most prominent; and they cross the drift set at an angle of 70°. The force by which the first set was produced was up-hill, towards the crest of the mountain, which, a few miles north of the road, rose some eight hundred or one thousand feet above the striæ. The force producing the second, or glacial set, was down-hill, in the direction of the river.

We find traces of another glacier, passing over the mountain towards Hancock. On reaching the cleared land, there are striæ in the bottom of the valley, pointing north 70° east, the agent of erosion being directed down the valley. In three places, also, before reaching the main branch of White River, are found accumulations of detritus, stretching across a considerable part of the valley, in the same manner as ancient terminal moraines are found in the valleys of the Alps. These have been somewhat modified by the subsequent action of water upon the surface.

At Hancock the valley meets the valley of White River at right angles; the striæ also are at right angles, for another glacier descended the valley of White River; and, like modern glaciers, these ancient ones united their forces at the junction, and travelled the larger valley together, bending, in their course, to all the sinuosities of the river, as the striæ curiously and clearly manifest.

Mr. H. had examined but one of the tributaries below, but there found (at Rochester) the clear evidences that a glacier came down its valley to meet the main one, which terminates near Stockbridge, where an immense terminal moraine crosses the valley. The total length of this glacier, so far as investigated, is eighteen miles, and each of the tributaries examined was about four miles. The slope, in all, was gradual and uniform.

A less striking example of the traces of glacial action is found upon the Otta Queechee, above Woodstock. Several miles further west, just east of Bridgewater, is a more decided example. Still others may be found on Deerfield River, running up to Searsburg, and at the Hoosac tunnel; at Windham, on the head waters of Saxton's River; at Mount Holly, running nearly east and west, on Black River; at Tinmouth, on Furnace Brook; and at Huntington. Probably the Green-Mountain Range was once covered with glaciers, on both sides, either before or after the drift period proper; for, in all these cases, away from the valleys, the drift striæ were found in abundance, pursuing a course diagonally to, or at right angles with, the course of the glaciers. If, as is probable, the glaciers existed before the drift, it would not be strange to find that occasionally the traces of their existence had disappeared, because the icebergs, etc., would wear away the striæ. The inaccessibility of their localities, and the decomposing character of the White Mountain rocks, made it less probable that glacier-marks would there be found. Still, research might very likely discover their traces.

ON THE THEORY OF IGNEOUS ROCKS AND VOLCANOES. BY T. S. HUNT, F. R. S.

In a note in the *American Journal of Science* for January, 1858, I have ventured to put forward some speculations upon the chemistry of a cooling globe, such as the igneous theory supposes our earth to have been at an early period. Considering only the crust with which geology makes us acquainted, and the liquid and gaseous elements which now surround it, I have endeavored to show that we may attain to some idea of the chemical conditions of the cooling mass, by conceiving these materials to again reäct upon each other under the influence of an intense heat. The quartz, which is present in such a great proportion in many rocks, would decompose the carbonates and sulphates, and, aided by the presence of water, the chlorides, both of the rocky strata and the sea, while the organic matters and the fossil carbon would be burned by the atmospheric oxygen. From these reäctions would result a fused mass of silicates of alumina, alkalies, lime, magnesia, iron, etc.; while all the carbon, sulphur, and chlorine, in the form of acid gases, mixed with watery vapor, azote, and a probable excess of oxygen, would form an exceedingly dense atmosphere. When the cooling permitted condensation, an acid rain would fall upon the heated crust of the earth, decomposing the silicates, and giving rise to chlorides and sulphates of the various bases, while the separated silica would probably take the form of crystalline quartz.

In the next stage, the portions of the primitive crust not covered by the ocean, undergo a decomposition under the influence of the hot, moist atmosphere charged with carbonic acid, and the feldspathic silicates are converted into clays with separation of an alkaline silicate, which, decomposed by the carbonic acid, finds its way to the sea in the form of alkaline bicarbonate, where, having first precipitated any dissolved sesquioxides, it changes the dissolved lime-salts into bicarbonate, which, precipitated chemically, or separated by organic agencies, gives rise to limestones, the chloride of calcium being at the same time replaced by common salt. The separation from the water of the ocean, of gypsum and sea-salt, and of the salts of potash, by the agency of marine plants, and by the formations of glauconite, are considerations foreign to our present study.

In this way we obtain a notion of the processes by which, from a primitive fused mass, may be generated the silicious, calcareous, and argillaceous rocks which make up the greater part of the earth's crust, and we also understand the source of the salts of the ocean. But the question here arises, whether this primitive crystalline rock, which probably approached to dolerite in its composition, is now anywhere visible upon the earth's surface. It is certain that the oldest known rocks are stratified deposits of limestone, clay, and sands, generally in a highly altered condition; but these, as well as more recent strata, are penetrated by various injected rocks, such as granites, trachytes, syenites, porphyries, dolerites, phonolites, etc. These offer, in their mode of occurrence, not less than their composition, so many analogies with the lavas of modern volcanoes, that they are also universally supposed to be of igneous origin, and to owe their peculiarities to slow cooling under pressure. This conclusion being admitted, we proceed to inquire into the sources of these liquid masses, which, from the earliest known geological period up to the present day, have been from time to time ejected from below. They are generally regarded as evidences, both of the igneous fusion of the interior of our planet, and of a direct communication between the surface and the fluid nucleus, which is supposed to be the source of the various ejected rocks.

These intrusive masses, however, offer very great diversities in their composition, from the highly silicious and feldspathic granites, eurites, and trachytes, in which lime, magnesia and iron are present in very small quantities, and in which potash is the predominant alkali, to those denser basic rocks, dolorite, dierite, hyperite, melaphyre, euphotide, trap, and basalt; in these, lime, magnesia, and iron-oxide are abundant, and soda prevails over the potash. To account for these differences in the composition of the injected rocks, Phillips, and after him Durocher, suppose the interior fluid mass to have separated into a denser stratum of the basic silicates, upon which a lighter and more silicious portion floats, like oil upon water; and that these two liquids, occasionally more or less modified by a partial crystallization and eliquation, or by a refusion, give rise to the principal varieties of silicious and basic rocks, while from the mingling of the two zones of liquid matter, intermediate rocks are formed.

An analogous view was suggested by Bunsen, in his researches on the volcanic rocks of Iceland, and extended by Streng to similar rocks in Hungary and Armenia. These investigators suppose a trachytic and a pyroxenic magma of constant composition, representing respectively the two great divisions of rocks which we have just distinguished; and have endeavored to calculate, from the amount of silica in any intermediate variety, the proportions in which these compounds must have been mingled to produce it, and consequently the proportions of alumina, lime, magnesia, iron-oxide, and alkalies which such a rock may be expected to contain. But the amounts thus calculated, as may be seen from Dr. Streng's results, do not always correspond with the results of analysis. Besides, there are varieties of intrusive rocks, such as the phonolites, which are highly basic, and yet contain but very small quantities of lime, magnesia, and iron oxide, being essentially silicates of alumina and alkalies in part hydrated.

We may here remark, that many of the so-called igneous rocks are often of undoubted sedimentary origin. It will scarcely be questioned that this is true of many granites, and it is certain that all the feldspathic rocks coming under the categories of hyperite, labradorite, euphotide, diorite, amphibolite, which make such so large a part of the Laurentian system in North America, are of sedimentary origin. They are here interstratified with limestones, dolomites, serpentines, crystalline schists and quartzites, which are often conglomerate. The same thing is true of similar feldspathic rocks in the altered Silurian strata of the Green Mountains. These metamorphic strata have been exposed to conditions which have rendered some of them quasi-fluid or plastic. Thus, for example, crystalline limestone may be seen in positions which have led many observers to regard it as intrusive rock, although its general mode of occurrence leaves no doubt as to its sedimentary origin. We find in the Laurentian system that the limestones sometimes envelop the broken and contorted fragments of the beds of quartzite, with which they are often interstratified, and penetrate like a veritable trap into fissures in the quartzite and gneiss. A rock of sedimentary origin may then assume the conditions of a so-called igneous rock, and who shall say that any of the intrusive granites, dolerites, euphotides, and serpentines, have an origin distinct from the metamorphic strata of the same kind, which make up such vast portions of the older stratified formation? To suppose that each of these sedimentary rocks has also its representative among the ejected products of the central fire, seems a hypothesis not only unnecessary, but, when we consider their varying composition, untenable.

We are next led to consider the nature of the agencies which have produced this plastic condition in various crystalline rocks. Certain facts, such as the presence of graphite in contact with carbonate of lime, and oxide of iron, not less than the presence of alkaliferous silicates, like the feldspars in crystalline limestones, forbid us to admit the ordinary notion of the intervention of an intense heat, such as would produce an igneous fusion, and lead us to consider the view first put forward by Poulett Scrope, and since ably advocated by Scheerer and by Elie de Beaumont, of the intervention of water aided by fire, which they suppose may communicate a plasticity to rocks, at a temperature far below that required for their igneous fusion. The presence of water in the lavas of modern volcanoes led Mr. Scrope to speculate upon the effect which a small portion of this element might exert, at an elevated temperature and under pressure, in giving liquidity to masses of rock, and he extended this idea from proper volcanic rocks to granites.

Scheerer, in his inquiry into the origin of granite, has appealed to the evidence afforded us by the structure of this rock, that the more fusible feldspars and mica crystallized before the almost infusible quartz. He also points to the existence in granite of what he has called pyrognomic minerals, such as allanite and gadolinite, which, when heated to low redness, undergo a peculiar and permanent molecular change, accompanied by an augmentation in density, and a change in chemical properties, — a phenomenon completely analogous to that offered by titanic acid and chromic oxide in their change by ignition from a soluble to an insoluble condition. These facts seem to exclude the idea of an igneous fusion, and point to some other cause of liquidity. The presence of natrolite, as an integral part of the zircon-syenites of Norway, and of talc and chlorite, and other hydrous minerals in many granites, shows that water was not excluded from the original granitic paste.

Scheerer appeals to the influence of small portions of carbon and sulphur in greatly reducing the fusing-point of iron. He alludes to the experiments of Schafhautl and Wöhler, which show that quartz and apophylite may be dissolved by heated water under pressure and recrystallized on cooling. He recalls the aqueous fusion of many hydrated salts, and finally suggests that the presence of a small amount of water, perhaps five or ten per cent., may suffice at a temperature which may approach that of redness, to give to a granitic mass a liquidity, partaking at once of the characters of an igneous and an aqueous fusion.

This ingenious hypothesis, sustained by Scheerer in his discussion with Durocher, is strongly confirmed by the late experiments of Daubrée. He found that common glass, a silicate of lime and alkali, when exposed to a temperature of 400° C., in presence of its own volume of water, swelled up and was transformed into an aggregate of crystals of wollastonite, the alkali with the excess of silica separating, and a great part of the latter crystallizing in the form of quartz. When the glass contained oxide of iron, the wollastonite was replaced by crystals of diopside. Obsidian, in the same manner, yielded crystals of feldspar, and was converted into a mass like trachyte. In these experiments upon vitreous alkaliferous matters, the process of nature in the metamorphosis of sediments is reversed; but Daubrée found still further that kaolin, when exposed to a heat of 400° C. in the presence of a soluble alkaline silicate, is converted into crystalline feldspar, while the excess of silica separates in the form of quartz. He found natural feldspar and diopside to be extremely stable in the presence of alkaline solutions. These beautiful results were communicated to the French Academy of Sciences in November, 1857, and enable us to understand the part which water may play in giving origin to crystalline minerals in lavas and intrusive rocks. The swelling up of the glass also shows that water gives a mobility to the particles of the glass at a temperature far below that of its igneous fusion.

I had already shown, in the report of the Geological Survey of Canada for 1856, p. 479, that the reäction between alkaline silicates and the carbonates of lime, magnesia and iron, at a temperature of 100° C., gives rise to silicates of these bases, and enables us to explain their production from a mixture of carbonates and quartz, in the presence of a solution of alkaline carbonate. I there also suggested that the silicates of alumina in sedimentary rocks may combine with alkaline silicates to form feldspars and mica, and that it would be possible to crystallize these minerals from hot alkaline solutions in sealed tubes. In this way I explained the occurrence of these silicates in altered fossiliferous strata. My conjectures are now confirmed by the experiments of Daubrée, which serve to complete the demonstration of my theory of the normal metamorphism of sedimentary rocks by the interposition of heated alkaline solutions.

But to return to the question of intrusive rocks: Calculations based on the increasing temperature of the earth's crust as we descend, lead to the belief that at a depth of twenty-five miles the heat must be sufficient for the igneous fusion of basalt. The recent observations of Hopkins, however, show that the melting-points of various bodies, such as wax, sulphur, and resin, are greatly and progressively raised by pressure; so that from analogy we may conclude that the interior portions of the earth are, although ignited, solid from great pressure. This conclusion accords with the mathematical deductions of Mr. Hopkins, who, from the precession of the equinoxes, calculates the solid crust of the earth to have a thickness of 800 or 1000 miles. Similar investigations by Mr. Hennessey, however, assign 600 miles as the maximum thickness of the crust. The region of liquid fire being thus removed so far from the earth's surface, Mr. Hopkins suggests the existence of lakes, or limited basins of molten matter, which serve to feed the volcanos.

Now the mode of formation of the primitive molten crust of the earth, would naturally exclude all combined or intermingled water, while all the sedimentary rocks are necessarily permeated by this liquid, and consequently in a condition to be rendered semi-fluid by the application of heat, as supposed in the theory of Scrope and Scheerer. If now we admit that all igneous rocks, ancient plutonic masses, as well as modern lavas, have their origin in the liquefaction of sedimentary strata, we at once explain the diversities in their composition. We can also understand why the products of volcanoes in different regions are so unlike, and why the lavas of the same volcano vary at different periods. We find an explanation of the water and carbonic acid which are such constant accompaniments of volcanic action, as well as the hydrochloric acid, sulphuretted hydrogen, and sulphuric acid, which are so abundantly evolved by certain volcanoes. The reäction between silica and carbonates must give rise to carbonic acid, and the decomposition of sea-salt in saliferous strata by silica in the presence of water, will generate hydrochloric acid, while gypsum in the same way will evolve its sulphur in the form of sulphurous acid mixed with oxygen. The presence of fossil plants in the melting strata would generate carburetted hydrogen gases, whose reducing action would convert the sulphurous acid into sulphuretted hydrogen; or the reducing agency of the carbonaceous matters might give rise to sulphuret of calcium, which would be in its turn decomposed by carbonic acid or otherwise. The intervention of carbonaceous matters in volcanic phenomena is indicated by the recent investigations of Deville, who has found carburetted hydrogen in the gaseous emanations of the region of Etna and the lagoons of Tuscany. The ammonia and the nitrogen of volcanoes are also in many cases probably derived from organic matters in the strata decomposed by subterranean heat. The carburetted hydrogen and bitumen evolved from mud volcanoes, like those of the Crimea and of Bakou, and the carbonized remains of plants in the *moya* of Quito, and in the volcanic matters of the Island of Ascension, not less than the infusorial remains found by Ehrenberg in the ejected matters of most volcanoes, all go to show that fossiliferous sediments are very generally implicated in volcanic phenomena. It is to Sir John F. W. Herschel that we owe, so far as I am aware, the first suggestions of the theory of volcanic action which I have here brought forward. In a letter to Sir Charles Lyell, dated February 20, 1836, he maintains that with the accumulation of sediment the isothermal lines in the earth's crust must rise, so that strata buried deep enough will be crystallized and metamorphosed, and eventually be raised, with their included water, to the melting-point. This will give rise to evolutions of gases and vapors, earthquakes, volcanic explosions, etc., all of which results must, according to known laws, follow from the fact of a high central temperature; while from the mechanical subversion of the equilibrium of pressure, following upon the transfer of sediments, while the yielding surface reposes upon a mass of matter, partly liquid and partly solid, we may explain the phenomena of elevation and subsidence. Such is a summary of the views put forward more than twenty years since by this eminent philosopher, which, although they have passed almost unnoticed by geologists, seem to me to furnish a simple and comprehensive explanation of several of the most difficult problems of chemical and dynamical geology.

To sum up in a few words the views here advanced. We conceive that the earth's solid crust of anhydrous and primitive igneous rock is everywhere deeply concealed beneath its own ruins, which form a great mass of sedimentary strata permeated by water. As heat from beneath invades these sediments, it produces in them that change which constitutes normal metamorphism. These rocks at a sufficient depth are necessarily in a state of igneo-aqueous fusion, and then in the event of fracture of the overlaying strata, may rise among them, taking the form of eruptive rocks. Where the nature of the sediments is such as to generate great amounts of elastic fluids by their fusion, earthquakes and volcanic eruptions may result, and these, other things being equal, will be most likely to occur under the more recent formations. — *Proc. Canadian Institute.*

ON SOME POINTS IN CHEMICAL GEOLOGY.

The following paper "On the Theory of the Transformation of Sedimentary Deposits into Crystalline Rocks," has been communicated to the London Geological Society, by Mr. T. Sterry Hunt, F. R. S., of the Canadian Geological Commission, and is reprinted from the Journal of the Geological Society, November, 1859, pp. 488—496. As elucidating many obscure points in chemical geology, it will be read with interest. — *Editor.*

In considering this process, we must commence by distinguishing between the local metamorphism which sometimes appears in the vicinity of traps and granites, and that normal metamorphism which extends over wide areas, and is apparently unconnected with the presence of intrusive rocks. In the former case, however, we find that the metamorphosing influence of intrusive rocks is by no means constant, showing that their heat is not the sole agent in alteration, while in the latter case different strata are often found affected in very different degrees; so that fossiliferous beds but little altered are sometimes found beneath crystalline schists, or even intercalated with them.

We cannot admit that the alteration of the sedimentary rocks has been effected by a great elevation of temperature, approaching, as many have imagined, to that of igneous fusion; for we find unoxidized carbon, in the form of graphite, both in crystalline limestone and in beds of magnetic iron-ore; and it is well known that these substances, and even the vapor of water, oxidize graphite at a red heat, with formation of carbonic acid or carbonic oxide. I have, however, shown that solutions of alkaline carbonates, in presence of silica and earthy carbonates, slowly give rise to silicates, with disengagement of carbonic acid, even at a temperature of 212 Fahr., — the alkali being converted into a silicate, which is then decomposed by the earthy carbonate, regenerating the alkaline salt, which serves as an intermedium between the silica and the earthy base. I have thus endeavored to explain the production of the various silicates of lime, magnesia, and oxide of iron, so abundant in crystalline rocks, and with the intervention of the argillaceous element, the formation of chlorite, garnet, and epidote.* I called attention to the constant presence of small portions of alkalies in insoluble combination in these silicates, both natural and artificial — a fact which had already led Kuhlmann to conclude that alkaline silicates have played an important part in the formation of many minerals; and I suggested † that, by combining with alkalies, clays might yield feldspars and micas, which are constantly associated in nature with the silicates above mentioned. This suggestion has since been verified by Daubrée, who has succeeded in producing feldspar by heating together for some weeks, to 400° C., mixtures of kaolin and alkaline silicates in the presence of water.

The problem of the generation from the sands, clays, and earthy carbonates of sedimentary deposits, of the various silicious minerals which make up the crystalline rocks, may now be regarded as solved; and we find the agent of the process, in waters holding in solution alkaline carbonates and silicates, acting upon the heated strata. These alkaline salts are constantly produced by the slow decomposition of feldspathic sediments, and are met with alike in the waters of the unaltered Silurian schists of Canada, and of the secondary strata of the basins of London and Paris. In the purer limestones, however, the feldspathic or alkaliferous elements are wanting; and these strata often contain soluble salts of lime or magnesia. These would neutralize the alkaline salts, which, infiltrating from adjacent strata, might otherwise effect the transformation of the foreign matters present in the limestones into crystalline silicates. By a similar process these calcareous or magnesian salts, penetrating the adjoining strata, would retard or prevent the alteration of the latter. These considerations will serve to explain the anomalies presented by the comparatively unaltered condition of some portions of the strata in metamorphic regions.‡

* Proceedings of the Royal Society, May 7, 1857.

† Report Geol. Surv. Canada, 1856, p. 479.

‡ De Senarmont, in his researches on the artificial formation of the minerals of metalliferous veins by the moist way, has shown that by aid of heated solutions of alkaline bicarbonates and sulphurets, under pressure at temperatures of 200° or 300° C., we may obtain in a crystalline form many native metals, sulphurets, and sulpharseniates, besides quartz, fluor-spar, and sulphate of barytes.

Daubrée has since shown that a solution of a basic alkaline silicate deposits a large portion of its silica in the form of crystalline quartz when heated to 400° C. We have here, beyond a doubt, a key to the true theory of metalliferous veins. The heated alkaline solutions, which are at the same time the agents of metamorphism, dissolve from the sediments the metallic elements which these contain disseminated, and subsequently deposit them, with quartz and the various spars, in the fissures of the rock.

II. As the history of the crystalline rocks becomes better known, we find that many which were formerly regarded as exclusively of plutonic origin are also represented among altered sedimentary strata. Crystalline aggregates of quartz and feldspar with mica offer transitions from mica-schist, through gneiss, to stratified granites, while the pyroxenic and hornblendic rocks of the altered Silurian strata of Canada pass, by admixtures of anorthic feldspars, into stratified diorites and greenstones. In like manner the interstratified serpentines of these regions are undoubtedly indigenous rocks, resulting from the alteration of silico-magnesian sediments, although the attitude of the serpentines in many countries has caused them to be ranked, with granites and traps, as intrusive rocks. Even the crystalline limestones of the Laurentian series, holding graphite and pyroxene, are occasionally found enveloping broken beds of quartzite, or injected among the fissures in adjacent silicious strata. From similar facts, observers in other regions have been led to assign a plutonic origin to certain crystalline limestones. We are thus brought to the conclusion that metamorphic rocks, such as granite, diorite, dolerite, serpentine, and limestone, may, under certain conditions, appear as intrusive rocks. The pasty or semi-fluid state which these rocks must have assumed at the time of their displacement, is illustrated by the observations of Daubrée upon the swelling up of glass and obsidian, and the development of crystals in their mass, under the action of heated water, indicating a considerable degree of mobility among the particles. The theory of igneo-aqueous fusion applied to granites by Poulett Scrope, and Scheerer, and supported by Elie de Beaumont, and by the late microscopic observations of Sorby, should evidently be extended to other intrusive rocks; for we regard the latter as being in all cases altered and displaced sediments.

III. The silico-aluminous rocks of plutonic and volcanic origin are naturally divided into two great groups. The one is represented by the granites, trachytes, and obsidians, and is distinguished by containing an excess of silica, a predominance of potash, and only small portions of soda, lime, magnesia, and oxide of iron. In the other group silica is less abundant, and silicates of lime, magnesia, and iron predominate, together with anorthic feldspars, containing soda, and but little potash. To account for the existence of these two types of plutonic rocks, Prof. J. Phillips supposes the fluid mass beneath the earth's crust to have spontaneously separated into a lighter, silicious, and less fusible layer, overlying a stratum of denser basic silicates. In this way he explains the origin of the supposed granitic substratum, of the existence of which, however, the study of the oldest rocks affords no evidence. From these two layers, occasionally modified by admixtures, and by partial separation by crystallization and eliquation, Prof. Phillips suggests that we may derive the different igneous rocks. Bunsen and Durocher have adopted, with some modifications, this view; and the former has even endeavored to calculate the composition of the normal trachytic and pyroxenic magmas (as he designates the two supposed zones of fluid matter underlying the earth's crust), and then seeks, from the proportion of silica in any intermediate species of rock, to deduce the quantities of alkalies, lime, magnesia, and iron, which this should contain.

So long as the trachytic rocks are composed essentially of orthoclase and quartz, and the pyroxenic rocks of pyroxene and labradorite, or a feldspar approaching it in composition, it is evident that the calculations of Bunsen will to a certain extent hold good; but in the analyses, by Dr. Streng, of the volcanic rocks of Hungary and Armenia, we often find that the actual proportions of alkalies, lime, and magnesia vary considerably from those deduced from calculation. This will necessarily follow when feldspars, like albite or anorthite, replace the labradorite in pyroxenic rocks. The phonolites are moreover highly basic rocks, which contain but very small amounts of lime, magnesia, or iron, being essentially mixtures of orthoclase with hydrous silicates of alumina and alkalies.

IV. In a recent inquiry into the chemical conditions of a cooling globe like our earth, I have endeavored to show that in the primitive crust all the alkalies, lime, and magnesia, must have existed in combination with silica and alumina, forming a mixture which perhaps resembled dolerite, while the very dense atmosphere would contain, in the form of acid gases, all the carbon, chlorine, and sulphur, with an excess of oxygen, nitrogen, and watery vapor. The first action of a hot acid rain, falling upon the yet uncooled crust, would give rise to chlorides and sulphates with separation of silica; and the accumulation of the atmospheric waters would form a sea charged with salts of soda, lime, and magnesia. The subsequent decomposition of the exposed portions of the crust, under the influence of water and carbonic acid, would transform the feldspathic portions into a silicate of alumina (clay) on the one hand, and alkaline bicarbonates on the other; these, decomposing the lime-salts of the sea, would give rise to alkaline chlorides and bicarbonate of lime — the latter to be separated by precipitation, or by organic agency, as limestone. In this way we may form an idea of the generation from a primitive homogeneous mass, of the siliceous, calcareous, and argillaceous elements which make up the earth's crust, while the source of the vast amount of carbonate of lime in nature is also explained.*

When we examine the waters, charged with saline matters, which impregnate the great mass of calcareous strata constituting, in Canada, the base of the Silurian system, we find that only about one-half of the chlorine is combined with sodium; the remainder exists as chlorides of calcium and magnesium, the former predominating, while sulphates are present only in small amount. If now we compare this composition, which may be regarded as representing that of the palæozoic sea, with that of the modern ocean, we find that the chloride of calcium has been in great part replaced by common salt, — a process involving the intervention of carbonate of soda, and the formation of carbonate of lime. The amount of magnesia in the sea, although diminished by the formation of dolomites and magnesite, is now many times greater than that of the lime; for so long as chloride of calcium remains in the water, the magnesian salts are not precipitated by bicarbonate of soda.†

When we consider that the vast amount of argillaceous sediment-matter in the earth's strata has doubtlessly been formed by the same process which is now going on, namely, the decomposition of feldspathic minerals, it is evident that we can scarcely exaggerate the importance of the part which the alkaline carbonates, formed in this process, must have played in the chemistry of the seas. We have only to recall waters like Lake Van, the natron lakes of Egypt, Hungary, and many other regions, the great amounts of

* Am. Jour. Sci. (2) xxv. 102, and Canadian Journal for May 1858.

† See Am. Jour. Science (2) xxviii. pp. 170 and 305; Annual of Scientific Discovery, 1859.

carbonate of soda, furnished by springs like those of Carlsbad and Vichy, or contained in the waters of the Loire, the Ottawa, and probably many other rivers that flow from regions of crystalline rocks, to be reminded that the same process of decomposition of alkaliferous silicates is still going on.

V. A striking and important fact in the history of the sea, and of all alkaline and saline waters, is the small proportion of potash-salts, which they contain. Soda is preëminently the soluble alkali; while the potash in the earth's crust is locked up in the form of insoluble orthoclase, the soda feldspars readily undergo decomposition. Hence we find in the analyses of clays and argillites, that of the alkalies which these rocks still retain, the potash almost always predominates greatly over the soda. At the same time these sediments contain silica in excess, and but small portions of lime and magnesia. These conditions are readily explained when we consider the nature of the soluble matters found in the mineral waters which issue from these argillaceous rocks. I have elsewhere shown that, setting aside the waters charged with soluble lime and magnesia salts, issuing from limestones, and from gypsiferous and saliferous formations, the springs from argillaceous strata are marked by the predominance of bicarbonate of soda, often with portions of silicate and borate, besides bicarbonates of lime and magnesia, and occasionally of iron. The atmospheric waters, filtering through such strata, remove soda, lime, and magnesia, leaving behind the silica, alumina, and potash — the elements of granitic and trachytic rocks. The more sandy clays and argillites being most permeable, the action of the infiltrating waters will be more or less complete; while finer and more compact clays and marls, resisting the penetration of this liquid, will retain their soda, lime, and magnesia, and, by subsequent alteration, will give rise to basic feldspars, containing lime and soda, and, if lime and magnesia predominate, to hornblende or pyroxene.

The presence or absence of iron in sediments demands especial consideration, since its elimination requires the interposition of organic matters, which, by reducing the peroxide to the condition of protoxide, render it soluble in water, either as a bicarbonate or combined with some organic acid. This action of waters, holding organic matter upon sediments containing iron oxide, has been described by Bischof and many other writers, particularly by Dr. J. W. Dawson, in a paper on the coloring matters of some sedimentary rocks, and is applicable to all cases where iron has been removed from certain strata and accumulated in others. This is seen in the fire-clays and iron-stones of the coal-measures, and in the white clays associated with great beds of greensand (essentially a silicate of iron), in the cretaceous series of New Jersey. Similar alternations of white feldspathic beds, with others of iron ore, occur in the altered Silurian rocks of Canada, and on a still more remarkable scale in those of the Laurentian series. We may probably look upon the formation of beds of iron ore as in all cases due to the intervention of organic matters, so that its presence, not less than that of graphite, affords evidence of the existence of organic life at the time of the deposition of these old crystalline rocks.

The agency of sulphuric and muriatic acids, from volcanic and other sources, is not, however, to be excluded in the solution of oxide of iron and other metallic oxides. The oxidation of pyrites, moreover, gives rise to solutions of iron and alumina salts, the subsequent decomposition of which, by alkaline or earthy carbonates, will yield oxide of iron and alumina; the absence of the latter element serves to characterize the iron ores of organic origin.* In this way the deposits of emery, which is a mixture of crystallized alumina with oxide of iron, have doubtless been formed.

Waters deficient in organic matters may remove soda, lime, and magnesia, from sediments, and leave the granitic elements mingled with oxide of iron; while, on the other hand, by the admixture of organic materials, the whole of the iron may be removed from strata which will retain the lime and soda necessary for the formation of basic feldspars. The fact that bicarbonate of magnesia is much more soluble than bicarbonate of lime, is also to be taken into account in considering these reäctions.

The study of the chemistry of mineral waters, in connection with that of sedimentary rocks, shows us that the result of processes continually going on in nature is to divide the silico-argillaceous rocks into two great classes, — the one characterized by an excess of silica, by the predominance of potash, and by the small amounts of lime, magnesia, and soda, and represented by the granites and trachytes, while in the other class silica and potash are less abundant, and soda, lime, and magnesia, prevail, giving rise to pyroxenes and triclinic feldspars. The metamorphism and displacement of sediments may thus enable us to explain the origin of the different varieties of plutonic rocks without calling to our aid the ejections of the central fire.

VI. The most ancient sediments, like those of modern times, were doubtlessly composed of sands, clays, and limestones, although from the principles already defined in IV. and V., it is evident that the chemical composition of these sediments in different geologic periods must have been gradually changing. It is from a too hasty generalization that an eminent geologist has concluded that limestones were rare in earlier times, for in Canada the Laurentian system — an immense series of stratified crystalline rocks, which underlie unconformably both the Silurian and the old Cambrian or Huronian systems — contains a limestone formation (interstratified with dolomites), the thickness of which Sir W. E. Logan has estimated at not less than 1000 feet. Associated with this, besides great volumes of quartzite and gneiss, there is a formation of vast but unknown thickness, the predominant element of which is a triclinic feldspar, varying in composition between anorthite and andesine, and containing lime and much soda, with but a small proportion of potash. These feldspars are often mixed with hypersthene, or proxene; but great masses of the rock are sometimes nearly pure feldspar. These feldspathic rocks, as well as the limestones, are associated with beds of hematitic and magnetic iron-ores, the latter often mixed with graphite. Ancient as are these Laurentian rocks, we have no reason to suppose that they mark the commencement of sedimentary deposits; they were doubtlessly derived from the ruins of other rocks, in which the proportion of soda was still greater; and the detritus of these Laurentian feldspars, making up our palæozoic strata, is now the source of alkaline waters, by which the soda of the silicates, rendered soluble, is carried down to the sea in the form of carbonate, to be transformed into chloride of sodium. The lime of the feldspars being at the same time removed as carbonate, these sedimentary strata, in the course of ages, become less basic, poorer in soda and lime, and comparatively richer in alumina, silica, and potash. Hence, in more

* Hydrated alumina, in the form of gibbsite, is however met with in incrusting limonite, and the existence of compounds like pigotite, in which alumina is united with an organic substance allied to crenic acid, seems to show that this base may, under certain conditions, be taken into solution by organic acids.

recent crystalline rocks, we find a less extensive development of soda-feldspars; while orthoclase, and mica, chlorite, and epidote, and silicates of alumina, like chiastolite, kyanite, and staurotide, which contain but little or no alkali, and are rare in the older rocks, become abundant.

The decomposition of the rocks is more slow now than formerly, because soda-silicates are less abundant, and because the proportion of carbonic acid in the air (an efficient agent in these changes) has been diminished by the formation of limestones and coal. It will be evident that the principles above laid down are only applicable to the study of rocks in great masses, and refer to the predominance of certain mineral species at certain geologic epochs, since local and exceptional causes may reproduce, in different epochs, the conditions which belong to other periods.

VII. Mr. Babbage* has shown that the horizons, or surfaces, of equal temperature in the earth's crust, must rise and fall, as a consequence of the accumulation of sediment in some parts, and its removal from others, producing, thereby, expansion and contraction in the materials of the crust, and thus giving rise to gradual and wide-spread vertical movements. Sir John Herschel† subsequently showed that, as a result of the internal heat thus retained by accumulated strata, sediments deeply enough buried will become crystallized, and ultimately raised, with their included water, to the melting-point. From the chemical reäctions at this elevated temperature, gases and vapors will be evolved, and earthquakes and volcanic eruptions will result. At the same time, the disturbance of the equilibrium of pressure, consequent upon the transfer of sediments, while the yielding surface reposes upon a mass of matter partly liquid and partly solid, will enable us to explain the phenomena of elevation and subsidence.

According then to Sir J. Herschel's view, all volcanic phenomena have their source in sedimentary deposits; and this ingenious hypothesis, which is a necessary consequence of high central temperature, explains, in a most satisfactory manner, the dynamical phenomena of volcanoes, and many other obscure points in their history — as, for instance, the independent action of adjacent volcanic vents, and the varying nature of their ejected products. Not only are the lavas of different volcanoes very unlike, but those of the same crater vary at different times; the same is true of the gaseous matters, hydrochloric, hydrosulphuric, and carbonic acids. As the ascending heat penetrates saliferous strata, we shall have hydrochloric acid, from the decompositon of sea-salt by silica, in the presence of water; while gypsum, and other sulphates, by a similar reäction, would lose their sulphur in the form of sulphurous acid and oxygen. The intervention of organic matters, either by direct contact, or by giving rise to reducing gases, would convert the sulphates into sulphurets, which would yield sulphuretted hydrogen when decomposed by water and silica, or carbonic acid — the latter being the result of the action of silica upon earthy carbonates. We conceive the ammonia so often found among the products of volcanoes, to be evolved from the heated strata, where it exists in part as ready-formed ammonia (which is absorbed from air and water, and pertinaciously retained by argillaceous sediments), and is in part formed by the action of heat upon azotized organic matter present in these strata, as already maintained by Bischof. Nor can we hesitate to accept this author's theory of the formation of boracic acid from the decomposition of borates by heat and aqueous vapor.

* "On the Temple of Serapis," Proc. Geol. Soc. vol. ii. p. 73.

† Ibid. vol. ii., pp. 548, 596.

The almost constant presence of remains of infusorial animals in volcanic products, as observed by Ehrenberg, is evidence of the interposition of fossiliferous rocks in volcanic phenomena.

The metamorphism of sediments *in situ*, their displacement in a pasty condition from igneo-aqueous fusion as plutonic rocks, and their ejection as lavas with attendant gases and vapors, are, then, all results of the same cause, and depend upon the differences in the chemical composition of the sediments, the temperature, and the depth to which they are buried: while the unstratified nucleus of the earth, which is doubtless anhydrous, and, according to the calculations of Messrs. Hopkins and Hennesey, probably solid to a great depth, intervenes, in the phenomena under consideration, only as a source of heat.*

VIII. The volcanic phenomena of the present day appear, so far as I am aware, to be confined to regions covered by the more recent secondary and tertiary deposits, which we may suppose the central heat to be still penetrating (as shown by Mr. Babbage), a process which has long since ceased in the palæozoic regions. Both normal metamorphism and volcanic action are generally connected with elevations and foldings of the earth's crust, all of which phenomena we conceive to have a common cause, and to depend upon the accumulation of sediments, and the subsidence consequent thereon, as maintained by Mr. James Hall in his theory of mountains. The mechanical deposits of great thickness are made up of coarse and heavy sediments, and by their alteration yield hard and resisting rocks; so that subsequent elevation and denudation will expose these contorted and altered strata in the form of mountain-chains. Thus the Appalachians of North America mark the direction and extent of the great accumulation of sediments, by the oceanic currents during the whole palæozoic period; and the upper portions of these having been removed by subsequent denudation, we find the inferior members of the series transformed into crystalline stratified rocks.†

* The notion that volcanic phenomena have their seat in the sedimentary formations of the earth's crust, and are dependent upon the combustion of organic matters, is, as Humboldt remarks, one which belongs to the infancy of geognosy (*Cosmos*, vol. v, p. 443, Otte's translation). In 1834, Christian Keferstein published his *Naturgeschichte des Erdkörpers*, in which he maintains that all crystalline non-stratified rock, from granite to lava, are products of the transformation of sedimentary strata in part very recent, and that there is no well-defined line to be drawn between neptunian and volcanic rocks, since they pass into each other. Volcanic phenomena, according to him, have their origin, not in an igneous fluid centre, nor an oxidizing metallic nucleus, but in known sedimentary formations, where they are the result of a peculiar process of fermentation, which crystallizes and arranges in new forms the elements of the sedimentary strata, with evolution of heat as an accompaniment of the chemical process. — *Naturgeschichte*, vol. i. p. 109; also *Bull. Soc. Géol. de France* (1) vol. vii. p. 197.

These remarkable conclusions were unknown to me at the time of writing this paper, and seem indeed to have been entirely overlooked by geological writers. They are, as will be seen, in many respects, an anticipation of the views of Herschel, and my own; although in rejecting the influence of an incandescent nucleus as a source of heat, he has, as I conceive, excluded the exciting cause of that chemical change, which he has not inaptly described as a process of fermentation, and which is the source of all volcanic and plutonic phenomena. See in this connection my paper on the Theory of Igneous Rocks and Volcanoes, in the Canadian Journal for May, 1858; see also Annual Sci. Dis., 1860.

† The theory that volcanic mountains have been formed by a sudden local elevation or tumefaction of previously horizontal deposits of lava and other volcanic

ON THE GEOLOGY OF THE CENTRAL PALÆOZOIC BASIN, OR AREA OF MIDDLE NORTH AMERICA.

In a paper communicated by Dr. I. J. Bigsby to the *Quarterly Journal of the Geological Society* of London, Vol. xiv. Part 4. No. 56, the author deduces the following conclusions respecting the geology of the central palæozoic basin or area of middle North America:

1. That, whatever may be the case elsewhere, the Silurian and Devonian systems of New York are parts of one connected and harmonious period, — the product of successive and varying Neptunian agencies, operating in waters which deepened westward from the Atlantic, and southwards from the Laurentine chain on the north.

2. That from the Catskill group (Old Red Sandstone) downwards through the whole series, to the Potsdam Sandstone, there is perfect and close conformability, and no such unwonted change in fossil life as to constitute a *systematic* break, except at one place — the Oriskany Sandstone, the base of the Devonian in New York, — there being no break of like importance at the Oneida conglomerate period, contrary to an opinion towards which able geologists are now inclining, — an opinion which leads them to consider the break at the Oneida conglomerate as systematic.

3. All the palæozoic groups of New York slowly pass one into the other by gradation of mineral and organic characters, with easily explained exceptions.

4. The palæozoic strata of New York are comparatively thin. They seem to have lost in thickness what they have gained in extension.

rocks, in opposition to the view of the older geologists, who supposed them to have been built up by the accumulation of successive eruptions, although supported by Humboldt, Von Buch, and Elie de Beaumont, has been from the first opposed by Cordier, Constant Prevost, Scrope, and Lyell. (See Scrope, *Geol. Journal*, vol. xii. p. 326, and vol. xv. p. 500; also Lyell, *Philos. Trans.* part 2, vol. cxlviii. p. 703, for 1858.) In these will, we think, be found a thorough refutation of the elevation hypothesis, and a vindication of the ancient theory.

This notion of paroxysmal upheaval once admitted for volcanoes, was next applied to mountains, which, like the Alps and Pyrenees, are composed of neptunian strata. Against this view, however, we find De Montlosier, in 1832, maintaining that such mountains are to be regarded only as the remnants of former continents, which have been cut away by denudation; and that the inversions and disturbances often met with in the structure of mountains are to be regarded only as local accidents. — *Bul. Soc. Geol.*, (1) vol. ii. p. 438, vol. iii. p. 215.

Similar views were developed by Prof. Hall, in his address before the American Association for the Advancement of Science, at Montreal, in August 1857. This address has not been published, but they are reproduced in the first volume of his *Report on the Geology of Iowa*, p. 41. He there insists upon the conditions which, in the ancient seas, gave rise to great accumulations of sediment along certain lines, and asserts that to this great thickness of strata, whether horizontal or inclined, we are to ascribe the mountainous features of North Eastern America as compared with the Mississippi valley. Mountain heights are due to original depositions and subsequent continental elevation, and not to local upheaval or foldings, which, on the contrary, give rise to lines of weakness, and favor erosion, so that the lower rocks become exposed in anticlinal valleys, while the intermediate mountains are found to be capped with newer strata.

In like manner, J. P. Lesley asserts that "mountains are but fragments of the upper layers of the earth's crust," lying in synclinals, and preserved from the general denudation and translation. — *Iron Manufacturer's Guide*, 1859, p. 53.

5. De Verneuil rightly divides the New York groups into two great classes, — the "constant" and the "local." Among the former are Potsdam Sandstone, Trenton Limestone, and Niagara. Among the latter are the four lower Helderbergs, and perhaps Oneida conglomerate, etc. This is a useful division.

6. That it is both convenient and natural to divide the Silurian and Devonian systems of this state each into three stages, — the division being based on change of sediment and their fossil contents.

7. The Middle Silurian stage is a period of especial transition — from the coarseness of some of its sediments, from their innumerable and minute alterations, and from the organic poverty prevailing.

8. That the presence of Oneida conglomerate in New York does not necessitate a change of name for all the strata below it (of "Cambrian" for instance), because a conglomerate does not always indicate *systematic* change, — not even if there be volcanic intercalation, provided there is conformableness, and some community of fossils.

The Oneida conglomerate seems to be local, is supernumerary, and only found at present on the east of middle North America.

9. The hardening and crystallizing effect of metamorphism is seen only in the neighborhood of hypogene rocks.

10. The New York basin exhibits few uplifts, and those of limited magnitude; no uplifts dividing it into a series of deep basins contained in hypogene beds, as in Bohemia, Wales, etc. Neither has it sheets of alternating volcanic grit (conformable), save in the Potsdam rock on Lake Superior.

This basin has a "lay," or position of its own, as a number of undulating sheets of sediment, dipping slightly to the southwest, here and there pierced by a peak of crystalline rock, and in certain regions raised into three broad, low domes, of great length.

11. The sedimentary rocks of this basin have submitted to two kinds of plutonic disturbance, independent of each other, and acting at distant intervals: 1st, that of secular or slow oscillation during deposition; 2nd, that of disturbance arising from paroxysmal uplifts long after their completion.

12. The whole Silurian and Devonian series of strata having, during deposition, sunk to the depth of 13,300 feet, it is submitted as a query whether it does not seem necessary to suppose that they were elevated into their present position by the post-carboniferous uplift, — such agency being sufficient to produce all the observed phenomena, and the effects diminishing westwards from the central line of disturbance. No other agency is known to me, although hinted at by [some] American geologists.

13. It is a remarkable fact that brine-springs exist in considerable quantity in the middle stage of the Silurian system, a group or two below the Onondaga salt-springs of the upper stage, and three palæozoic systems below any salt deposits in Europe.

14. That the form and direction of the five great Canadian lakes are not due originally and mainly to the passage of loaded waters over their site, but that they follow the outcrops of their containing sedimentary rocks; changes in shape and size having, nevertheless, occurred since.

15. The contours of the valley of the St. Lawrence generally (to which much of New York belongs), and its increasing elevation south-westwards, inland from Montreal, are due to the successive altitudes assumed westward, in slopes and plateux, by the Silurian and Devonian strata — the lowest

or most ancient being on the east. This is beautifully evidenced in the rocks forming the basins of the great Canadian lakes.

16. That some of the groups, during and after deposition, were sub-atmospheric, presenting the conditions of dry land and shallow waters for long and varying periods: and that, together with the marine life they supported, they enjoyed the influences of the sun, and other meteorological agencies. This is indicated by animal tracks, sun-cracks on ancient shores, the short ripple-marks of a chopped sea, impressions of reeds waving in running water, and in presence of bog-iron ore. This is conformable with what took place in the carboniferous, permian, triassic, liassic, oolite, wealden, and later periods. Denudations also occurred to most of the groups to a large extent.

17. That in New York, as elsewhere, there is an intimate connection between fossils and their sediment or habitat. The calcareocolous animals are always found in limestone more or less pure, and the arenicolous in sandstone more or less pure, — with exceptions, such as usually happen with locomotive animals. The calcareocolous are everywhere the most numerous. It is true that molluscs are the principal agents in the deposition of calcareous sea bottoms; but these latter greatly favor afterwards the multiplication of individuals.

18. That the iron ore which we so frequently see investing invertebrate remains, had access to them after their death and sepulture.

19. Every group, as established by the State Geologists of New York, is a distinct centre of life — a separate realm or community of animated beings, which may be called epochal, so marked are the differences.

The majority of these existences always perished at the end of the group when certain deposits ceased, because the new sediment, with its new and peculiar flora (and for other reasons), was only able to nourish a few, if any, of the old molluscs.

20. In New York the species of fucoids occupy and are typical of only one group.

21. All the individual existences are perfect at once, from the earliest dawn of life, in their organization and social relations.

22. It is a great thought, that throughout the incalculably long succession of fossiliferous deposits, palæozoic or more modern, all animal and vegetable life was constructed upon the same idea of innervation, organs of sense, supply and waste, fecundation, etc.

23. There is another kind of life-centre — the geographic, belonging to one and the same group. This forms numerous separate provinces, linked together by a few common fossils, and displaying extraordinary variety. This principle or regulation is carried out abundantly everywhere. Bohemia and Scandinavia have scarcely a Silurian fossil in common. One-half of the Russian and Irish fossils, and two-thirds of those of New York, are new and peculiar. Even the east and west sides of the small districts in Wales and England, investigated by Prof. Philips, differ remarkably in their population. We see this in the American Tertiaries, and in the recent seas.

24. Contrary to the opinion of Mr. D. Sharpe, the mollusc having the greatest vertical range has the greatest horizontal extension, being found in the most distant regions.

25. There is no evidence of multiplication of species by transmutation.

26. Fossils may be contemporaneous in geological age, without being contemporaneous *in time*, as commonly understood.

Geological age is partly determined by fossil evidence. Now, the presence of living beings (subsequently fossil) depends on mineral and other conditions, such as temperature, depth, currents, etc., which were nowhere the same for large spaces, but were always undergoing changes from plutonic and other causes — changes always more or less local and limited, the deposits being thick or thin in places: so that the universal scheme of palæozoic life was not everywhere worked up to the same point. Here preparations were making for Lower Silurian deposits; there, for the Upper, or Devonian, and so on. Thus isochronism was perhaps not common.

27. The principles of recurrency, succession, increment, and relative abundance of fossil species, are the same in New York, Wales, and elsewhere, modified by local circumstances.

28. Recurrency, or reäppearance in different strata, is at the same time the measure of viability in the species, and of connection in the groups of strata. It is a kind of living nexus, pointing out that the groups belong to one and the same order of things. It may have been partly caused by migration.

Recurrency is not so common in New York as in Wales; in other words, vertical range is longer in Wales. Great depth is an obstacle to the existence or transmission of living creatures.

29. Everywhere, on the eastern as well as on the western continent, the same fossils, of all orders and kinds, appear in the same succession. A very few Crustacea and a *Lingula* or *Obolus* or two, amid a dense matting of fucoids, appear at what now seems to be the dawn of life; then some Gasteropoda, a few Cephalopoda, and a few Brachiopoda in the third group from below (Chazy). But in the fifth group from below (Trenton), multitudes of Zoöphyta, Bryozoa, Brachiopoda (save *Spirifrei*), Orthocerata, and Trilobites spring forth; but not a Lamellibranchiate. As species, they nearly all perish with the advent of a new deposit; but, as genera, they appear one after another through the successive epochal centres, becoming multiplied in numbers and perfect in form. Then they lessen in numbers, dwindle in size, and finally disappear.

30. There is a close similarity in New York and Wales in the increment and decrement of Zoöphyta, Bryozoa, Echinodermata, Brachiopoda, etc.; that is, these fossils are numerous and few at the same points of the Silurian scale.

31. The same genera, species, and amount of individuals abound or are few in the countries just named. Brachiopoda, Crustacea, Orthocerata, are many; Lamellibranchiates few. The extraordinary opulence in fossils of the Rhenish Devonian strata does not obtain in New York. In New York, however, according to our present list, the Lower Silurian stage is the most fossiliferous; in Wales, it is the Upper. Future discoveries may change this condition of things.

32. A remarkable feature in the uppermost four groups of New York Siluria (the Lower Helderberg) is the substitution in them of limestone for the arenaceous mud of the Welsh Ludlows, their contemporaries. It has given them a Wenlock character. But it is to be remembered that the Ludlow and Wenlock groups of Wales are in close fossil connection, — 74 out of 311 species of organic remains being common to both, or very nearly one quarter.

I shall not proceed at present with these inferences into the American Devonian system, although there is no want of interest. I may just remark that many Silurian Brachiopoda and some other molluscs work themselves up into the Devonian as representatives of a common period. They may even be found in the carboniferous system, as has been proved by D'Archiac and De Verneuil, to be not uncommonly the case in Europe.

The great ruling zoölogical principles of the Silurian system are continued into the Devonian; but in the latter we have the introduction of Vertebrates in profuse variety, and of new and complex types of Invertebrates in unwonted abundance, the old forms dying out. — *Silliman's Journal*, March 1859.

BEAUTIFUL APPLICATION OF GEOLOGICAL SCIENCE TO MINING ENGINEERING.

One of the most beautiful and successful applications of geological science to mine engineering has recently been made in England, on the estate of the Duke of Newcastle, near Nottingham. In 1853, it was considered desirable to open a particular vein of coal, known as the "top-hard," at a point removed from its outcrop and workings; and, under the advice of experienced geologists, a location on the new red sandstone formation, five miles distant, was selected, and the work of sinking a shaft commenced. The confidence entertained in the geological estimates is well illustrated by the fact, that nearly five years of uninterrupted labor have been required to reach the proposed depth, where the vein has been struck (during the past year), as was predicted. The strata passed through, in sinking the shaft, were as follows: 54 feet of new red sandstone and marl; 112 feet of Permian limestones, shales, and sandstones; and 1364 of strata belonging to the Carboniferous formation: total, 1530 feet. One sandstone (sixty-six feet thick) in the coal-measures was so full of water, that nearly twenty months were taken up in working through it, — the water being stopped, step by step, with iron tubing.

THE FROZEN WELL OF BRANDON, VERMONT.

At the meeting of the American Association for the Promotion of Science, 1859, Prof. Hitchcock presented the following paper on the curious frozen well of Brandon, Vt.:

This well is situated about one mile southwest of Brandon village, from an eighth to a quarter of a mile east of the creek. The surface is not raised very much above the river, and is composed of sand and gravel, with one of the varieties of the lower Silurian limestone, showing itself occasionally in bosses and low ridges, breaking through the ground, and doubtless underlying the whole superficial deposit at no great depth. It is just such a region of sand and gravel as may be seen in many places along the western side of the Green Mountains, and indeed all over New England. It is what is called modified drift, and lies above genuine drift, having been the result of aqueous agency, subsequent to the drift period. The well was dug in November 1858. For about ten feet it passed through soil and gravel, then about four feet of clay. Below this lay a deposit, from twelve to fifteen feet thick, of frozen gravel, with quite large boulders intermixed. Continuing the excavation two feet farther in the same material, water was reached. The frozen part passed through appeared precisely like the same materials frozen at the surface in winter. The depth of the well is about thirty-four and a half feet, and it has about two and a half feet of water in it. Its diameter is about three feet, and it is properly stoned up with rounded boulders of limestone, and has a curb around the top. A marble slab, with a circular hole eighteen inches in diameter, covers the well, the windlass being protected by a roof made of a couple of boards nailed together.

Immediately west of the well rises a hill of gravel and sand, which may be thirty feet above the well, and at its south end some fifty to seventy feet high. This ridge is an eighth of a mile long, and runs northeast and southwest. Near its northern end it is crossed by a road which has been excavated to a depth of sixty-two feet. At the top of the ridge the bed of clay and the layers of sand and gravel are nearly horizontal, but lower down they dip easterly fifteen or twenty degrees. At the foot of the hill they take a horizontal position. The pebbles in the strata were about three inches in diameter, and remarkably free from sand and gravel. The dip of those beds of gravel, sand, and clay, make it almost certain that this ridge of drift was formed by a current from the northeast.

The well was stoned up late in the autumn, and during the winter ice formed upon the water, in one night, two inches thick. It continued to freeze till April, since which time no ice has formed on the surface; but when visited June 25th, the stones of the well, for some four or five feet above the water, were mostly loaded with ice, and the temperature of the water was only one degree above freezing. July 14th, there was ice in the well. The water at that time was twenty-two inches deep. About one hundred rods distant is another well, the temperature of which, on the 25th of June, was fifty-one. Another well, twelve feet deep, sixty rods distant, had a temperature of forty-five.

In this connection, Prof. Hitchcock entered at length upon similar phenomena which had been observed in other places, — of a well in Ware, Mass., dug through gravel and sand, which froze last year, though not to the extent of that at Brandon. There were other instances of frozen wells on record, — one in the thirty-sixth volume, first series, of the *American Journal of Science.* This well is in Owego, N. Y. In this, the flame of a candle was deflected, indicating a current of air passing through the gravel strata. The well was on the table-land of the Susquehanna, about thirty feet above the river. There was also an account of an ice-mountain in Virginia, which was satisfactorily explained as being a natural refrigerator, — the cold of the winter being retained through summer on account of a variety of causes. Sir Roderick Murchison has mentioned a similar mountain in Siberia.

Prof. Hitchcock said, that before giving a probable theory of the phenomena at Brandon, he would present a few preliminary propositions.

1. He regarded the cases at Ware and Owego as essentially like that at Brandon, and to be explained in the same manner.

2. The phenomena most probably have a connection with a gravelly and sandy soil; hence we should make the character of such soils an element in our investigations.

3. As the gravelly deposit is in such a soil, the idea is precluded that the congelation is the result of chemical reägents.

4. The temperature in the wells is strongly affected by the temperature

of the air at the surface. In winter the cold is much more intense than in summer.

The subject presented two leading inquiries. 1st. When, and by what agency, was the congelation produced so deep beneath the surface? 2d. By what means is the frost preserved from external and internal heat? In reply, there were two suggestions to be made. 1st. These frozen deposits may have been produced during the glacial period that accompanied the formation of the drift.

This suggestion was dwelt upon at length, and it was contended that a frozen deposit of any past period might be indefinitely preserved. Experiments had been made which showed that even a thin layer of clay was a powerful resistant to heat. The clay on the surface at Brandon would exclude the external heat, while the gravelly strata, free from sand, would act as a tunnel to carry the ascending internal heat to the surface, and it would not, therefore, reach the frozen deposit. The arrangement at Brandon was in many respects similar to the most approved ice-houses. But, after all, he was not sure that this was the true theory.

There was another theory. 2d. We maintain that, in porous depositions, especially when interstratified with those nearly impervious to air, ice may be formed in large quantities at any depth, and remain unmelted for a great length of time. This position was elaborated, — showing by diagrams that when a porous mass was overlaid by clay, the heat of summer could have but little effect upon it. It had been stated, and it had not been disproved, that there were subterranean currents of air. At Owego, the candle-flame was deflected at the depth of thirty feet.

Upon the whole, though it is possible that the Brandon deposit is a remnant of a glacial period, he looked with more favor upon the supposition that it was the result of operations now going on, produced by currents of air through the porous deposit.

In a discussion of these phenomena at a recent meeting of the Boston Society of Natural History, Prof. W. B. Rogers observed, "that it was important to consider the mean temperature of the place, in explaining the phenomena of frozen wells. The mean annual temperature of Brandon is only 45° F.; of the winter, 20°; of the spring, 40°; giving for the winter and spring a temperature of 30°, or two degrees less than the freezing-point of water. In fact, at about the depth of thirty or forty feet, a reversal of the seasons takes place, so slow is the progression of temperature downward. The access of external air is also important. The temperature of the air in winter at the bottom of this well must be very low. The lateral perforation of this low temperature ought to be traced; the law of progress of temperature from the surface downward, in this special locality, should be ascertained. So that the question of explanation becomes very complicated."

In connection with this subject, some interesting observations have been made by Mr. J. W. Andrews, of Albany, on the temperature of Lake Dunmore, a considerable body of water, situated about eight miles in a northeasterly direction from the well at Brandon. The average depth of water in this lake, Mr. Andrews found, by frequent soundings, to be between fifty and sixty feet, and the maximum, accurately found, being seventy-five feet. At this last point, a maximum and minimum registering thermometer was let down, and gave the following curious results:

Temperature of the air,		73° F.
"	surface water,	70° F.
"	bottom water,	41° F.

or nine degrees above the freezing-point, and within seven degrees of the water in the ice-well of Brandon. At another sounding in sixty-five feet of water, the self-registering thermometer recorded 46°, showing an increase of temperature of five degrees by a diminution of ten feet depth of water. A repetition of the experiments, on a subsequent day, gave the same results. Mr. Andrews, therefore, surmises that there is a stratum of constant underground frost, extending from the Brandon well to localities widely separated.

ON THE ARTESIAN WELLS AT LOUISVILLE, KY., AND COLUMBUS, OHIO.

The following account of a remarkable artesian well, recently bored at Louisville, Ky., is furnished to *Silliman's Journal*, March, 1859, by Prof. J. Laurence Smith, of the University of Louisville.

This work was commenced in April 1857, from the bottom of a well that had a depth of 20 feet; the boring tools employed made a hole 5 inches in diameter to the depth of 76 feet from the surface; the boring was now reduced to 3 inches, and thus continued to the bottom of the well. The depth of the well is 2086 feet; flow of water, 330,000 gallons in twenty-four hours; rise above the surface, 170 feet. The rock struck, which geologically belongs to the Devonian series, is, for 38 feet, shell limestone; then, for 40 feet, coralline limestone; at which depth the Upper Silurian is reached. Without being able to make out, with any degree of certainty, the amount of Upper Silurian passed through, we suppose it to be over 1200 feet. At the depth of 1600 feet a sandstone was reached, doubtless of the Lower Silurian, and 97 feet deeper was encountered the first stream of water which reached the surface. This flowed out abundantly, and with much force. The quantity not being sufficient, the boring was continued. After this, it was unnecessary to use the bucket to take out the material detached by the borer, the force of the water bringing up the fragments very readily. The water increased in quantity in going deeper, the increase being more marked at 1879 feet, and still more at 1900 feet, where pieces of rock, weighing an ounce or two, came up with the water. The water increased every 10 or 20 feet to the depth of 2036 feet; here a very hard magnesian limestone was encountered, 6 feet in thickness; after which the sandstone reäppeared, and for the next 50 feet there was no increase of water. At the urgent request of many of the citizens of Louisville, the boring was now stopped, to give a fair test of the medical virtues of the water that was pouring forth at the rate of 230 gallons per minute, or about 330,000 gallons in twenty-four hours. The water, by its own pressure, rises in pipes 170 feet above the surface.

The boring was accomplished in sixteen months, and the depth reached is 2086 feet. In order to conduct the water to the surface, and prevent its passing off into the gravel beds below, a tube, 5 inches in diameter, leads from the surface to the rock, a depth of 76 feet, into which it is driven with a collar of vulcanized gum-elastic around it. No tubing is found necessary for any other part of the boring.

When the size of the bore (3 inches in diameter) and its depth are considered, the flow of water from the well is unequalled by any other artesian well yet constructed that flows above the surface; for, although the Grenelle well at Paris delivers 600,000 gallons in twenty-four hours, it has, at the bottom, an area six times as great as the Louisville well, and a few hundred feet up seven times as great. A corresponding diameter to the Louisville well would, according to just and reasonable calculations, furnish about 2,000,000 gallons in twenty-four hours; also, the elevation of water above the surface is greater than that of any other artesian well, and it is only exceeded in depth by the St. Louis well, and that to an extent of 113 feet.

The water comes out with considerable force from the 5-inch opening, and a heavy body thrown into the mouth of the well is rejected almost as readily as a piece of pine wood. By an approximate calculation, its mechanical force is equal to that of a steam-engine with cylinder 10 by 18 inches, under 50 lbs. pressure, with a speed of 55 revolutions per minute — a force rated at about 10-horse power. The top of the well is now closed, and the water conducted about 30 feet to a basin, with a large jet d'eau on the centre, from which there is a central jet of water, 40 feet in height, with a large water-pipe, from which the water passes in the form of a sheaf. When the whole force of water is allowed to expend itself on the central jet, it is projected to the height of from 90 to 100 feet, settling down to a steady flow of a stream 60 feet high.

Temperature of the Water. — The water, as it flows from the top of the well, has a constant temperature of 76½° Fah., and is not affected either by the heat of summer or the cold of winter. The temperature at the bottom of the well is several degrees higher than this, as ascertained by sinking a Walferdin's registering thermometer to the bottom, which indicated 82½° Fah. Taking as correct data that the point of constant temperature below the surface of Louisville is the same as at Paris, namely, 53° Fah., at 90 feet below the surface, we have an increase of 1° for every 67 feet below that point. The increase in Paris is 1° for every 61·2 feet. The temperature of the water is sufficient for comfortable bathing during most of the year.

Nature of the Water. — The water is perfectly limpid, with a temperature, as already stated, of 76½°, which is invariable all the year round. Its specific gravity is 1·0113. The solid contents left on evaporating one wine gallon to dryness are 915½ grains, consisting of chloride of sodium, 621·5 grains; sulphate of magnesia, 77.3; sulphate of soda, 72·2; chloride of calcium, 65·7; sulphate of lime, 29·4; bicarbonates of soda, lime, magnesia, and iron, 11·6; phosphate of soda, 1·5; iodide and bromide of magnesium, 0·9; chloride of lithium, 0·1, etc. etc.

Artesian Well at Columbus Ohio. — The artesian well at the State House in Columbus, Ohio, according to a report by Prof. Mather, had reached a depth of 1858 feet in December 1858, and has since, we understand, been excavated several hundred feet farther, making it the deepest well in existence. For the first 23 feet, the material passed through was sand, clay and gravel; then 15 of slate, and 14 of Columbus limestone, referred to the Devonian; 115½ feet Columbus limestone, probably Upper Silurian; below this, 277 feet, the blue limestone of Cincinnati; then, 187 feet (or to a depth of 764), limestone shales, with salt water, at 675 feet; then 823 feet of greenish marly slate, probably equivalent to the Utica slates of New York. Prof. Mather observes that "if the Cincinnati or blue limestone be the equivalent of the Trenton limestone, Utica slates, and Hudson River group, there must be a great depth of mud rock in Ohio, of which no traces exist in New York, Pennsylvania, or other states," adjacent.

ON THE DE-BITUMENIZATION OF COAL.

At a meeting of the Philadelphia Academy, May 1859, Dr. Emmons remarked, that the de-bitumenization of coal was effected through the agency of heat, but he did not think that the de-bitumenization of anthracite was due to heat emanating from an incandescent body, whether that body be injected trap or other pyrocrystalline rocks. In his opinion the heat which de-bitumenized the coal of the anthracite region was disengaged or generated by the collision of the rocks enclosing it at the time of their upheaval. In support of this view he referred to the correlation of forces, the equivalent of heat, etc.; and stated he found by experiment, a year ago, that the volatile matter of the bituminous slates of North Carolina began to come off at 350°, and that it was all driven off as paraphine, and all at about 608°. Hence he inferred that coals are de-bitumenized at low temperatures, and that intense ignition is not required.

ORIGIN OF BITUMINOUS SCHISTS.

M. Reviere communicated to the French Academy, Oct. 25, 1858, a curious observation, which had led him to a new theory of the origin of certain rocks which are found to contain a small quantity of combustible matter. He was first struck by the resemblance between these rocks and the earth saturated with ordinary coal-gas by the leakage of the pipes which convey it. By a series of experiments he found,

1st. That the soil surrounding the pipe was, in certain circumstances, and after some time, more or less impregnated with carbon and bitumen, so as to become sometimes very combustible, and as black as impure coal.

2d. That the nature of the soil had much influence on the absorption; thus, whilst a clayey, slightly damp soil charged with vegetable or animal debris favored this absorption, it was, on the contrary, but slight in dry sand.

3d. That the thickness of the upper strata favored absorption.

4th. That it was greater near the cracks and stratification joints.

5th. That the absorbing materials increase in weight, and sometimes in bulk.

6th. That the vegetable matters were gradually converted into carbon more or less bituminous according to circumstances.

7th. That the ferruginous materials were altered, more or less converted into oxides, sulphates, or sulphites; and that they would probably have been converted into sulphurets and carbonates, had the gas been less purified, and had the action been sufficiently prolonged and the circumstances favorable.

ON THE SO-CALLED "TALCOSE SCHISTS" OF VERMONT, ETC.

At the meeting of the American Association for the Promotion of Science, Mr. C. H. Hitchcock stated that the geological surveys of the various States have made known the existence of a broad belt of rocks from Canada to Georgia, consisting of green schists, denominated talcose, associated with gneiss. This implies the presence of the mineral *talc*, which contains a large percentage of magnesia. Recent investigations had, however, rendered it probable that the character of the whole belt was *aluminous* rather than *magnesian*. Mr. T. S. Hunt, of Montreal, had analyzed some of these rocks at their northern extent in Canada, and had decided that magnesia was present in them in inconsiderable quantity only; and he had, therefore, proposed the name of *nacreous* schists, instead of *talcose*.

ON THE STRATIGRAPHICAL POSITION OF THE SANDSTONES OF THE CONNECTICUT RIVER VALLEY.

In a communication on this subject, made to the American Association for the Promotion of Science, Springfield, 1859, by Mr. J. D. Whitney, the author stated, that the peculiarity of this sandstone series of rocks in the Connecticut River Valley, was its almost uniform easterly dip, in a direction at right angles to the greatest longitudinal extension of the basin. As regards the origin, or cause, of this dip, extended observations on the formation had led him to the following conclusions:

1st. That it was a physical impossibility that the sandstone should have been deposited in a horizontal position, and then elevated, so as to have its present dip, by the elevation of the metamorphic or so-called "primary" rocks to the west. 2d. That it could not have acquired its present dip from the intrusion of the trap. 3d. It must therefore have been deposited with its present dip, and under the influence of some cause acting with considerable uniformity along the whole extent of the basin. 4th. This agent which produced the deposition of materials with an inclined dip, must have been a more or less violent current setting across the basin, or into it from one side, throughout its whole length. 5th. The cause of this current was to be sought for in a fault running along one side of the basin, followed by a depression of its area, which was greatest on its western edge, and which gradually decreased in amount towards the east, and which was continued for a considerable time, with greater or less regularity. Mr. W. argued that this cause was the only one sufficient to account for all the phenomena, especially those of the dip of the sandstone and the peculiar association of this rock with the trap which no theory yet proposed seemed satisfactorily to dispose of. Local variations of dip in the vicinity of the trap were allowed to be present, especially in the upper part of the basin; but the general facts seemed to be better reconciled by the aid of this theory than of any other yet proposed.

In the discussion which followed, Mr. C. H. Hitchcock dissented from the views of Mr. Whitney, and considered that the delicate footprints existing in these strata proved that they must have been horizontal when in a plastic state. If they had been lying at an angle of 45½, the appearance of the tracks would have been different.

Mr. Whitney replied, that his views were applicable to the region taken as a whole, and the place where the tracks were found might be an exception, arising from some local cause.

GEOLOGICAL SUMMARY FOR 1859.

On Elongated Pebbles in a Conglomerate, at Newport, R. I.—At the Springfield meeting of the American Scientific Association, Prof. Hitchcock called attention to the existence of curiously elongated quartzose pebbles and transverse joints in a conglomerate rock, at the well-known locality, "purgatory," at Newport, R. I. The pebbles are sometimes elongated to the extent of a foot in length, while their axes are always in the same direction. Joints, or breaks, occur at intervals, which divide both the pebbles and the matrix, as if a clean cut had been made crosswise through the entire mass. Prof. H.

advanced the idea that the pebbles, though hard and rounded when the conglomeration was effected, had since been softened, and while so, were flattened by lateral pressure.

Prof. Andrews, of Marietta, Ohio, had visited the spot, and was satisfied that the pebbles had been fused, and not elongated by lateral pressure.

Prof. Hitchcock said that the view presented by Prof. Andrews was formerly his own; but he thought the weight of evidence in favor of his present theory.

Wisconsin "Potash Kettles." — Prof. Charles Whittlesey, in a paper read before the American Scientific Association, 1859, stated that along the summit or dividing ridge between the waters of Rock River and those of Lake Michigan, there are numberless crater-like depressions in the drift materials, which are called by the people "potash kettles." They are in the form of cavities, sunk below the general surface ten, fifteen, and even one hundred feet, their outline rudely circular, and their sides as steep as the earth will stand. They have been traced about a hundred miles. The materials in which they are found are the coarse drift. They seldom contain water; boulders are found in and around them. In the southern part of the state, timber grows in them.

While exploring the state, in 1849, it occurred to him that these cavities cannot be explained by the usual and well-known examples of aqueous deposits. Terraces and oblong ridges of sand and gravel might be formed by currents and eddies acting on loose material; but these are depressions on an even surface. As explanatory of the matter, he would suggest that the phenomena was understood on the supposition that it was owing to glacial action.

On the Gold Deposits of Australia. — Mr. Selwyn, director of the geological survey of Victoria, Australia, in a letter recently read before the Royal Geological Society (London), stated that the auriferous quartz veins of Victoria appeared to be as rich in gold, at a depth of 200, 230, and 400 feet, as at the surface; but that certainly the large size of the nuggets found in the gold-drifts, contrasted with that of the nuggets found in the quartz-veins, seems to prove that the now worn away upper parts of the veins were probably richer than the lower and now remaining portions. Mr. Selwyn, according to his observations, thinks that none of the gold-drifts are older than the Pliocene age. Miocene and Eocene tertiaries have been recognized in Victoria, and some probably chalk fossils have also been found.

Hydraulic Mining in Georgia. — Within the past year the gold placers in northern Georgia have attracted considerable attention, and two or more extensive canals or ditches have been constructed to convey water to them, at an elevation sufficient to wash out the gold, by the California hydraulic method. These placers have been examined and reported on by Mr. Wm. P. Blake and Dr. Charles T. Jackson. The aqueduct from the Yahoola River is about twelve miles long, and to take the water across a valley near Dahlinega, a trestle 240 feet high, and about 1500 feet long, is required. A notice of the placers, and the improved methods of working them, was presented at the meeting of the American Association, by Mr. Blake.

On the occurrence of Diamonds in Georgia. — Prof. C. U. Shepard, in a communication to *Silliman's Journal*, Jan. 1859, descriptive of a locality of Lazulite, in Lincoln County, Georgia, calls attention to the resemblance of the rock at this point (itacolumnite, and a hematitic mixture of cyanite and quartz) to the diamond gangue of Brazil. Prof. S. also states that he was informed that at least ten crystals of the diamond had been found in Burke County, Ga., two in Habersham, two in Hall, and one in Union County. The largest of these is said to have been sold for $150 in Philadelphia. The whole number of diamonds thus far found in the United States, cannot therefore be less than thirty, nearly all of which occurred in itacolumite.

Mineralogy of Greenland. — A Danish company, formed some years since for the purpose of working the mines of Greenland, have reported, as the result of their preliminary investigations, the discovery of numerous strata of coal, some of which contain trunks of trees more than three feet in diameter, — a fact which strikingly indicates the great change of climate in this country, since the only tree which is now found is the meagre and sorry salix-arotica. In Fredrickshab, yellow copper and tin pyrites have been discovered.

Tin in California. — At a recent meeting of the Boston Nat. Hist. Soc., Dr. C. T. Jackson stated that a locality containing tin ore had been discovered at Los Angelos, California, within the limits of the United States; the quantity of ore is very large, and it yields 60½ per cent. of oxide of tin, with brown oxide of iron. A company has been formed to work it.

Remarkable Vein of Gold in Georgia. — At the last meeting of the American Association at Springfield, Mr. Wm. P. Blake described a remarkably rich gold vein in the bed of the Chestatee River, Georgia. It occurs in very hard hornblendic gneiss, which requires blasting. The gold is found in a layer of quartz and carbonate of line about an inch thick, and is associated with Bornite (a telluret of bismuth), and other minerals. About $3000 worth of gold was thrown out at one blast, and the fragments of rock could be placed in a bushel basket. The specimens are remarkably beautiful.

Lake and Pond Ramparts in Vermont. — At the meeting of the Am. Association for the Promotion of Science, 1859, Mr. C. H. Hitchcock, in a paper on the above subject, referred in the first instance to the reported walled lake in Iowa. This is situated in Wright County, in a large plain, covering an area of 1900 acres; is from two to twenty-five feet deep, with a red, sandy bottom. Around the lake is a wall of heavy stone, in some places ten feet high, and thirteen feet wide at the base, sloping up both sides to five feet at the top, composed of boulders from fifty pounds to three tons in weight. The top of the wall is level, while the land is undulating. This work has been referred by some to aborigines of the country, but such a supposition is without foundation. In Vermont, similar walls of an artificial appearance have been noticed, — one on Willoughby Lake, being from five to six feet in height. The agency which has produced these embankments, Mr. H. considered to be ice, which in the winter, by expansion, would force the fragments of rocks from the central part of the lake to the shore. In one winter the progress would be small: but in the course of years, or of ages, the collection might be large, if the materials were abundant. Mr. J. D. Whitney said he had conversed with a gentleman who had visited the lake in Iowa, and he had told him that the statements which had been published were greatly exaggerated. There was nothing like a regular wall. He considered it not very different from other phenomena connected with drift boulders which he had seen.

On the occurrence of Fossiliferous Limestone beneath Granite and Mica Slate in Vermont. — At the Springfield meeting of the American Association for the Promotion of Science, Prof. Hitchcock called attention to a deposit of fossiliferous limestone, recently discovered by him beneath granite and mica slate, at Derby, Vermont, on the east shore of Lake Memphremagog, on the Canada line. The granite, which was exceedingly characteristic and typical, not only overlaid the limestone, but dipped down into it in veins, which there (in the limestone) terminated. The limestone contains numerous fossils.

In reference to this communication of Prof. Hitchcock, Sir Wm. Logan said he thought the granite had cut through the limestone, and it would be readily inferred that when an intrusive rock cuts through a fossiliferous rock, it might well overlie it. He conceived this granite to be of the same age with the general formation of the granite in Maine. It was, in his view, Devonian granite. He believed the limestone to be the same with the beautiful Rutland marble, and was of the same age.

Interesting Palæontological Discovery.— During the past year, an exceedingly perfect specimen of a fossil fish, of the genus *Pteraspis*, has been discovered in the Lower Ludlow rocks, England. The position of these rocks is assigned by Mr. Murchison to higher beds of the Upper Silurian. Fish have hitherto been found in the Upper Ludlow rocks, but none in the Lower Ludlow, and consequently this discovery carries back the appearance of fishes in the palæozoic rocks to a period more remote than has before been determined.

At the Aberdeen meeting of the British Association, 1859, Mr. D. Page stated that explorations made during the past summer, by Mr. Slimon and Son, in the Upper Silurian formations of Scotland, had afforded ample indication of a very varied and curious crustacean fauna, altogether new to Palæontology. Molluscous remains of well-known Upper Silurian genera had also been obtained in sufficient numbers to prove the affinities of the beds; and indications of both an aquatic and terrestrial flora seemed by no means rare throughout the strata. The specimens obtained had a threefold value; first, as proving the true Upper Silurian epoch of the Nilberry strata, and thus affording a clue to the investigations of other Sub-Devonian tracts in Scotland, yet but very imperfectly understood; secondly, as adding new forms to the life of a former epoch, and thus extending the boundaries of our zoölogical knowledge; and, thirdly, as enabling the Government palæontologists, who had recently published their first monograph on the Eurypteridæ, to understand more clearly the nature of this curious family of Crustaceans, and to correct what must now evidently appear as misinterpretations of their structure and affinities. In none of the beds explored had there ever been detected any trace of fish-life. Sir R. I. Murchison remarked that language could scarcely exaggerate the value of Mr. Slimon's discoveries to palæontologists.

Sub-Silurian Fossils. — At a recent meeting of the Philadelphia Academy, Dr. Leidy called attention to specimens of Palæotrochus presented this evening by Prof. E. Emmons, from Sub-Silurian strata. He stated that its organic nature had been denied by able authorities, but considered that its symmetry and uniformity were in favor of its being a fossil. It had most strongly the appearance of a coral.

Dr. Le Conte had seen a similar body of larger size from the copper-bearing rocks of Point Keewenaw, Lake Superior. He could not conceive that such numbers of masses of similar form could arise from molecular action forming concretions.

Fossils from the Laurentian Limestones. — At the meeting of the American Association, Springfield, 1859, Sir William Logan, of the Canada Survey, gave an account of some impressions recently found in the Laurentian limestones. He said these were the lowest rocks in Canada, are from 10,000 to 15,000 feet thick, and have always been considered azoic, or devoid of animal life; but, from some specimens shown by the speaker to the audience, he was led to think they did show impressions of coral. If these impressions had been found in Silurian, or Metamorphic rocks, they would at once have been referred to the corals.

Fossil Reindeer from New York. — At a meeting of the Philadelphia Academy, August 23d, 1859, Dr. Leidy read a letter from Dr. G. J. Fisher, dated at Sing Sing, New York, giving an account of an antler of the Reindeer, which had been found in the vicinity of the place mentioned. The specimen was discovered, in excavating a peat-bed, at the depth of six feet from the surface. The peat-bed is almost an acre in extent, surrounded by high ground, and looks as if it had been the site of an ancient lake. Dr. L. observed that there is a similar specimen of an antler of the Reindeer in the museum of the Academy, which had been found near Vincentown, New Jersey, at the depth of four feet. (See Proc. 1858, 179.) The discovery of these remains of the Reindeer, and likewise of the remains of the Walrus, in similar positions in New Jersey (See Trans. Am. Phil. Soc., xi. 83), favor the view that the Arctic fauna, at one period, extended its boundary much more southerly than at present.

On the occurrence of Bones and Teeth in the Lead-bearing Crevices of the North-West. — At the meeting of the American Association, 1859, Mr. J. D. Whitney exhibited fossil bones and teeth, found in the lead-bearing crevices of the North-West. In the cap-rock, as it is called by the miners, there are fissures and cavities, from fifty to one hundred feet beneath the surface. These cavities are usually lined with lead-ore; in them are found the teeth of the mastodon, — usually the milk-teeth of the young,— also of the peccary, also of the buffalo. The teeth were in a good state of preservation. They are found in many localities — the teeth of the mastodon predominating. He believed that this part of the country never was subject to the drift, as no boulders were to be found — no striae marks. Mr. J. W. Foster also described the geological position of the bones of the extinct peccary of the West. They exist on the line of the Burlington and Mississippi Railroad. In a cut on that road he found one skeleton at the depth of eight feet, a second at the depth of twenty-five feet, and a third at the depth of twenty-eight feet.

Eruptions of Mount Vesuvius. — During the past year Vesuvius has been in a state of nearly constant activity, without any very great or striking eruptions. M. Palmieri, who has been engaged in observations on its action, states, among other interesting memoranda, that a great abundance of lead has been sublimed from the crater and the lava, mainly in the state of chloride. The chloride and sulphate are also found mixed. Much of the volcanic smoke has been found, by M. Palmieri, to be chloriodic acid.

Sub-Marine Eruption. — The barque *Rolla*, of New York, reports, on the 4th of January, in the Gulf of Mexico, passing through a scum of smoking pitch which extended for several miles, and emitted a most nauseating odor.

ON THE EROSION OF ROCKS IN VERMONT.

At the Springfield meeting of the American Association for the Promotion of Science, Prof. Hitchcock presented a paper on the evidences of erosion, exhibited by the rocks of Vermont. A satisfactory proof of the existence of currents of water in particular localities in former times, was to be found in the "pot-holes" in solid rock ; and numerous examples of these in Vermont, at various elevations above existing streams, showed that the whole valley had been worn out beneath the pot-holes. In New-Fane, they were found 300 feet above the valley. In North Wardsboro', 600 feet; and in West Wardsboro', upon the dividing ridge between two valleys, 1200 feet above the valley, and nearly 2000 feet above the ocean. In fact, these pot-holes may indicate the courses of large rivers upon this continent in former periods, when the configuration of the continent was much different from what it is at present.

Another proof of erosion was to be found in the varied inclinations of strata. If the same kind of rock was found in the places dipping in opposite directions, like the roof of a house, it was reasonable to infer that they were formerly connected together, and by prolonging upon the paper the inclinations and distances of these strata, the amount of rock that had been worn away could be measured exactly. Sections now show where this measurement might be made, and it was stated that in some cases it might be clearly seen that at least four miles in thickness of rock had been removed by erosion.

Another and new proof of the amount of erosion was suggested by the position of lofty peaks of protrusive granites, etc. Mount Ascutney, in Vermont, was instanced as an example of granite extending more than two thousand feet above all adjacent rocks. When the granite was melted, it must have been sustained in its place by other rocks that were sedimentary and not igneous; otherwise the melted granite would have flowed over the surrounding rocks. Hence, at this locality, as much as 2000 feet of material must have been eroded, leaving the granite mountain now towering far above the adjacent ledges.

ORIGIN OF THE PRAIRIES OF THE NORTH-WESTERN UNITED STATES.

In the *Geology of Iowa*, Vol. I. by Hall and Whitney, the various theories which have, at different times, been brought forward to account for the absence of trees in the prairie region, are discussed and pronounced to be inadequate. It is attempted in the report to show that the extreme fineness of the particles of which the soil is made up, is the predominating cause of this peculiar condition of the vegetation, and some facts are stated to confirm this theory. Reasoning from analogy of the smaller prairies to the thickly-wooded region of the Upper Peninsula of Michigan, it is inferred, "that the whole region now occupied by the prairies of the North-west was once an immense lake, in whose basin sediment of an almost impalpable fineness gradually accumulated, under conditions, the discussion of which is postponed to another volume, in which the drift phenomena of the North-west will be taken up; that this basin was drained by the elevation of the whole region, but, at first, so slowly, that the finer particles of the superficial deposits were not washed away, but allowed to remain where they were originally deposited. After the more elevated portion of the former prairies had been laid bare, the drainage becoming concentrated in narrower channels, the current thus produced, aided perhaps by a more rapid rise of the region, acquired sufficient velocity to wear down through the finer material on the surface, wash away a portion of it altogether, and mix the rest so effectually with the underlying drift materials, or with abraded fragments of the rock in place, as to give rise to a different character of soil in the valleys from that of the elevated land. This valley soil, being much less homogeneous in its composition, and containing a larger proportion of coarse materials than that of the uplands, seems to have been adapted to the growth of forest vegetation; and in consequence of this, we find such localities covered with an abundant growth of timber.

"Wherever there has been a variation from the usual conditions of the soil, on the prairie or in the river bottom, there is a corresponding change in the character of the vegetation. Thus, on the prairies we sometimes meet with ridges of coarse material, apparently deposits of drift, on which, from some local cause, there has never been an accumulation of fine sediment; in such localities we invariably find a growth of timber. This is the origin of the groves scattered over the prairies, for whose isolated position and peculiar circumstances of growth we are unable to account in any other way."

ICEBERGS IN THE SOUTHERN OCEAN.

Capt. Kirby, of the ship *Uncowah*, from New York to San Francisco, reports an encounter with a mass of ice off Cape Horn, Aug. 9th, immense, almost beyond precedent, for the latitude. He states "that at first he could not believe that it was ice, and, thinking he might have been drifted to the northward during the several days in which he had not been able to get an observation, set it down as an island covered with snow. The wind was from the eastward, and the ship going at the rate of eight knots; she soon brought the whole body above the horizon, and not long after the ice was found to stretch along the whole head and on the weather bow. The course of the ship was then altered, so as to bring the ice on the lee bow, and gradually, as the bearings altered, five icebergs, of various sizes, were made out. The ship passed within a few miles to the windward of them.

"The ice-field and icebergs were estimated to be from eight to ten miles long, and very high — a solid mass of ice against which the sea broke, as upon the iron-bound shores of a continent. At four miles distance, the water about the ship was agitated with eddies and ripples, caused by the opposing presence of so large a body to the usual ocean currents. The sides along which the ship passed appeared to be precipitous up for more than a hundred feet from the water, when they broke up towards the peaks in the interior of the island; and down the steppes, the spy-glass showed the existence of great gullies and water-courses. When the sun shone full upon the island, it reflected the light with great brilliancy."

ON THE ORES OF ZINC AND MANGANESE FROM ARKANSAS.

Dr. Wm. Elderhorst has analyzed various specimens of Smithsonite from the counties of Lawrence, Marion, and Independence. The principal mines are situated in Lawrence county; the principal ore is a massive, brownish-yellow, cellular Smithsonite, occasionally sub-crystalline. The analyses of average specimens show a very high per centage of oxide of zinc, varying from 49 to 61·7 per cent.; a very impure specimen, a mixture of carbonate of zinc with clay, yielded 33 per cent. of oxide of zinc. The Arkansas ores, therefore, compare very favorably with the best European ores, for example, with those of Upper Silescia, the Rhenish workings, Belgium, Polonia, etc. The ore occurs in dolomite, sometimes in regular veins, and firmly adhering to the rock, but usually in more or less rounded, irregular pieces, imbedded in a red ferruginous clay. Both the dolomite and the red clay contain small quantities of carbonate of zinc; the dolomite, in some localities, nearly 2 per cent., the red clay only 0·38 per cent. At another locality, occurs, associated with galena, a very light and soft clay, of ochre-yellow color, which contains rather more than 8 per cent. of oxide of zinc.

The Smithsonite of Marion county is occasionally found incrusted with a white hydro-carbonate of zinc, whose composition is expressed by the formula $3(ZnO.CO_2)+2(ZnO.3HO)$ and for which the name of *Marionite* is proposed. It contains nearly 4 per cent. more oxide of zinc than Smithson found in his analysis of zinc bloom.

The same chemist publishes analyses of three specimens of psilomelane, from Independence county — considering them, with Rammelsberg, as compounds of peroxide of manganese with bases of the constitution RO. He derives from his analyses the following formulæ, as expressive of their composition.

$(MnO.BaO.HO).MnO_2$+6·37 per cent. of MnO_2 mechanically intermixed, and $(MnO.BaO.CaO.HO).MnO_2$+3·84 per cent. of MnO_2 mechanically intermixed.

A specimen of wad, from Izard county, has the same composition as the wad from Rubeland, analyzed by Rammelsberg, namely.

$$(MnO.CoO.BaO).2MnO_2+3HO+xMnO_2$$

The composition of a fifth specimen of manganese ore is expressed by the formula $4(MnO.CaO.MgO.HO).3MnO_2$; or, if the small quantities of lime, magnesia, and water are considered as accidental impurities, by Mn_2O^3, the composition of bramite; the proportion of manganese to oxygen being as 69·68 to 29·72; in braunite the proportion is 69·68 : 30·42.

Prof. Elderhorst expresses the opinion that Arkansas is destined to take the lead of all the Western States in her resources of ores of zinc and manganese. — *First Report of a Geological Reconnoissance of the Northern Counties of Arkansas. By D. D. Owen, Wm. Elderhorst, and Edward T. Cox. Little Rock,* 1858.

PROF. OWEN ON FOSSIL MAMMALS.

The following is an abstract of the concluding lecture of a course recently delivered by Prof. Owen, before the Royal Institution (London), "On Fossil Mammals," in which the causes of their extinction are particularly considered.

On the problem of the extinction of species, I have little to say; and of the more mysterious subject of their coming into being, nothing profitable or to the purpose, at present. As a cause of extinction in times anterior to man, it is most reasonable to assign the chief weight to those gradual changes in the conditions affecting a due supply of sustenance to animals in a state of nature which must have accompanied the slow alternations of land and sea brought about in the æons of geological time. Yet this reasoning is applicable only to land animals; for it is scarcely conceivable that such operations can have affected sea-fishes.

There are characters in land animals rendering them more obnoxious to extirpating influences, which may explain why so many of the larger species of particular groups have become extinct, whilst smaller species of equal antiquity have survived. In proportion to its bulk is the difficulty of the contest which the animal has to maintain against the surrounding agencies that are ever tending to dissolve the vital bond, and subjugate the living matter to the ordinary chemical and physical forces. Any changes, therefore, in such external agencies as a species may have been originally adapted to exist in, will militate against that existence in a degree proportionate to the size which may characterize the species. If a dry season be gradually prolonged, the large mammal will suffer from the drought sooner than the small one; if such alteration of climate affect the quantity of vegetable food, the bulky herbivore will first feel the effects of stinted nourishment; if new enemies be introduced, the large and conspicuous animal will fall a prey, while the smaller kinds conceal themselves and escape. Small quadrupeds, moreover, are more prolific than large ones. Those of the bulk of the mastodons, megatheria, glyptodons, and diprotodons, are uniparous. The actual presence, therefore, of small species of animals in countries where larger species of the same natural families formerly existed, is not the consequence of degeneration — of any gradual diminution of the size — of such species, but is the result of circumstances which may be illustrated by the fable of the "Oak and the Reed;" the smaller and feebler animals have bent and accommodated themselves to changes to which the larger species have succumbed.

That species should become extinct, appears, from the abundant fact of extinction, to be a law of their existence; whether, however, it be inherent in their own nature, or be relative and dependent on inevitable changes in the conditions and theatre of their existence, is the main subject for consideration. But, admitting extinction as a natural law which has operated from the beginning of life on this planet, it might be expected that some evidence of it should occur in our own time, or within the historical period. Reference has been made to several instances of the extirpation of species, certainly, probably, or possibly, due to the direct agency of man; but this cause avails not in the question of the extinction of species at periods prior to any evidence of human existence; it does not help us in the explanation of the majority of extinctions, as of the races of aquatic invertebrata and vertebrata which have successively passed away.

Within the last century, academicians of St. Petersburg and good naturalists have described and given figures of the bony and the perishable parts, including the alimentary canal, of a large and peculiar fucivorous Sirenian — an amphibious animal like the Manatee, which Cuvier classified with his herbivorous Cetacea, and called Stelleria, after its discoverer. This animal inhabited the Siberian shores and the mouths of the great rivers there disemboguing. It is now believed to be extinct, and this extinction seems not to have been due to any special quest and persecution by man. We may discern in this fact the operation of changes in physical geography, which have, at length, so affected the conditions of existence of the Stelleria as to have caused its extinction. Such changes had operated, at an earlier period, to the extinction of the Siberian elephant and rhinoceros of the same regions and latitudes. A future generation of zoölogists may have to record the final disappearance of the Arctic buffalo (*Ovibos moschatus*). Fossil remains of Ovibos and Stelleria show that they were contemporaries of *Elephas primigenius* and *Rhinoceros tichorrhinus*.

The great Auk (*Alca impennis*, L.) seems to be rapidly verging to extinction. It has not been specially hunted down, like the dodo and dinornis, but by degrees has become more scarce. Some of the geological changes affecting circumstances favorable to the well-being of the *Alca impennis*, have been matters of observation. A friend who last year visited Iceland, informs me that the last great auks, known with anything like certainty to have been there seen, were two which were taken in 1844, during a visit made to the high rock called "Eldey," or "Meelsoekten," lying off Cape Reykianes, the south-west point of Iceland. This is one of three principal rocky islets formerly existing in that direction, of which the one, specially named from this rare bird, "Geirfugla Sker," sank to the level of the surface of the sea during a volcanic disturbance in or about the year 1830. Such disappearance of the fit and favorable breeding-places of the *Alca impennis*, must form an important element in its decline towards extinction. The numbers of the bones of *Alca impennis* on the shores of Iceland, Greenland, and Denmark, attest the abundance of the bird in former times. A consideration of such instances of modern partial or total extinctions, may best throw light, and suggest the truest notions, of the causes of ancient extinction.

As to the successions, or coming in, of new species, one might speculate on the gradual modifiability of the individual; on the tendency of certain varieties to survive local changes, and thus progressively diverge from an older type; on the production and fertility of monstrous offspring; on the possibility, e. g., of a variety of auk being occasionally hatched with a somewhat longer winglet, and a dwarfed stature; on the probability of such a variety better adapting itself to the changing climate or other conditions than the old type — of such an origin of *Alca torda*, e. g.; — but to what purpose? Past experience of the chance aims of human fancy, unchecked and unguided by observed facts, shows how widely they have ever glanced away from the gold centre of truth.

As the result of the evidence accumulated by geologists, I have affirmed that the successive extinction of Amphitheria, Spalacotheria, Triconodons, and other mesozoic forms of mammals, has been followed by the introductions of much more numerous, varied, and higher organized forms of the class, during the tertiary periods. There are, however, geologists who maintain that this is an assumption, based upon a partial knowledge of the facts. Mere negative evidence, they allege, can never satisfactorily establish the proposition that the mammalian class is of late introduction, nor prevent the conjecture that it may have been as richly represented in secondary, as in tertiary times, could we but get evidence of the terrestrial Fauna of the oolitic continent. To this objection I have to reply: in the palæozoic strata, which, from their extent and depth, indicate, in the earth's existence as a seat of organic life, a period as prolonged as that which has followed their deposition, no trace of mammals has been observed. It may be conceded that, were mammals peculiar to dry land, such negative evidence would weigh little in producing conviction of their non-existence during the Silurian and Devonian æons, because the explored parts of such strata have been deposited from an ocean, and the chance of finding a terrestrial and air-breathing creature's remains in oceanic deposits is very remote. But, in the present state of the warm-blooded, air-breathing, viviparous class, no genera and species are represented by such numerous and widely dispersed individuals, as those of the order Cetacea, which, under the guise of fishes, dwell, and can only live, in the ocean. In all Cetacea the skeleton is well ossified, and the vertebræ are very numerous: the smallest Cetaceans would be deemed large amongst land mammals, the largest surpass in bulk any creatures of which we have yet gained cognizance; the hugest ichthyosaur, iguanodon, megalosaur, mammoth, or megathere, is a dwarf in comparison with the modern whale, of a hundred feet in length. During the period in which we have proof that Cetacea have existed, the evidence in the shape of bones and teeth—which latter enduring characteristics in most of the species are peculiar for their great number in the same individual—must have been abundantly deposited at the bottom of the sea; and as cachalots, grampuses, dolphins, and porpoises, are seen gambolling in shoals in deep oceans, far from land, their remains will form the most characteristic evidences of vertebrate life in the strata now in course of formation at the bottom of such oceans. Accordingly, it consists with the known characteristics of the Cetacean class to find the marine deposits which fell from seas tenanted, as now, with vertebrates of that high grade, containing the fossil evidences of the order in vast abundance. The red crag of our eastern counties contains petrified fragments of the skeletons and teeth of various Cetacea, in such quantities as to constitute a great part of that source of phosphate of lime for which the red crag is worked for the manufacture of artificial manure. The scanty evidence of Cetacea in cretaceous beds seems to indicate a similar period for their beginning as for the soft-scaled cycloid and ctenoid fishes which have superseded the ganoid orders of mesozoic times.

We cannot doubt but that, had the genera Ichthyosaurus, Pliosaurus, or Plesiosaurus, been represented by species in the same ocean that was tempested by the Balænodons and Dioplodons of the miocene age, the bones and teeth of those marine reptiles would have testified to their existence as abundantly as they do at a previous epoch in the earth's history. But no fossil relic of an enaliosaur has been found in tertiary strata, and no living enaliosaur has been detected in the present seas; and they are consequently held by competent naturalists to be extinct. In like manner does such negative evidence weigh with me in proof of the non-existence of marine mammals in the liassic and oolitic times. In the marine deposits of those secondary or mesozoic epochs, the evidence of vertebrates governing the ocean, and preying on inferior marine vertebrates, is as abundant as that of air-breathing vertebrates in the tertiary strata; but in the one, the fossils are exclusively of the cold-blooded reptilian class; in the other, of the warm-blooded mammalian class. The Enaliosauria, Cetiosauria, and Crocodilia, played the same part, and fulfilled similar offices, in the seas from which the lias and oolites were precipitated, as the Delphinidæ and Balænidæ did in the tertiary, and still do in the present seas. The unbiassed conclusion, from both negative and positive evidence in this matter, is, that the Cetacea succeeded and superseded the Enaliosauria. To the mind that will not accept such conclusion, the stratified oolitic rocks must cease to be monuments or trustworthy records of the condition of life on the earth at that period. So far, however, as any general conclusion can be deduced from the large sum of evidence above referred to, and contrasted, it is against the doctrine of the Uniformitarians. Organic remains, traced from their earliest known graves, are succeeded, one series by another, to the present period, and never reäppear when once lost sight of in the ascending search. As well might we expect a living Ichthyosaur in the Pacific, as a fossil whale in the Lias. The rule governs as strongly in the retrospect as the prospect. And not only as respects the Vertebrata, but the sum of the animal species at each successive geological period has been distinct and peculiar to such period. Not that the extinction of such forms or species was sudden or simultaneous: the evidences so interpreted have been but local. Over the wider field of life, at any given epoch, the change has been gradual; and, as it would seem, obedient to some general, but as yet ill-comprehended law. In regard to animal life, and its assigned work on this planet, there has, however, plainly been an ascent and progress in the main.

Although the Mammalia, in regard to the plenary development of the characteristic orders, belong to the Tertiary division of geological time, just as "Echini are most common in the superior strata; Ammonites in those beneath, and Producti with numerous Encrini, in the lowest" of the secondary strata; yet the beginnings of the class manifest themselves in the formations of the earlier preceding division of geological time. No one, save a prepossessed Uniformitarian, would infer from the Lucina of the permian, and the Opis of the trias, that the Lamellibranchiate Molluscs existed in the same rich variety of development at these periods, as during the tertiary and present times; and no prepossession can close the eyes to the fact that the Lamellibranchiate have superseded the Palliobranchiate bivalves.

On negative evidence, Orthisina, Theca, Producta, or Spirifer, are believed not to exist in the present seas: neither are the existing genera of siphonated bivalves and univalves deemed to have abounded in permian, triassic, or oolitic times. To suspect that they may have then existed, but have hitherto escaped observation, because certain Lamellibranchs with an open mantle, and some holostomatous and asiphonate Gastropods, have left their remains in secondary strata, is not more reasonable, as it seems to me, than to conclude that the proportion of mammalian life may have been as great in secondary as in tertiary strata, because a few small forms of the lowest orders have made their appearance in triassic and oolitic beds.

Turning from a retrospect into past time to the prospect of time to come, — and I have received more than one inquiry into the amount of prophetic insight imparted by Palæontology, — I may crave indulgence for a few words, of more sound, perhaps, than significance. But the reflective mind cannot evade or resist the tendency to speculate on the future course and ultimate fate of vital phenomena in this planet. There seems to have been a time when life was not; there may, therefore, be a period when it will cease to be. Our most soaring speculations still show a kinship to our nature; we see the element of finality in so much that we have cognizance of, that it must needs mingle with our thoughts, and bias our conclusions on many things. The end of the world has been presented to man's mind under divers aspects: as a general conflagration: as the same, preceded by a millennial exaltation of the world to a Paradisiacal state, — the abode of a higher and blessed race of intelligences. If the guide-post of Palæontology may seem to point to a course ascending to the condition of the latter speculation, it points but a very short way; and, in leaving it, we find ourselves in a wilderness of conjecture, where to try to advance is to find ourselves "in wandering mazes lost."

With much more satisfaction do I return to the legitimate deductions from the phenomena we have had under review.

In the survey which I have taken, in the present course of lectures, of the genesis, succession, geographical distribution, affinities, and osteology of the mammalian class, if I have succeeded in demonstrating the perfect adaptation of each varying form to the exigencies and habits and well-being of the species, I have fulfilled one object which I had in view, viz., to set forth the beneficence and intelligence of the Creative Power. If I have been able to demonstrate a uniform plan pervading the osteological structure of so many diversified animated beings, I must have enforced, were that necessary, as strong a conviction of the unity of the Creative Cause. If, in all the striking changes of form and proportion which have passed under review, we could discern only the results of minor modifications of the same few osseous elements, surely we must be the more strikingly impressed with the wisdom and power of that Cause which could produce so much variety, and at the same time such perfect adaptations and endowments, out of means so simple. For, in what have those mechanical instruments — the hands of the ape, the hoofs of the horse, the fins of the whale, the trowels of the mole, the wings of the bat — so variously formed to obey the behests of volition in denizens of different elements — in what, I say, have they differed from the artificial instruments which we ourselves plan with foresight and calculation for analogous uses, save in their greater complexity, in their perfection, and in the unity and simplicity of the elements which are modified to constitute these several locomotive organs. Everywhere in organic nature we see the means not only subservient to an end, but that end accomplished by the simplest means. Hence we are compelled to regard the Great Cause of all, not like certain philosophic ancients, as a uniform and quiescent mind, as an all-pervading *anima mundi*, but as an active and anticipating intelligence. By applying the laws of comparative anatomy to the relics of extinct races of animals contained in and characterizing the different strata of the earth's crust, and corresponding with as many epochs in the earth's history, we make an important step in advance of all preceding philosophies, and are able to demonstrate that the same pervading, active, and beneficent Intelligence which manifests His power in our times, has also manifested His power in times long anterior to the records of our existence. But we likewise, by these investigations, gain a still more important truth, viz., that the phenomena of the world do not succeed each other with the mechanical sameness attributed to them in the cycles of the Epicurean philosophy; for we are able to demonstrate that the different epochs of the history of the earth were attended with corresponding changes of organic structure; and that, in all these instances of change, the organs, as far as we could comprehend their use, were exactly those best suited to the functions of the being. Hence we not only show intelligence evoking means adapted to the end, but, at successive times and periods, producing a change of mechanism adapted to a change in external conditions. Thus the highest generalizations in the science of organic bodies, like the Newtonian laws of universal matter, lead to the unequivocal conviction of a great First Cause, which is certainly not mechanical. Unfettered by narrow restrictions, — unchecked by the timid and unworthy fears of mistrustful minds, clinging, in regard to mere physical questions, to beliefs, for which the Author of all truth has been pleased to substitute knowledge, — our science becomes connected with the loftiest of moral speculations; and I know of no topic more fitting to the sentiments with which I desire to conclude the present course. If I believed — to use the language of a gifted contemporary — that the imagination, the feelings, the active intellectual powers, bearing on the business of life, and the highest capacities of our nature, were blunted and impaired by the study of physiological and palæontological phenomena, I should then regard our science as little better than a moral sepulchre, in which, like the strong man, we were burying ourselves and those around us in ruins of our own creating.

But surely we must all believe too firmly in the immutable attributes of that Being, in whom all truth, of whatever kind, finds its proper resting-place, to think that the principles of physical and moral truth can ever be in lasting collision.

DISCOVERY OF THE REMAINS OF A FOSSIL EXTINCT REPTILE, THE HADROSAURUS, IN NEW JERSEY.

During the summer and fall of 1858, the remains of a huge herbiverous saurian reptile, closely allied, but larger, than the extinct Iguanodon, of the Weaden and Lower Greensands of Europe, were discovered, by William P. Foulke, of Philadelphia, in the cretaceous marls of Haddonfield, Camden Co., N. J. The circumstances attending this discovery, and the following description of the bones, are given in the proceedings of the Phil. Academy, for December 14, 1858.

During the summer and autumn of 1858, Mr. Foulke visited a neighbor, Mr. Hopkins, near his own summer residence at Haddonfield, in New Jersey, a few miles out from Camden, on the Camden and Atlantic Railroad; and, in the course of conversation, Mr. H. described from memory some teeth and vertebræ which had been thrown out from a marl-pit on his property not less than twenty years ago. One by one they had been given away to curious friends, or casual acquaintances, or lost. He could remember no long or large bones, but only teeth and vertebræ. Receiving permission to reöpen the spot, Mr. Foulke set a gang of marl-diggers to work at the bottom of a small ravine near where it opens upon Cooper's Creek, and about twenty feet below the surrounding farm land of the neighborhood. Three or four feet of soil brought the workmen to the face of the marl, and, discovering the old digging, went down along its edge six or seven feet, through a small bed of shells, to where the bones had been exhumed. At this point a collection of bones was found. They consisted of a thigh-bone forty inches long, with a breadth at the head and adjoining trochanter of nine inches; a tibia thirty-six and a half inches in length, and eleven inches broad at the upper part; humerus perfect, and twenty-three inches in length; ulna, twenty-three inches long; radius twenty inches, and six inches in circumference in the middle. In addition to the above, there were also obtained twenty-eight vertebræ, mostly with their processes broken away; an ilium and pubic bone, imperfect; a femur; two metatarsal bones, and a first phalanx, complete; also, nine teeth, and a small fragment of the lower jaw.

The bones are ebony black, from the infiltration of iron, and are exceedingly heavy. Their texture is firm and well preserved; and they are neither crushed nor water rolled. In association with them, beside the shells and wood, were found several teeth of *Odontaspis* and *Enchodus*.

Most of the specimens of teeth appear to have belonged to the lower jaw. These, when unworn and perfect, are about two inches long, and of all known teeth mostly resemble those of the *Iguanodon*. They have a demiconoidal crown, with a lozenge-shaped enamel surface directed inwardly, and divided by a prominent median carina. The upper borders of this surface are provided with short, transverse, tuberculated ridges.

The sides and bottoms of the teeth exhibit the impressions of lateral and inferior successors, and appear to indicate that the teeth in use, together with those more or less developed within the jaw, had a quincuncial arrangement. Two of the specimens of teeth, perhaps, belong to the upper jaw.

They differ from the others in the extraordinary degree of development of the medium carina of the crown. These teeth also exhibit the impress of successors holding the same relative position with one another as in the lower teeth.

At the meeting of the Academy above referred to, Dr. Leidy stated, that he had determined the bones to have belonged to a huge herbiverous saurian, which was closely allied to the Iguanodon; the genus, however, was different, and he proposed for it the name hadrosaurus — designating the species from the discoverer of the bones, Hadrosaurus Foulkii. Dr. Leidy then proceeded to point out the reptilian characters recognized in the bones in question: The thigh-bone ossified, not, like the mammal's, from half a dozen centres, but from one single centre, as in the iguana, alligator, etc., and furrowed at the ends with the large blood vessels of reptile joints, instead of being smooth, as in all mammalians. The whole form of the bones was different from that of the mammalia, and the vertebræ of the tail were armed above with the backward leaning processes, and below with the loosely shaped, and likewise backward leaning spines, which characterize the powerful, long, thin, deep reptilian tail. The teeth were also reptilian, but not carniverous, like the crocodile's, but herbiverous, like the iguana's, and most curiously shaped and set.

The creature was evidently of huge dimensions. Its hind-leg bones, when put together, would reach seven feet, upon which the pelvis and back-bone and upper skin would still go on, making it nine or ten feet high upon the haunches. On the contrary, the fore legs were so disproportionately short, that, had they been found at a different time or in a different place, no anatomists would have hesitated to assign them to animals of different kinds, or at least to different individuals.

"This great disproportion of size," says Dr. Leidy, "between the fore and back parts of the skeleton, leads me to suspect that the Hadrosaurus may have been in the habit of browsing, sustaining itself, kangaroo like, in an erect position on its back extremities and tail. As we, however, frequently observe a great disproportion between the corresponding parts of the body of recent and well-known extinct saurians, without any tendency to assume such a position as that mentioned, it is not improbable that *Hadrosaurus* retained the ordinary prostrate condition, progressing in the manner which has been suspected to have been the case in the extinct batrachian of an earlier period, the *Labyrinthodon*."

"If we estimate the number of vertebræ of the trunk of *Hadrosaurus* to have been the same as in the recent Crocodile and Iguana, the number of sacral vertebræ to have been the same as in the *Iguanodon*, and the number of caudal vertebræ to have been fifty, the whole number of vertebræ would have been eighty. A calculation of the length of the specimens of vertebræ in our possession, with a proper allowance of separation by invertebral fibro-cartilages, and an addition of two and a half feet as an estimate of the length of the head, would give, as the total length of the animal, about twenty-five feet."

Its tail must have been three feet deep; its neck thin, and its head no doubt small. Its teeth are but two inches long, but set in such a tessalated wall around the mouth as to make a formidable cutting and grinding apparatus.

Hadrosaurus was most probably amphibious; and though its remains were obtained from a marine deposit, the rarity of them in the latter leads us to suppose that those in our possession had been carried down the current of a river, upon whose banks the animal lived.

The enormous size of this animal may be imagined when it is stated that its thigh-bone is nearly one-third longer than that of a mastodon in the collection of the Academy.

There is also in the possession of the Academy a fragment of a thigh-bone, found in the greensand of New Jersey some years since, and hitherto uncharacterized, which now seems to have belonged to another much larger individual of the Hadrosaurus genus than the one whose remains were discovered by Mr. Foulke.

Fragments of fossil wood found in proximity to the bones, have been shown by Dr. Hammond, of Philadelphia, to belong to a species of conifer, not differing materially in microscopic character from the pines that now grow in the same locality. Various specimens of shells, all marine, were also found so near, or interspersed with the bones and coniferous wood, as to tend to prove that the animals and plants which they represent lived in the vicinity of the shores which the *Mollusca* inhabited, for these show that they were deposited in a sediment totally and completely at rest. The most tender and delicate forms remain without abrasion, and usually, in the case of the bivalves, the two valves are attached.

ON THE CRETACEOUS SYSTEM OF THE UNITED STATES.

In connection with the foregoing description of the Hadrosaurus, the following paper, on the Cretaceous System of the United States, was read to the Philadelphia Academy by Isaac Lea, Esq.

Geological science is indebted to the late Professor Vanuxem for the identification of the marl-beds of New Jersey and Delaware with the Cretaceous group of Europe; but it was not then known in either country that there were so many subdivisions of the group, and the exact parallelism of the greensand was not attempted to be traced. In 1828, Mr. Vanuxem, in the Journal of the Academy, gave a tabular view of the "relative geological position" of the secondary, tertiary, and alluvial formations of the United States, and also defined their geographical position, and stated that "this bed (greensand) was argillaceous, and contained greenish particles analogous to those which are found in the greensand, or chalk, of Europe," and that it was "characterized by six genera, viz., *Terebratula*, *Gryphaea*, *Exogyra*, *Ammonites*, *Baculites*, and *Belemnites*." These views of Professor Vanuxem were subsequently confirmed in various papers, published by Dr. Morton and other geologists, and from year to year new explorations have tended to demonstrate the vast extent of the Cretaceous formation in the United States east of the Rocky Mountains.

The Cretaceous Formation commences at Martha's Vineyard, in Massachusetts, is largely developed in New Jersey, and is found in Delaware, Maryland, Virginia, and the Carolinas. In Georgia, it is more largely developed. Here, sweeping round the inferior strata, — the Primary, Silurian, and Carboniferous masses, — it continues in a very enlarged band in a northerly direction, through Alabama, Mississippi, and Tennessee, to near the mouth of the Ohio River. Crossing the Mississippi River, it descends to the southwest, through Arkansas, where, on the upper waters of the Red River, it expands to the north, through Nebraska Territory, far into the British Possessions east of the Rocky Mountains, embracing the head waters of the

River Saskatchewan.* To the west, from the Red River, it extends to and beyond Santa Fe, embracing the head waters of the Colorado, and, stretching north-west, reaches the head waters of the Columbia, as well as those of the Missouri River. Following a south-western direction from Red River through Texas, it crosses the Rio Grande into New Leon, and thence south through St. Luis Potosi, it passes indefinitely into Mexico.

In all the great extent of this formation there is evidence of the cretaceous period, while most of the species differ from our eastern fauna, as the lithological characters do in the rocks and sediments. In New Jersey, the greensand beds are but slightly calcareous, the limestone, lying above, having about 80 per cent. of lime. In North and South Carolina, it is, according to Prof. Tuomey, "25 to 30 per cent. of the mass," but in Alabama it is "highly calcareous." This vast extent of a simultaneous deposit of this kind, is calculated to excite the greatest interest, when we consider how much it affects our agricultural prospects.

In 1840, Prof H. D. Rogers published his Report on the Geology of New Jersey, in which he separated the cretaceous group into five divisions, under the name of "the upper secondary series, embracing the greensand formation." 1. A group of sands and clays extremely white and pure. 2. A mixed group, consisting of greensand, alternating with, and occasionally replaced by, layers of a blue, sandy, micaceous clay, the so-called "greensand formation." 3. A yellowish, granular limestone, having a profusion of organic remains. 4. A yellow, very ferruginous coarse sand, with some fossil shells of the green sand formation. 5. A coarse, brown, ferruginous sandstone, sometimes passing into a conglomerate. Subsequently, in Johnston's Physical Atlas, 1855, under the name of "Newer Mesozoic," he continues these divisions, the whole thickness of which he presumes to be a thousand feet. Prof. Tuomey, in the tables of his geological survey of South Carolina, in 1848, calls the New Jersey deposits "upper greensand;" those of South Carolina, "the gault;" those of Alabama, the lower greensand, equivalent to the Néocomien of the French geologists.

In 1854, Messrs. Hall and Meek made a communication to the American Academy of Arts and Sciences, on some fossils from the Cretaceous Formation of Nebraska. This they divide into five sections. 5. Arenaceous clay, passing into argillo-calcareous sandstone. 4. Plastic clay, the principal fossiliferous bed of the upper Missouri. 3. Calcareous marl, containing *Ostrea congesta*, etc. 2. Clay, containing few fossils. 1. Sandstone and clay.

In 1855, Mr. Marcou publised, in the *Bulletin* of the Geological Society of France, an account of the Geology of the United States, in the cretaceous division of which (page 70), after giving to Prof. Vanuxem the credit of being the first to detect this group in the United States, he says that it may be divided provisionally into "three great groups," which have been named in Europe, 1st, le Néocomien; 2d, le grès vert supérieur et la craie marneuse; 3d, la craie blanche.

In March 1856, Mr. Meek and Dr. Hayden published their section of the Cretaceous formation of Nebraska. 5. Gray and yellowish arenaceous clays,

* See the map of Nebraska, by Lieut. Warren and Dr. Hayden, with explanations by the latter, who has done so much for the geology of the Western Territories; also the excellent map of Hall and Lesley, in Major Emory's Report on the Mexican Boundary Survey, and Prof. Hall's Report of the Geology of the Boundary, in the same volume. Also, the various papers of Meek and Hayden.

with great numbers of marine mollusca, few land plants, and bones of Mosasaurus. 4. Bluish and dark plastic clay, containing numerous marine Mollusca. 3. Lead-gray calcareous marl, with scales of fishes. *Ostrea congesta*, *Inoceramus*, etc. 2. Dark-gray laminated clay, with scales of fishes, small ammonites, etc. 1. Heavy bedded yellowish sandstone, with waterworn lignite. This formation, they say, may not belong to the cretaceous system.

Prof. Hall, in his Geological Report, August 1856, connected with Major Emory's Mexican Boundary Survey, gives an excellent table, prepared by Prof. G. H. Cooke, of the New Jersey Survey, which divides the whole of this system in New Jersey into eight members, which may be thus succinctly given:

8. Greensand, 3d or upper bed.
7. Quartzose Sand.

Nos. 4 and 5 Nebraska section.

6. Greensand, 2d. bed — (a) *Eschara*, etc.
   (b) *Gryphæa*, etc.
   (c) *Cucullea*, etc.
5. Quartzose Sand, highly ferruginous — *Exogyra*, etc.
4. Greensand, 1st or lower bed — *Exogyra*, *Ostrea*, etc.
3. Dark-colored clay, containing greensand — *Ammonites, Delawarensis*, etc.
2. Dark-colored clay — Fossil wood, no animal remains.
1. Fire Clay and Potter's Clay — Fossil wood and leaves, no animal remains.

In May 1857, Mr. Meek and Dr. Hayden, in the Proceedings of the Academy, continued their valuable papers on the Tertiary and Cretaceous formation of Nebraska, and gave a table of equivalents with the New Jersey deposits; and Dr. Hayden, in June of the same year, made a communication entitled "Explanations of a second edition of a geological map of Nebraska and Kansas," in which the whole series of formations is reviewed, including the cretaceous system.

It is a very important matter, in discussing these organic remains, to ascertain, as nearly as possible, the horizon on which this particular formation would stand in regard to its parallelism with those of Europe, where so much has been written on the subject of the various members of the Cretaceous group. Sir Charles Lyell says that the New Jersey "strata consist chiefly of greensand and green marl, with an overlying coraline limestone, of a pale-yellow color; and the fossils, on the whole, agree most nearly with those of the upper European series, from the Maestricht beds to the gault, inclusive.*

Prof. Rogers, in his New-Jersey Report, does not seem to agree with this idea; he "does not regard these strata as the equivalents, in the strict sense of the word, of the greensand formation, so-called, of Europe" (page 178). "Nor are we able," he says, "positively to decide, merely by the relationship of the genera, whether the cretaceous period embraces both the commencement and termination of the American greensand series" (page 179). M. D'Orbigny † considers the chalk formation of North America to belong to his "étage sénonien" (the upper chalk of Morris), and not to the "grès verts," as supposed by Dr. Morton and others. Dr. Mantell considered that the teeth of the *Mosasaurus*, found in the greensand formation of New Jer-

* Manual, third edition, p. 224.

† Cours Elémentaire, p. 671.

sey, described by Dr. Harlan, were in every respect analogous to those of the Maestricht reptile, and that the deposit was equivalent to the Maestricht bed. The Blackdown greensand of Dr. Fitton * has in its fossil mollusca a very strong resemblance to our greensand fossils; and as D'Orbigny makes this formation an equivalent to his Cénomanien, there is some evidence that the New Jersey greensand may be on the same horizon; for, according to D'Orbigny's tables, the genus *Belemnites* ceases with the Cénomanien, and we have abundance of that genus in our greensand formation. If he be correct as to the decadence of the Cephalopoda, then we could not place this formation higher up in the series than his Cénomanien, which is the "Glauconie crayeuse" of Brogniart, found at Cap le Hève, in France, the Blackdown greensand of Fitton, and the Upper greensand of Mantell in the south of England.

Under all the information we have, however, from the various investigations made by so many distinguished geologists, I think the evidence is in favor of D'Orbigny's opinion, that the greensand formation, from which the remains of the Hadrosaurus were exhumed, belong to his Sénonien; but it may prove, upon further examination, to be a little lower in the Cretaceous series.

ON THE INFUSORIAL DEPOSITS OF THE TERTIARY OF VIRGINIA.

At a recent meeting of the Boston Nat. Hist. Society, Prof. W. B. Rogers presented some masses of Infusorial earth from the Tertiary strata of Virginia and Maryland, and gave a description of the geological and other conditions in which this and the associated deposits exhibit themselves in and near Richmond, in the former of these states.

The Tertiary formations which underlie the wide plain extending from the seaboard to the eastern margin of the granitic and gneissoid rocks, approach their termination along this meridian in a series of strata which are separated by only a short interval from the irregular granitic floor. A little further toward the west they reach their boundary, partly by a rapid thinning away, and in part by abutting, along the hill-sides, against the indented shore of these ancient rocks, here rising to the level of the general upland surface.

In the deep ravines leading into the valley of Shockoe Creek, especially on its western side, we meet with several extensive exposures of the Tertiary strata, one of which embraces nearly the whole thickness of both the Eocene and Meiocene formations as locally developed in this neighborhood. In all these localities the *infusorial deposit* is found occupying a position immediately above the upper limit of the Eocene strata or separated from it by a thin layer of whitish or of more or less ferruginous clay. Like the associated beds, it fluctuates in thickness as traced from one neighboring exposure to another, varying from twenty to upwards of thirty feet at the different localities on the north side of the valley, and presenting, where measured some years ago, on the opposite or Church-Hill side, a thickness of nearly fifty feet. In addition to the microscopic fossils, which in a more or less perfect condition make up so large a portion of the mass, this deposit presents a few casts of shells of well-known Meiocene forms, of which the Astarte undulata may be mentioned as of the most frequent occurrence. It also contains imperfectly preserved remains of a slender creeping plant, as

* Strata below the chalk.

well as fragments of woody stems and branches, flattened and converted into lignite, and in some cases filled in all directions with the perforations of a Teredo.

The material of the Infusorial stratum is generally of a very fine texture, admitting of being bruised between the fingers into an almost impalpable powder, singularly free from gritty particles. Although usually of a light-gray, almost white color, it includes in some localities layers of an ashy tinge, which are, however, not inferior to the rest of the deposit in the abundance of their minute organic forms. It has throughout a tendency to lamination in a horizontal direction, and toward its upper limit this structure is so distinct as to cause it readily to separate in thin crumbly plates. But, of all its mechanical peculiarities, its great lightness is the most characteristic. From experiments made many years ago, Prof. Rogers found that, when pure and quite free from moisture, this material, in its ordinary state of compactness, has a weight only one-third as great as an equal bulk of water. The minute siliceous fossils for which this deposit has long been noted, belong, as is well known, almost entirely to the family of Diatomaceæ, and include a very large proportion of Coscinodiscus and allied forms, whose exquisitely thin plates, lying in parallel positions in the mass, have probably contributed to the laminated structure before referred to. The number of such frustules and other siliceous skeletons in each cubic inch of the pure material can only be reckoned in millions, and a cubic foot would contain a multitude far exceeding in number the entire human population of the globe.

ON THE SO-CALLED "BIRD-TRACKS" OF THE CONNECTICUT RIVER VALLEY.

The following paper was presented to the American Association for the Promotion of Science, 1859, by Roswell Field, Esq., of Turner's Falls, Mass.

"When fossil foot-prints were first discovered in the sandstones of the Connecticut Valley, the theory that they were produced by birds was received by most scientific men with great distrust and skepticism. And it was not until after Dr. Edward Hitchcock had spent much time and labor in comparing, describing, and distributing specimens, that the scientific public became satisfied that they were the tracks of once living birds.

"The great and only proof that they are the tracks of birds, is the organization of the foot, — and in the number and arrangement of the joints they probably do agree with living types, — and the alternate steps of right and left feet. Living in the vicinity of Turner's Falls, the locality that has furnished the greatest number, and beyond all comparison the most beautiful specimens of these tracks, my attention was early drawn to this subject, and I think I may safely say, that I have uncovered more foot-prints, and found more new species, than any other person. I have, moreover, seen thousands of tracks which others have not seen, since, from injudicious blasting and carelessness of workmen, many fine specimens have been broken and lost; others, from the shrinkage of the matrix, or the presence of sun-cracks, are worthless for removing from the quarries. I consider that I have thus seen thousands of specimens that others have not seen; and the better acquainted I have become with the subject, the greater have become my doubts as to the ornithoid character of the tracks. I have no new theory to advance; but if I can rightly decipher the impressions, the animals producing them should all be classed among the reptilia. They appear to me to have all been quadrupeds, which usually walked upon two feet, but were capable of walking upon four feet when necessity required. In proof of this, we find tracks, as perfect as if made in plastic wax, which, in the number of toes and phalangeal expansions, agree perfectly with living birds, and yet it is certain that they were made by quadrupeds, from the impressions left by their forward feet. And in other cases, where the animal sunk deep in the mud, they usually dragged their tails, leaving a furrow, or groove, ploughed up in the soft material, of from one-half an inch to an inch in width. This groove is not always found on the surface where the foot rested, since, when the weight of the animal caused the feet to sink through the upper and yielding stratum, the tail dragged upon the then immediate surface; and the existence of a tail appendage is only evident under the above conditions. That these were quadrupeds, therefore, at this date of the deposition of these sandstones, that had hind feet perfectly agreeing with those of birds, renders it a matter of great doubt whether there were any birds at this epoch — this age of reptiles. If there were, they must have been apterous and naked; for it is impossible to suppose that ordinary birds, congregating together in such numbers, and pluming themselves, would not pull out some of their feathers. No impressions of feathers, however, have been found, although we constantly meet with impressions of the smallest leaves of vegetables, and the tracks and markings of the annelids and insects, some of which are so small, that they require the aid of a lens to describe them correctly.

Mr. F. said "he was aware that men very eminent in science had come to a conclusion different from his own in this matter, and it was not for him to say that they were wrong; he would only suggest, that so little was known in regard to the subject when they made their examinations, that possibly our first discoverers may have been mistaken.

"Very few, probably, have any conception of the marvellous perfection of these fossil inscriptions at Turner's Falls, or of the once countless individuals who have left unmistakable evidence of their existence in what is now the valley of the Connecticut River."

ON THE DISCOVERY OF THE REMAINS OF MAN IN RECENT GEOLOGICAL FORMATIONS.

Much interest has of late been excited by the discovery of the remains of man, or his works, under conditions which seem to imply an existence of the *genus homo* during the later geological epochs. In addition to what was brought forward on this subject at the British Association in 1858, by Prof. Owen and Mr. Pengelley, and before the Royal Society by Mr. Horner (see *Annual Scien. Dis.* 1859, pp. 324, 326), we herewith furnish our readers with a résumé of all the additional contributions to our knowledge on this subject. (See also Sir Charles Lyell's address before the geological section of the British Association for 1859, pp. 6, 7, present volume.) — *Editor.*

At a meeting of the Society of Antiquaries (London), June 2, 1859, Mr. Evans read a paper "On the occurrence of Flint Implements in undisturbed Beds of Gravel, Sand, and Clay (such as are known by Geologists under the name of Drift) in several Localities, both on the Continent and this Country." The first discovery of these implements is due to M. Boucher de Perthes, of Abbeville, who, in the pits in that neighborhood, found flints evidently fashioned by the hand of man, under such conditions as forced upon him the conclusion that they must have been deposited in the spots where they were found at the very period of the formation of the containing beds. M. de Perthes announced his discoveries in a work entitled "Antiquités Celtiques et Antédiluviennes," in two vols., the first published in 1849, and the second in 1857; but, owing in some measure to the admixture of theory with the facts therein stated, his work has not received the attention it deserves. The late discovery in the Brixham Cave, in Devonshire, of flint weapons in conjunction with the bones of the extinct mammals, had brought the question of the coëxistence of man with them again prominently forward among geologists, and determined Mr. Prestwich, who has devoted much attention to the later geological formations, to proceed to Abbeville, and investigate upon the spot the discoveries of M. de Perthes. He had there been joined by Mr. Evans, and they had together visited the pits where flint weapons had been alleged to have been found, both in the neighborhood of Abbeville and Amiens. The chalk hills near both these towns are capped with drift, which, apparently, is continued down into the valleys, where it assumes a more arenaceous character, and in these beds of sand, as well as more rarely in the more gravelly beds. Upon the hills, mammalian remains have been found in large quantities. They include the extinct elephant, rhinoceros, bear, hyæna, tiger, stag, ox, and horse — in fact, most of the animals whose bones are so commonly associated together in the drift and caverns of the Postpliocene period. On the hills near Abbeville, and at St. Acheul, near Amiens, the drift varies in thickness from about ten to twenty feet, and consists of beds of subangular gravel, with large flints, and above them sands containing the fragile shells of fresh-water mollusca, and beds of brick-earth. It is among the basement beds of gravel, at a slight distance above the chalk, that the flint implements are usually found. They are of three forms: — 1. Flakes of flint, apparently intended for knives or arrow-heads. 2. Pointed implements, usually truncated at the base, and varying in length from four to nine inches — possibly used as spear or lance heads, which, in shape, they resemble. 3. Oval or almond-shaped implements, from two to nine inches in length, and with a cutting edge all round. They have generally one end more sharply curved than the other, and occasionally even pointed, and were possibly used as sling-stones, or as axes, cutting at either end, with a handle bound round the centre. The evidence derived from the implements of the first form is not of much weight, on account of the extreme simplicity of the implements, which at times renders it difficult to determine whether they are produced by art or by natural causes. This simplicity of form would also prevent the flint flakes made at the earliest period from being distinguishable from those of a later date. The case is different with the other two forms of implements, of which numerous specimens were exhibited, — all indisputably worked by the hand of man, and not indebted for their shape to any natural configuration or peculiar fracture of the flint. They present no analogy in form to the well-known implements of the so-called Celtic or stone period, which, moreover, have for the most part some portion, if not the whole, of their surface ground or polished, and are frequently made from other stones than flint. Those from the drift are, on the contrary, never ground, and are exclusively of flint. They have, indeed, every appearance of having been fabricated by another race of men, who, from the fact that the Celtic stone weapons have been found in the superficial soil above the drift containing these ruder weapons;

as well as from other considerations, must have inhabited this region of the globe at a period anterior to its so-called Celtic occupation. This difference in form and character from the ordinary types of stone implements, strengthened the probability of their having been found under entirely different circumstances; and Mr. Evans then proceeded to examine the evidence of their having been really discovered in undisturbed beds of gravel, sand, and clay. He showed, from various circumstances in connection with them, such as their discoloration by contact with ochreous matter, whitening when imbedded in a clayey matrix, and in some instances being incrusted with carbonate of lime, the extreme probability of their having been deposited in these beds at the very time of their formation, inasmuch as the unwrought flints adjacent to them had been affected in a precisely similar manner, and to no greater extent. This discoloration and incrustation of the implements, also proved that they had really been found in the beds out of which they were asserted to have been dug; and their number, and the depth from the surface at which they were found were such, that if they had been buried at any period subsequent to the formation of the drift, some evident traces must have been left of the holes dug for this purpose; but none such have been observed, though many hundreds of the implements had been found dispersed through the mass. But, besides this circumstantial evidence, there was the direct testimony of MM. Boucher de Perthes, Rigollot and others, to the fact of these implements having been discovered underneath undisturbed beds of drift, and many of them under the immediate eye of M. de Perthes, who, indeed, had been the first to point out the existence of these implements to the workmen. Of the correctness of this testimony, Mr. Evans, when visiting with Mr. Prestwich the gravel pit at St. Acheul near Amiens, had received ocular proof. There, at the depth of eleven feet from the surface, in the face of the bank or wall of gravel, the whole of which, with the exception of the surface soil, had its layers of sand, gravel, and clay entirely undisturbed, was one of these implements *in situ*, with only the edge exposed, the remainder being still firmly imbedded in the gravel. After having photographs taken of it, so as to verify its position, this implement had been exhumed, and was now exhibited with other specimens. At a subsequent visit of Mr. Prestwich and some other geologists to the spot, one of the party, by digging into the bank of gravel at a depth of sixteen feet from the surface, had dislodged a remarkably fine weapon of the oval form, the beds above being also in a perfectly undisturbed condition. The inevitable conclusion drawn from these facts was, that M. Boucher de Perthes' assertions were fully substantiated, and that these implements had been deposited among the gravel at the time of the formation of the drift. And this conclusion was corroborated in the most remarkable manner by discoveries which had been made long since in England, but whose bearing upon this question had until the present time been overlooked. In the 13th vol. of the "Archæologia," is an account, by Mr. Frere, in 1797, of the discovery of some flint weapons in Suffolk, in conjunction with elephant remains, at a depth of eleven to twelve feet from the surface, in gravel overlaid by sand and brick-earth, presenting a section extremely analogous with some that might be found near Amiens or Abbeville. Some of these weapons are preserved in the Museum of the Society of Antiquaries and in the British Museum, and are identical in form with those found on the Continent. Mr. Prestwich had been to Suffolk, and verified the discoveries recorded by Mr. Frere. Flint implements are still found there, as well as mammalian remains, but in diminished quantity, only two of the weapons having been brought to light during the winter. Another of these implements is in the British Museum, having been formerly in the Kemp and Sloane Collections, and is recorded to have been found with an elephant's tooth in Gray's Inn Lane. Similar implements are also reported to have been found in the gravel near Peterborough. These accumulated facts prove, almost beyond controversy, the simultaneous deposition of instruments worked by the hand of man with bones of the extinct mammalia in the drift of the Postpliocene period. Whether the age of man's existence upon the earth is to be carried back far beyond either Egyptian or Chinese chronology, or that of the extinct elephant, rhinoceros and other animals brought down nearer to the present time than has commonly been allowed, must remain a matter for conjecture. This much appears nearly indisputable, — that at a remote period, possibly before the separation of England from the Continent, this portion of the globe was densely peopled by man; that implements, the work of his hands, were caught up, together with the bones of the extinct mammals, by the rush of water, through whose agency the gravel beds were formed; that above this gravel, in comparatively tranquil fresh water, thick beds of sand and loam were deposited, full of the delicate shells of fresh-water mollusca; and that where all this took place now forms table-land on the summit of hills nearly two hundred feet above the level of the sea, in a country whose level is now stationary, and the face of which has remained unaltered during the whole period which history or tradition embraces. In conclusion, Mr. Evans suggested a careful examination of all beds of drift in which elephant remains had been found, with a view of ascertaining the coëxistence with them of these flint implements, and still further illustrating their history. Their rudeness, and the fact that they had not been sought for by those who have investigated the drift, may well account for their not having been more generally found."

The authenticity of the so-called works of art, found in the drift by Mr. Prestwich having been very strenuously called in question and denied by various writers, Prof. A. C. Ramsay, in a communication to the *London Athenæum*, under date of July 13th, thus reviews the whole subject.

With regard to the presence of works of art in the Upper Drift, the subject easily divides itself into two heads: First, are the objects discovered genuine works of art? and, secondly, were they actually found in strata deposited at a period contemporary with the organic remains with which they are associated?

The first duty of all inquirers is to free their minds from all prepossessions respecting the antiquity of the human race. On this point most geologists may be charged with having heretofore had the strongest preconceived opinions respecting the late date of the appearance of man on the world, in confirmation of which I may appeal to the writings of Buckland and many others. They were, therefore, no more likely than other observers to adopt in haste any hypothesis that might tend to prove his extreme antiquity. They were, however, so far prepared for such a contingency, that their habits of thought, might lead them to accept good evidence, when offered with comparative facility, and their daily occupations give them some advantages in dealing with the question.

For more than twenty years, like others of my craft, I have daily handled stones, whether fashioned by Nature or Art; and the flint hatchets of Amiens and Abbeville seem to me as clearly works of art as any Sheffield whittle. It does not matter whether they occur under unexpected circumstances or not. The question is, Is there reason to believe that flints are ever so fashioned by natural processes? Certainly, flints moulded by "motion in water" assume forms quite the reverse of implements made by man, or even of flints fractured by any mere blow, or by the action of the weather. The action of running water, or of waves on a beach, is to remove all asperities, and other accidental marks, on stones of every description. So thoroughly is this the case, that stones that have been simply *scratched* by the onward motion of a glacier, lose not only their finer structures, but all their angles get rubbed off, and they become rounded and *water-worn* by attrition, as they rattle on each other in their passage down the stream. This result is universal, not only in brooks and rivers, but also on sea-shores, like the Chesil Bank, for instance, where all the stones, instead of being sharply fractured, are water-worn and rounded. Atmospheric influences often produce angularity in stones; but these weather-broken fragments never possess those repeated small fractures at the edge, the result of many taps, and that peculiar artificial symmetry so evident in the presumed flint hatchets of Abbeville.

With respect to their position in the Drift, we have the testimony of various independent observers, both French and English. I accept this part of the evidence from Mr. Prestwich alone, as I would accept the evidence of the existence of the planet Neptune from Prof. Adams. Mr. Adams's peers knew his value, and all British, and most Continental geologists are aware that Mr. Prestwich is not only a man of long-tried experience, but is alike skilful and cautious in all his determinations.

Observations on the Ossiferous Caves near Palermo, Sicily. — The following is an abstract of a communication on the above subject, made to the Geological Society (London) by Dr. Falconer, June 22d, 1859.

Dr. F. first described the physical geography of that portion of the northern coast of Sicily in which the ossiferous caves abound, namely, between Termini on the east, and Trapani on the west. Along the Bay of Palermo, and again at Carini, the hippurite limestone presents inland vertical cliffs, from the base of which stretch slightly inclined plains of pliocene deposits, usually about a mile and a half broad, towards the sea. The majority of fossil shells in these tertiary beds belong to recent species. At the base of those inland cliffs, but sometimes fifty feet above the level of the plain, and upwards of two hundred feet above the sea, the ossiferous caves occur. One of the best known of these is the Grotto di Santo Ciro, in the Monte Griffone, about two miles from Palermo. This cave has been often described. Like many others, it contains a mass of bone breccia, on its floor, extending also beyond its mouth, and overlying the pliocene beds outside, where great blocks of limestone are mixed with the superficial soil. The bones from this cave had long been known, and were formerly thought to be those of giants. Some years since, bones were here excavated for exportation; and M. Christol, at Marseilles, was surprised to recognize the vast majority of remains of two species of hippopotami amongst bones brought there, and counted about three hundred astragli. Besides the Hippopotamus, remains of Elephas also occur. Professor Ferrara suggested that the latter were due to Carthaginian elephants, and the former to the animals imported by the Saracens for sport. The government of Palermo having ordered a correct survey of this cave and its contents, it was found that beneath the bone breccia was a marine bed, with shells, and continuous with the external tertiary deposits. The wall of the cave, to the height of eight feet from the floor, had been thickly bored by Pholades; for the space of ten feet higher the side was smooth; and still further up it was cancellar or eroded. Above the breccia were blocks of limestone, covered by earthy soil, in which bones of hippopotami, with a few of those of Bos and Cervus, light and fragile, not fossilized as in the breccia, occurred plentifully. In a late visit to the San Ciro Cave, Dr. Falconer collected (besides the Hippopotamus) remains of Elephas antiquus, Bos, Cervus, Sus, Ursus, Canis, and a large Felis, some of which indicated a pliocene age. Another cave, the Grotto di Maccagnone, about twenty-four miles to the west of Palermo, was lately the especial subject of the author's research. In its form it differs from that of San Ciro, being much wider. Its sides show no Pholad markings nor polished surfaces, as far as they are yet bared. It has a reddish or ochreous stalagmitic crust covering the interior. It agrees with the San Ciro Cave in its situation at nearly the same elevation above the sea and above the tertiary plain; and in its enormous mass of bone breccia and great accumulation of limestone boulders covered by the humatile soil with loose bones. The floor had already been dug over for bones. Beneath this was the usual ochreous loamy earth (called "cave-earth"), with huge blocks of blue limestone, which impeded the operations of search; then a reddish-gray, mottled, spongy loam, cemented with stalagmite, occurring in thick patches, and called "cinere impastate" by the peasants. This covers bone breccia resembling that of San Ciro, and, like it, full of bones of hippopotami. The remains of a large Felis, two extinct species of deer, and of Elephas antiquus, were met with also. The last is characteristic of the other pliocene caves of Europe. Coprolites of a large hyena occur in ochreous loam, and especially in a recess on the face of the cliff near the cave's mouth. A patch of the "cinere impastate" was found under the superficial earthy floor of the cave, at one spot near the inner wall. The author next described some remarkable conditions in the roof of the cave. About half-way in from the mouth, and at ten feet above the floor, a large mass of breccia was observed, denuded partly of the stalagmite covering, and composed of a reddish-gray argillaceous matrix, cemented by a calcareous paste, containing fragments of limestone, entire land shells of large size finely preserved, splinters of bone, teeth of ruminants, and of the genus Equus, together with comminuted fragments of shells, bits of carbon, specks of argillaceous matter resembling burnt clay, together with fragments of shaped siliceous objects of various tints, varying from the milky or smoky color of calcedony to that of jaspery hornstone. The brecciated matrix was firmly cemented to the roof, and, for the most part, covered over with a coat of stalagmite. In the S. S. E. expansion of the cavern, near the smaller aperture, a considerable quantity of coprolites of hyæna was found similarly situated in an ochreous calcareous matrix, adhering to the roof, mingled with some bits of carbon, but without shells or bone splinters. On the back part of the cavern, where the roof shelves towards the floor, thick masses of reddish calcareous matrix were found attached to the roof, and completely covered over by a crust of ochreous stalagmite. It contained numerous fragments of the siliceous objects, mixed with bone splinters and bits of carbon. In fact, all round the cavern, wherever the stalagmitic crust on the roof was broken through, more or less of the same appearances were presented. In some parts the matrix closely resembled the characters of the "cinere impastata," with a larger admixture of calcareous paste. With regard to the fragments of the siliceous objects, the great majority of them present definite forms, namely, long, narrow, and thin; having invariably a smooth conchoidal surface below, and above, a longitudinal ridge bevelled off right and left, or a concave facet replacing the ridge; in the latter case presenting three facets on the upper side. The author is of opinion that they closely resemble, in every detail of form, obsidian knives from Mexico, and flint knives from Stonehenge, Arabia, and elsewhere, and that they appear to have been formed by the dislamination, as films, of the long angles of prismatic blocks of stone. These fragments occur intimately intermixed with the bone splinters, shells, etc., in the roof breccia, in very considerable abundance; amorphous fragments of flint are comparatively rare, and no pebbles or blocks occur either within or without the cave. But similar reddish flint, or chert, is found in the hippurite limestone near Termini. In regard to the theory of the various conditions observed in the Maccagnone Cave, the author considers that it has undergone several changes of level, and that the accumulation of bone breccia below and outside is referable to a period when the cave was scarcely above the level of the sea. Dr. Falconer points out the significance of the fact, that although coprolites of hyæna were so abundant against the roof and outside, none, or but very few, of the bones of hyæna were observed in the interior. He remarked, also, on the absence of the remains of small mammalia, such as rodents. He inferred that the cave, in its present form, and with its present floor, had not been tenanted by these animals. The vast number of these hippopotami implied that the physical condition of the country must have been very different at no very distant period from what obtains now. He considered that all deposits *above* the bone breccia had been accumulated up to the roof by materials washed in from above through numerous crevices or flues in the limestone, and that the uppermost layer, consisting of the breccia of shells, bone splinters, siliceous objects, burnt clay, bits of charcoal, and coprolites of hyæna, had been cemented to the roof by stalagmitic infiltration. The entire condition of the large fragile Helices proved that the effect had been produced by tranquil agency of water, as distinct from any tumultuous action. There was nothing to indicate that the different objects in the *roof breccia* were other than of contemporaneous origin. Subsequently a great physical alteration in the contour, altering the flow of superficial water, and of the subterranean springs, changed all the conditions previously existing, and emptied out the whole of the loose incoherent contents, leaving only the portions agglutinated to the roof. The wreck of these ejecta was visible in the patches of "cinere impastata," containing fossil bones, below the mouth of the cavern. That a long period must have operated in the extinction of the hyæna, cave-lion, and other fossil species, is certain; but no index remains for its measurement. The author would call the careful attention of cautious geologists to the inferences — that the Maccagnone Cave was filled up to the roof within the human period, so that a thick layer of bone splinters, teeth, land-shells, coprolites of hyæna, and human objects, was agglutinated to the roof by the infiltration of water holding lime in solution; that subsequently, and within the human period, such a great amount of change took place in the physical configuration of the district as to have caused the cave to be washed out and emptied of its contents, excepting the floor breccia, and the patches of material cemented to the roof and since coated with additional stalagmite.

In connection with the above paper, and at the same meeting of the Society, Mr. Prestwich gave in a few words the results of the examination of the bone-cave at Brixham, in Devonshire. The cave has been traced along three large galleries, meeting or intersecting one another at right angles. Numerous bones of Rhinoceros tichorinus, Bos, Equus, Cervus tarandus, Ursus spelæus, and Hyæna, have been found; and several flint implements have been met with in the cave-earth and gravel beneath. One in particular was met with immediately beneath a fine antler of a reindeer and a bone of the cave-bear, which were imbedded in the superficial stalagmite in the middle of the cave.

Mr. J. W. Flower also described a flint implement recently discovered in a bed of gravel, at Saint Acheul, near Amiens, France.

The gravel capping a slight elevation of the chalk at Saint Acheul is composed of water-worn chalk-flints, and is about ten feet thick; above it is a thin band of sand, surmounted by sandy beds (three feet six inches) and brick-earth (eleven feet nine inches). In this gravel the remains of elephant, horse, and deer have been found, with land and fresh-water shells of recent species. From the gravel Mr. Flower dug out a flint implement, shaped like a spear-head, at about eighteen inches from the face of the pit, and sixteen feet from the surface of the ground. Mr. Flower, in this communication, pointed out evidences to prove that this and many other similar flint implements obtained from the same gravel were really the result of human manufacture, at a time previous to the deposition of the gravel in its present place.

"These interesting discoveries," says a writer in the *London Athenæum*, "taken in connection with the discovery of human teeth and bones associated with those of the mammoth on the Swabian Alps, with the human bones in the Köstriz and other bone-caves, and with the more recent discovery of the association of stone knives and fossil elephant bones in France, seems to promise that, before long, geologists, by perseverance, may come upon evidences of an earlier date for man's occupation of European ground than has been usually granted. Still, however, the stone knives are of no older date than the 'Pleistocene period' of geologists — the beginning of the present state of things around us, when the existing hills and valleys had been formed, the present climates settled, and the present fauna and flora established, though still combined with some representatives of the past."

On the Bone-Cavern of Torquay, England. — In this connection, the following notice of the cavern of "Kent's Hole," Torquay, England (celebrated for its animal remains), from a recent publication by its explorer, Rev. J. MacEnery, may not be uninteresting.

The favorite entrance to this cavern is simply a cleft in the rock, shaped like a reversed wedge, about seven feet wide at the bottom and five feet high. When the accumulated rubbish was cleared away from the entrance, the interior was found to rise rapidly, and to spread out into a spacious vault, while the rock floor was polished as if by constant use.

Ordinary tourists visit caverns for the purpose of admiring the sparry concretions (the stalactites and stalagmites) that frequently adorn them with the most singular shapes. Kent's Hole is not destitute of these natural ornaments, yet does not abound in them so remarkably as some other caverns. In the upper gallery, the concretions at the roof appear like clusters of cones, disposed at regular intervals, like the pendants of a Gothic screen, connected by a transparent curtain of stalactite. While the mere tourist would admire the natural architecture, and heed nothing beyond its beauty, the geologist is chiefly attracted by it because it has rendered him the invaluable service of sealing down the floor hermetically, and preserving the precious deposits of animal bones beneath through many centuries, without permitting natural decay or accidental disturbance. So hard was the floor, that attempts to penetrate it were abandoned in despair, until, by following the cracks that traversed it like a pavement, a flag was turned over, and groups of skulls and bones were found adhering to the stalagmite. Succeeding flags, when upturned, exhibited like interesting objects. The place was evidently an ursine cemetery — intramural, indeed, as respected rock walls, but extramural as regarded all habitations of town-loving man. Here the remains of the bear prevailed to the exclusion of all others. The bones retained their natural freshness, as if they had been derived from animals in a high state of vigor; while some of the teeth displayed dazzling enamel. Two skulls were buried in the stalagmite as in a mould, and were brought away in that state. The unbroken condition of most of these remains appeared to indicate that they belonged to animals that died a natural death in this spot during a succession of ages.

The most interesting part of the cavern was at a point where the roof and floor nearly met, and which was always regarded as the extreme limit of the cavern, until, by removing heaps of loose stones, a passage was opened to a small group of chambers, probably untrodden before by the foot of mortal man. A column of spar connecting roof and floor being removed, it was found, to the explorer's inexpressible joy, to have covered the head of a wolf — "perhaps the largest and finest skull, whether fossil or modern, of that animal in the world." Near it lay one of its under jaws entire, — the other could not be found. The stalagmite at this point was a foot and a half thick, excessively hard, marked by mixture of rolled rocky fragments, but in the interior moulding itself purely upon a mass of bones. These were so thickly packed together, that no idea of their number could be given. They had suffered from pressure, and had been impelled by violence into this narrow neck of the hollow. Some were even driven into the interstices of the opposite wall; others were piled in the greatest confusion against its side. From this spot alone Mr. MacEnery gathered some thousands of teeth of the horse and hyena, and in the midst of all were myriads of Rodentia. The earth was saturated with animal matter; it was fat with the sinews and marrow of more wild beasts than would have peopled all the menageries in the world.

In one part of the cavern, which has received the name of the "Cave of Rodentia," it was found that the remains and dust of this class of animals constituted the whole floor, and that they were agglutinated together by calcareous matter into a bony breccia or conglomerate. Not only had their tiny remains penetrated into every cleft and crevice of the rock, but they had even insinuated themselves into the chambers of the large bones. Here, then, were myriads of minute animal remains accumulated by the side of those of the elephant, rhinoceros, and hyena, in one common sepulchre. When a handful of the dust was thrown into the air, hundreds of teeth rose to the surface, and only in this way could they be collected. Land and water rats (*campagnols*), bats, weasels, and moles, had all left innumerable remains on this spot. That they all existed and died here, was made manifest by the condition of their remains, every part indicating prolonged habitation and peaceable death.

The distribution of animal remains over the whole cavern may be thus summarily stated. The ancient floor of the cavern was covered with the remains of the hyena, bear, and campagnol — the two latter occupying its opposite extremities, the former occupying the remainder and the centre and the upper gallery. The great body of the cavern was occupied by the hyena; while, in addition to the remains of its own species, which perished by a natural death, there were found remains of its prey, accompanied by other evidences of the conversion of the cavern by hyenas into a favorite den, resembling that of Kirkdale, in Yorkshire, so well explored and described by Dr. Buckland, in his *Reliquiæ Diluvianæ.*

In addition to these animal remains, the upper portions of the stalagmite floor have yielded abundant rélics of man; viz., in the lowest of the more modern deposits, innumerable flint spears and arrow-heads; then pottery, beads of opaque glass, human crania and teeth; while, finally, sun-baked urns, fragments of breastplates, heaps of shells, and pins and bodkins of bone, indicate the visits of Britons — perhaps Romanized Britons.

FOSSIL CETACEAN IN VERMONT.

At the Springfield meeting of the American Association for the Promotion of Science, 1859, Mr. Edward Hitchcock, Jr., exhibited the remains of a fossil whale, found in Charlotte, Vt., in August 1849, during an excavation for the Rutland and Burlington railroad. It was found in blue clay, lying from ten to fourteen feet below the surface, the head almost four feet higher than the tail. The Irishmen who discovered it, supposing it to be the bones of a horse, wantonly broke many of them, and particularly the head. Enough of the head, however, was saved to show the two spiracles, or blow-holes, which are characteristic of the cetaceans. Nine conical teeth were also found, which were considerably worn, showing that it was not a young animal. Of the fifty, or perhaps fifty-two vertebræ which belong to the genus Beluga, forty-one were found. The caudal vertebræ, particularly the last ones, are flattened horizontally, giving another indication of the whale family. The total length of the vertebral column, including the intervertebral cartilages, must have been one hundred and thirty-seven inches; and this, with the head and caudal fin, must have made the animal about fourteen feet in length.

Of the five cheek-bones which belong to the Beluga, only one is missing, and two of them are perfect. The ribs are very badly broken, though at least four are perfect. Their whole number was twenty-six. This whale is, without doubt, of the genus Beluga; and the specific name *Vermontana*, was given it by the late Prof. Z. Thompson, of Burlington, Vermont, as commemorative of the State where the remains were found.

In connection with the above statement, Sir William Logan, of the Canada Survey, remarked, that the remains of a similar skeleton had been found near Montreal, in a clay pit, which was dug for the purpose of making bricks, fifteen feet below the surface. They were found associated with five species of marine shells, and also with some plants and pieces of wood.

ON THE COMPOSITION OF THE SOMBRERO GUANO.

At a recent meeting of the Philadelphia Academy, Dr. Leidy called attention to the large number of turtle bones included in the masses of the so-called Sombrero Guano, which significantly pointed to the origin of the rock, imported as a manure rich in phosphates, from the island Sombrero, W. I.

This island, situated about one hundred and thirty miles east of Porto Rico, is about two and one-half miles long, one-half to three fourths of a mile wide, and rises from twenty to forty feet above the level of the ocean. It is a barren rock, formerly avoided by navigators, and appears to be entirely composed of the rich phosphatic mineral. Analyses of the substance, by competent chemists, indicate it to bear a resemblance in composition to bones deprived of their cartilage, and otherwise altered, as we might suppose bones to be, exposed to the influence of the ocean water. It contains about the same proportion of phosphate of lime as calcined bones; and it is this circumstance which has directed the attention of merchants and agriculturists to its value as a manure.

From this, the Sombrero material deserves to be distinguished by a new name; and perhaps the easy one of *Osite*, from its resemblance in composition to bones, and its probable origin, would not be inappropriate. But are we to ascribe the immense mass forming the Sombrero rock to animal origin? Many reefs and shores of vast extent are known positively to have had their origin in the testaceous coverings of the lower animals, but Sombrero appears to be the first instance of an extensive island formed alone of the remains of the higher animals. The composition of the Sombrero substance, with its included bones, leads us to suspect that the island was once a shoal swarming with turtles and other vertebral animals, whose accumulated remains of ages have been cemented together, and gradually elevated above the ocean level to the present position of the island.

GIGANTIC AUSTRALIAN LIZARD.

Professor R. Owen has communicated to the Royal Society the description of some remains of a gigantic Land Lizard from Australia. A collection of fossil remains now in the British Museum, demonstrates the former existence in Australia of a land lizard far surpassing in bulk the largest species now known. The characters are derived from vertebræ, partially fossilized, equalling in size the largest known crocodiles. They are of the procœlian type, presenting lacertian modifications, and agreeing closely with those of the existing lace-lizard of Australia. A generic distinction is indicated by the comparatively contracted area of the neural canal, and by the inferior development of the neural spine of this fossil vertebra, which, from the proportions of the body, must have belonged to an animal not less than twenty feet in length. For this probably extinct lizard the name of *Megalanea prisca* is proposed.

Prof. Owen also has communicated to the Geological Society, "Notes on some Outline-drawings and Photographs of the Skull of *Zygomaturus trilobus*, Macleay, from Australia," received by him from Sir R. Murchison, being seven photographs, three of which are stereoscopic, of perhaps the most extraordinary mammalian fossil yet discovered in Australia. This unique and extraordinary skull of a probably extinct mammal, together with other bones, but without its lower jaw, were found at King's Creek, Darling Downs, — the same locality whence the entire skull and other remains of the *Diprotodon* have been obtained. Mr. Macleay has described the fossil under notice as belonging to a marsupial animal, probably as large as an ox, bearing a near approach to, but differing generically from, *Diprotodon*. He has named it *Zygomaturus trilobus*. The skull has transversely ridged molars, and a long process descending from the zygomatic arch, as in the *Megatherium* and *Diprotodon*, and exhibits an extraordinary width of the zygomatic arches. The skull, at its broadest part, across the zygomata, is fifteen inches wide, and is eighteen inches long. In *Diprotodon*, the skull is about three feet long by one foot eight inches broad: so that, while the latter must have had a face somewhat like that of the Kangaroo, the *Zygomaturus* more resembled the Wombat in the face and head.

ON THE VEGETABLE STRUCTURE OF COAL.

The following is an abstract of a paper recently presented to the Geological Society (London), by Prof. J. W. Dawson, of M'Gill College, Montreal:

After referring to the labors of others in the elucidation of the history of coal, the author remarks, that in ordinary bituminous coal we recognize, by the unaided eye, laminæ of a compact and more or less lustrous appearance, separated by uneven films and layers of fibrous anthracite or mineral charcoal. As these two kinds of material differ to some extent in origin and state of preservation, and in the methods of study applicable to them, he proceeds to treat of his subject under two heads: 1st, The structures preserved in the state of mineral charcoal. This substance consists of fragments of prosenchymatous and vasiform tissues in a carbonized state, somewhat flattened by pressure, and more or less impregnated with bituminous and mineral matters derived from the surrounding mass. It has resulted from the *subaërial* decay of vegetable matter; whilst the compact coal is the product of *subaqueous* putrefaction, modified by heat and exposure to air. The author proceeded (after describing the methods used by him in examining mineral charcoal and coal) to describe the tissues of Cryptogamous plants in the state of mineral charcoal. Among these he mentions *Lepidodendron* and *Ulodendron*, also disintegrated vascular bundles from the petioles of Ferns, the veins of Stigmarian leaves, and from some roots or stripes. He then describes tissues of Gymnospermous plants in the state of mineral charcoal; especially wood with discigerous fibres, and also with scalariform tissue, such as that of *Stigmaria* and *Calamodendron;* and the author remarks that probably the so-called cycadeous tissue hitherto met with in the coal has belonged to *Sigillariæ*. The next chief heading of the paper has reference to structures preserved in the layers of compact coal, which constitute a far larger proportion of the mass than the mineral charcoal does. The laminæ of pitch or cherry-coal, says Dr. Dawson, when carefully traced over the surfaces of accumulation, are found to present the outline of flattened trunks. This is also true, to a certain extent, of the finer varieties of slate-coal; but the coarse coal appears to consist of extensive laminæ of disintegrated vegetable matter mixed with mud. When the coal (especially the more shaly varieties) is held obliquely under a strong light, in the manner recommended by Goeppert, the surfaces of the laminæ of coal present the forms of many well-known coal-plants, as *Sigillaria*, *Stigmaria*, *Poacites*, (or *Nœggerathia*), *Lepidodendron*, *Ulodendron*, and rough bark, perhaps of Conifers. When the coal is traced upward into the roof-shales, we often find the laminæ of compact coal represented by flattened coaly trunks and leaves, now rendered distinct by being separated by clay. The relation of erect trees to the mass of the coal, and the state of preservation in which the wood and bark of these trees occur, — the microscopic appearance of coal, — the abundance of cortical tissue in the coal, associated with remains of herbaceous plants, leaves, etc., are next treated of.

The author offers the following general conclusions:

1. With respect to the plants which have contributed the vegetable matter of the coal, these are principally the *Sigillariæ* and *Calamiteæ*, but especially the former.

2. The woody matter of the axes of *Sigillariæ* and *Calamiteæ*, and of coniferous trunks, as well as the scalariform tissues of the *Lepidodendræ* and *Ulidodendræ*, and the woody and vascular bundler of Ferns, appear principally in the state of mineral charcoal. The outer cortical envelop of these plants, together with such portions of their wood and of herbaceous plants and foliage as were submerged without subaërial decay, occur as compact coal of various degrees of purity, — the cortical matter, owing to its greater resistance to aqueous infiltration, affording the purest coal. The relative amounts of all these substances found in the states of mineral charcoal and compact coal depend principally upon the greater or less prevalence of subaërial decay occasioned by greater or less dryness of the swampy flats on which the coal accumulated.

3. The structure of the coal accords with the view that its materials were accumulated by growth without any driftage of materials. The *Sigillariæ* and *Calamiteæ*, tall and branchless, and clothed only with rigid linear leaves, formed dense groves and jungles, in which the stumps and fallen trunks of dead trees become resolved by decay into shells of bark and loose fragments of rotten wood, which currents must have swept away, but which the most gentle inundations, or even heavy rains, could scatter in layers over the surface, where they gradually became imbedded in a mass of roots, fallen leaves, and herbaceous plants.

4. The rate of accumulation of coal was very slow. The climate of the period, in the northern temperate zone, was of such a character that the true conifers show rings of growth not larger, or much less distinct, than those of many of their northern congeners.* The *Sigillariæ* and *Calamites* were not, as often supposed, succulent plants. The former had, it is true, a very thick cellular inner bark; but their dense woody axes, their thick and nearly imperishable outer bark, their scanty and rigid foliage, would indicate no very rapid growth. In the case of *Sigillariæ*, the variation in the leaf-scars in different parts of the trunk, the intercalation of new ridges at the surface representing that of new woody wedges in the axis, the transverse marks left by the successive stages of upward growth, all indicate that at least several years must have been required for the growth of stems of moderate size. The enormous roots of these trees, and the conditions of the coal-swamps, must have exempted them from the danger of being overthrown by violence. They probably fell, in successive generations, from natural decay; and, making every allowance for other materials, we may safely assert that every foot of thickness of pure bituminous coal implies the quiet growth and fall of at least fifty generations of *Sigillariæ*, and therefore an undisturbed condition of forest-growth enduring through many centuries. Further, there is evidence that an immense amount of loose parenchymatous tissue, and even of wood, perished by decay; and we do not know to what extent even the most durable tissues may have disappeared in this way; so that in many coal-seams we have only a very small part of the vegetable matter produced.

Lastly. The results stated in this paper refer to coal-beds of the middle

* Paper on Fossils from Nova Scotia, Proc. Geol. Soc., 1847.

coal-measures. A few facts which I have observed lead me to believe that in the thin seams of the lower coal-measures remains of *Nœggerathia* and *Lepidodendron* are more abundant than in those of the middle coal-measures.* In the upper coal-measures similar modifications may be expected. These differences have been to a certain extent ascertained by Goeppert for Silesia, and by Lesquereux for those of Ohio; but the subject is deserving of further investigation.

ON THE AGE AND FOSSILS OF THE CONNECTICUT RIVER SANDSTONES.

Prof. Hitchcock, in his recent work, *Ichnology of New England*, in discussing the age of the Connecticut River Sandstones, concludes that the upper half of the sandstones — that east of the half range of Mount Tom — is not older than the Lias; and that the Virginia and North Carolina beds are of equivalent age; the lower half of the same sandstone, which may be a mile in thickness, according to the measurements of Prof. H., are thick enough to embrace the Triassic and Permian; but no evidence has been obtained that the Permian is represented.

Since the discovery of the Permian in the west, as a direct continuation of the Carboniferous beds, and as the closing part properly of the Carboniferous system, it has become more apparent, we think, that the beds on the Atlantic border, from the Connecticut valley to North Carolina, belong to a later period. The elevation of the Appalachian mountains appears to have closed the Palæozoic era, and thus separates the Permian period, the last of the Carboniferous age, from the Triassic, the first of the Reptilian. The observations of Prof. Hitchcock tend to confirm this view, for the rocks all appear to belong to one system: the fossils of the upper half are as recent, probably, as Lias; and no trace of a Permian species has been found in any of the beds.

The foot-prints found in the Connecticut River Sandstones, are referred to by Prof. Hitchcock as follows: — To Marsupialoid animals (5 species); Birds (31 species); Ornithoid reptiles, or reptiles walking on their posterior feet (12); Lizards (17); Batrachians (16); Chelonians (8); Fishes (4); Crustaceans, Myriapods, and Insects (19); Annelids (10); — in all 123 species, more than double the number announced ten years since. The reference of some of these species to the special division in which they occur, is still doubtful, as Professor Hitchcock states, especially the Chelonian and Marsupialoid tracks. — *Silliman's Journal*, March, 1859.

ON SOME FOSSIL PLANTS OF RECENT FORMATIONS.

Prof. Leo Lesquereaux, in a communication to *Silliman's Journal*, May 1859, states, that he finds, on examination of a collection of fossil plants made by Dr. John Evans, from the coal formations at Nanaimo, Vancouver's Island, and at Bellingham Bay, Washington Territory, that, with one exception, "there is not a single plant collected which does not show a near relation to some species of the Miocene of Europe," — a conclusion that un-

* I may refer to my late paper on Devonian Plants from Canada, for an example of a still older coal, made up principally of remains of Lycopodiaceous plants of the genus *Psilophyton*.

mistakably establishes the age of the coal strata of Oregon and Vancouver. Of the coal itself, Dr. Evans has given the following description.

"These coals do not belong to the true coal-measures, but to the tertiary period; they have, however, been altered by volcanic action. The Bellingham Bay coal particularly, in consequence, is of a remarkable crystalline structure, and presents under the magnifier a very singular and beautiful appearance. It will produce an excellent coke, and is well suited to manufacturing and domestic purposes. It burns freely, and, although rather light for long sea voyages, unless the construction of furnaces should be changed, lessening the draft, is suitable for river navigation. The coal crops out at various points from the British line, to near Port Oxford in Oregon, and is accessible to sail and steam navigation, and almost inexhaustible in quantity. These coals, with imperfect machines and facilities for mining, can be delivered, ready for shipment, for at from $2 to $3 per ton."

If we examine, says M. Lesquereaux, the plants obtained in Oregon and Vancouver, conjointly with those obtained by Prof. Safford from the Pliocene of Tennessee, by Dr. D. D. Owen from the chalk-banks, or Pleistocene of the Mississippi, and with those figured by Prof. Heer in his *Fossil Flora of European Tertiary*, "we are at once struck with the remarkable character of the Miocenic flora of Oregon and Vancouver Island, which evidently indicates a tropical climate at this period of the geological formations. Palm trees, figs, Cinnamomum, and Proteineæ are now generally distributed at least 30° lower than they were then. But it is still more extraordinary to find just on the same latitude, but on an opposite point of the globe, in Switzerland, a contemporaneous fossil flora, of which the species have so near a relation to those of Oregon, that some of them may be regarded as truly identical. This shows a remarkable uniformity in the direction of the isothermal lines at the epoch of the Miocene formation, and establishes, beyond a doubt, that the oscillations of temperature have been generally marked around our globe, and have not been the result of local geological disturbances. That the oscillations were slow and progressive is shown by the distribution of the species of plants in both the following formations. In the Miocene of Vancouver the Proteineæ are dominant. It has also palm trees and Salisburia, all tropical plants, and most of the species are without relation to the plants now living on this continent. In the Pliocene of Tennessee, the Proteineæ appear still abundant, and the flora finds its relatives in the southern shores of Florida and on the islands of the Gulf of Mexico. The Post-pliocene of the Mississippi, near the mouth of the Ohio River, and even above it, has the same species of plants as are now found along the shores of the Atlantic, in the Southern States. We have thus, apparently, a steady decrease in the temperature, from the Miocene to the Post-pliocene of the Mississippi. From this it appears to follow that the chalky banks, of which the true geological position is still uncertain, ought to be regarded as anterior in origin to the Drift. For it is probable that if they had been deposited after or at the time of the ice period, the distribution of the plants would show a colder climate, rather than the climate of our southern shores."

ERUPTION OF MAUNA LOA, IN THE ISLAND OF HAWAII, SANDWICH ISLANDS.

One of the most terrific volcanic eruptions on record, took place from the volcano of Mauna Loa, Sandwich Islands, during the past year, commencing January 23d, 1859. On the evening of Saturday, January 22, the snow on the mountain was seen white and unobscured by clouds or vapor; there were no signs of smoke, and none of eruption. On Sunday, thick clouds of smoke were seen gathering about the mountain, and at evening the whole sky was lighted with a terrific glare, and the lava could be seen spouting from a crater near the summit of Mauna Loa. As in all the other eruptions from that mountain, the lava was thrown up in a jet, apparently nearly one thousand feet high; it flowed down the northern slope of the mountain, and in one or two days "formed for itself a covered channel from the summit crater to the plain between the mountains."

A writer in the *Pacific Commercial Advertiser,* published at Honolulu, S. I., thus describes the incidents of a visit to the volcano during the continuance of this great eruption:

From the distance at which we observed the crater, about ten miles, and from various points of observation, it *appeared* to be circular, its width being about equal to its breadth, and perhaps three hundred feet across the mouth. This may be too moderate an estimate, and it may prove to be five hundred or even eight hundred feet across it. The rim of the crater is surrounded or made up of cones formed from the stones and scoria thrown out. The lava does not simply run out from the side of the crater, like water from the side of a bowl, but is thrown up in continuous columns, very much like the Geyser springs, as represented in school geographies. At times this spouting appeared to be feeble, rising but little above the rim of the crater; but generally, as if eager to escape from the pent-up bowels of the earth, it rose to a height nearly equal to the base of the crater. But the columns and masses of lava thrown out were ever varying in form and height. Sometimes, when very active, a spire or cone of lava would shoot up like a rocket, or in the form of a huge pyramid, to a height of nearly double the base of the crater. If the mouth of the crater is five hundred feet across, the perpendicular column must be eight hundred to one thousand feet in height! Then, by watching it with a spyglass, the column could be seen to diverge, and fall in all manner of shapes, like a beautiful fountain.

This part of the scene was of wonderful grandeur. The fiery redness of the molten lava, ever varying in form, from the simple gurgling of a spring to the hugest fountain conceivable, is a scene that will remain on the memory of the observer till death. Large masses of red-hot lava, weighing hundreds, if not thousands, of tons, thrown up with inconceivable power to a great height, could be seen occasionally falling outside or on the rim of the crater, tumbling down the cones and rolling over the precipice, remaining brilliant for a few moments, then becoming cold and black, and lost among the surrounding blocks of lava.

A dense, heavy column of smoke continually rose out of the crater, but always on the north side, and took a north-easterly direction, rising in one continuous column far above the mountain, to a height of perhaps ten thousand feet from the crater.

On leaving the crater, the lava stream does not appear at the surface for some distance, say an eighth of a mile, as it has cut its way through a deep ravine or gulch, which hides it from the eye. How deep this gulch may be, is all conjecture, as it is impossible to get near enough to look into it; but it probably is several hundred feet deep. The first, then, that we see of the lava, after being thrown up in the crater, is its branching out into various streams some distance below the fountain-head. Instead of running in one large stream, it parts, and divides into a great number, spreading out over a tract of five or six miles in width. For the first six miles from the crater, the descent is rapid, varying from four to ten miles an hour. But after reaching the level plain the stream moves slower. Here the streams are not so numerous as higher up, there being a principal one, which varies, and is very irregular, from an eighth to a half mile in width, though there are frequent branches running off from it. This principal stream reached the sea, near Wainanalii, on the 31st of January, after a flow of eight days. When it reached the sea, it spread out about half a mile in width. Some of the finest scenes of the flow were the cascades or falls formed in it before the lava reached the plain. There were several of them, and they appeared to be changing, and new ones formed in different localities as new streams were made. One, however, that remained apparently unchanged for two days, must have been eighty or one hundred feet in height. First, there was a fall; then, below were cascades or rapids. To watch this fall during the night, when the bright, red-hot stream of lava was flowing over it, at the rate of ten miles an hour, like water, was a scene never to be forgotten.

Another writer describes the jets from the crater of the volcano, as follows: — "Before you, at a distance of two miles, rises the new-formed crater, in the midst of fields of black, smoking lava, while from its centre there jets a column of red-hot lava to an immense height, threatening instant annihilation to any presumptuous mortal who should come within the reach of its scathing influence. The crater may be one thousand feet in diameter, and from one to one hundred and fifty feet high. The column of liquid lava which is constantly sustained in the air, is from two hundred to five hundred feet high, and perhaps the highest jets may reach as high as seven hundred feet! There is a constant and rapid succession of jets, one within another; the masses falling outside, and cooling as they fall, form a sort of dark veil, through which the new jets darting up with every degree of force and every variety of form, render this grand fire-fountain one of the most magnificent objects that human imagination can conceive of. From the top of the lava jets, the current of heated air carries up a large mass of scoria and pumice, which falls again in constant showers for some miles around the crater."

Prof. Haskell, of Oahu College, thus describes the flow of the river of lava from the mountain to the sea:

"Descending by the stream of lava flowing from the mountain, we were able to follow it on its south side, as a strong wind was blowing from that direction. Here we found good walking, and could with safety approach within a few feet of the channel. The width of the stream was from twenty to one hundred feet, but its velocity almost incredible. Some of our party thought it one hundred miles per hour. We could not calculate it in any way, for pieces of cold lava thrown into it would sink and melt almost instantly. The velocity certainly seemed as great as that of a railroad car. For eight or ten miles the stream presented a succession of cascades, rapids, curves, and eddies, with an occasional cataract. Some of these were formed by the nature of the ground over which it flowed, some by the new lava itself. The stream had built up its own banks on each side, and had added to the depth of its channel by melting at the bottom. The stream flowed more gracefully than water. In consequence of its immense velocity and imperfect mobility, its surface took the same shape as the ground over which it flowed. It therefore presented not only hollows, but ridges. In several places, for a few feet, the course of the stream was an ascent of five to ten degrees, in one instance of twenty-five. Where the turns in the stream were abrupt, the outside of the stream was much higher than the inside. So much was this the case, that the outside sometimes curved over the inside, forming a spiral. It is needless to add, that we were filled with wonder and admiration at the sights we saw.

"The clinkers are always formed by deep streams, and generally by wide ones, which flow sluggishly, become damned up in front by the cooling of the lava, and in some instances cooled over the top, forming, as it were, a pond or lake. As the stream augments beneath, the barriers in front and the crust on the surface are broken up, and the pieces are rolled forward and coated over with melted lava, which cools and adheres to them more or less. Then, from the force of the melted lava, behind and underneath, the stream rolls over and over itself. In this way a bank of clinkers, ten to forty feet high, resembling the embankment of a railroad, is formed. Often, at the end of the stream, no liquid lava can be seen, and the only evidence of motion is the rolling of the jagged rocks of all sizes down the front of the embankment. Sometimes the stream breaks through this embankment, and flows on for a time, until it gets clogged up again, and then the same processes are repeated. In this latter case, the outbursting stream often carries, as it were, on its back immense masses of clinkers, which look like hills walking. We found no clinkers until we reached the plain, and it would seem that none are formed except where the descent is but little, or the lava but imperfectly melted."

It is said that ships sailing along the windward shores of Hawaii, Maui, and Molokai, during the week in which the eruption commenced, and before the lava reached the ocean, encountered immense shoals of dead fish; leading to the supposition that there might have been a sub-oceanic eruption before the outpouring from the mountain, and that possibly the whole island might have been overwhelmed, had not this side passage given issue to a portion of the lava.

SEISMOGRAPHIC MAP OF THE WORLD.

A very interesting Map has been published, with this title, in England, in which, on Mercator's projection, are laid down careful indications of the regions subject to earthquakes and the sites of volcanoes. In the language of its constructor, it shows "the surface distribution and space of earthquakes," and is intended to illustrate a paper contributed by Mr. Robert Mallet, F. R. S., etc., of Dublin, and his son, Dr. J. W. Mallet, to the late meeting of the British Association at Leeds. As a very large number of copies of the map is required, and the greatest accuracy of delineation is necessary, it has been executed in chromo-lithography, and printed in a series of different tints from eight different stones. Thus, various shades of orange and orange-red show what are termed the "seismic bands" in their position and relative intensity. Small black disks denote "volcanoes, fumeroles, solfataras," now active, or presumed to have been so within historic or recent geologic periods. A speckled gray-blue shade indicates the areas of subsidence (whether sub-oceanic or terranean) now proceeding. A green line demarcates land from sea. Of the great oceans, only the Atlantic shows much of that agency which produces earthquakes, and that chiefly in its latitudes north of the equator. The Pacific has almost an immunity from these throes of earth's inner crust. Of the continents, Europe has the fainter tints of "seismic bands" in the north; but only in Iceland does the deeper hue indicate great intensity, accompanied by the signs of considerable volcanic action — there being ten smaller dots, besides the large one for Hecla. The Azores, Teneriffe, and Cape Verd Islands, are all shown to be volcanic; and along the south of Europe the band is of greater intensity, and especially in Italy, also marked as volcanic. There is a deep band from the Levant and Cairo to Tiflis, and it meanders across Persia and Central India to Calcutta. A large tract of sea and land, encircling Borneo, is clearly one of the most intensely seismic and volcanic regions of the earth. The bands then extend in a north-easterly direction, over Hong Kong, Jeddo, etc., and across the ocean to the Russian and British territories on the north-west coast of North America. The band extends along the whole of the western coast of Labrador, California, etc., increasing in intensity as it enters Mexico; and here again volcanoes become prevalent. This continues over Central America, and again pursues the line of the west coast of South America to Cape Horn. In the West Indies is another line or band, and the coast of the United States has a band of less intensity; while the only approach to the centre of the North American continent is along the valley of the Mississippi. The most northerly portions of Europe, Asia, and North America, are quite free from these influences. But from the West Indies a band extends southward (with a branch touching the south-east coast of Australia), through New Zealand, to nearly 80° south latitude, terminating in the volcanic peak of Mount Erebus.

TRACES OF ERUPTIVE ACTION IN THE MOON.

The following remarks on the above subject were recently made before the Royal Astronomical Society (London), by the Rev. T. W. Webb:

"The inquiry as to the continuance of volcanic or explosive action on the surface of the moon must be admitted to be a very interesting one. Astronomers are generally agreed as to its entire cessation on any conspicuous scale; but this would not necessarily infer the impossibility, or even improbability, of minor eruptions, which might still continue to result from a diminished but not wholly extinguished force. Till the publication of the labors of Beer and Mädler the necessary data for the determination of the question were very imperfect; and since that time the general impression would seem to be adverse to the idea of any physical change. Before, however, it is entirely acquiesced in, it may be well to see whether any evidence of an opposite nature exists. Want of leisure has hitherto prevented me from entering upon the subject in any other than the most incidental manner; but I would request permission to direct attention to one or two regions where an accurate investigation might be desirable. One of these is the spot named *Cichus*, near the south extremity of the *Mare Nubium*. Here, many years ago, in comparing Schröter's drawings with the moon, I was struck with the apparent enlargement of the small crater which has defaced one side of the ring. On procuring the map of Beer and Mädler, I found that they had also seen it enlarged. Could we, in this instance, depend upon the older drawings, we might reasonably infer the probability of a change since the year 1792. Schröter was undoubtedly a coarse draughtsman, but still he was faithful and careful; nor does there seem any appearance, but the reverse, that his designs were copied from one another to save trouble; if not, the agreement of three separate figures seems fair evidence that this little crater was not then of its present magnitude."

VOLCANIC EMANATIONS.

The deficiency of our information regarding the gaseous products of Volcanoes seems to have induced the Academy of Sciences to send two of their men of science — Messrs. St. Clair Deville and Leblanc — to Italy, on a special mission to examine the gases which issue from the volcanoes of that country. They were supplied with peculiar apparatus, made for the purpose of collecting and preserving the gases, and partly for examining them on the spot. The memoir containing the result of their investigations has been made the subject of a report by three very accomplished members of the Academy, — Messrs. Dumas, Boussingault, and Elie de Beaumont. They state that M. Deville and his associate were enabled by their apparatus to collect gases over mercury, not only at the orifice of the volcano, but *at great depths in the vent;* in the latter case by slender tubes, which were rapidly closed by the blow-pipe. The gases they brought away and analyzed in Paris, were from Vesuvius, the Phlegrean Fields, one of the Lipari Isles (Vulcano), and Etna. Mixed with the gaseous products they found much heated air, more or less altered by the addition of gas or vapors, or the absorption of oxygen, which led them to believe that common air penetrates into the vent of the volcano by a fissure, is exhaled by it, and escapes heated. Generally, the report confirms the opinions of Davy as to Vesuvius, Boussingault as to the Andes, and Bunsen as to Iceland, but with some additions. They show that different fumeroles of one volcano do not yield the same gas, and that the gas from a single fumerole is not always the same. Further, the gas from the different fumeroles varies with their distance from the eruptive crater, and varies also with the time elapsed from the commencement of the preceding eruption. The report concludes by expressing an opinion that the gaseous emanations, carefully analyzed and compared, will throw light on the chemical processes which gave them birth, and enable observers in the vicinity of a volcano, and, through them, the surrounding population, *to foresee the course which a coming eruption is likely to run*, and of course serve as a useful warning.

NATIVE IRON.

The following communication is made to *Silliman's Journal*, Sept. 1859, by Dr. F. A. Genth:

About four years ago I received, for examination, a mineral, which was said to be found in the neighborhood of Knoxville, Tennessee, in considerable quantities, and which was believed to be a valuable nickel ore. A qualitative analysis of it, made at that time, proved it to be almost pure iron, and the total absence of carbon, phosphorus, and sulphur, and its peculiar appearance, made it very probable that it was *real native iron*. The specimen which I received was $1\frac{1}{2} \times 1\frac{1}{2}$ in size; on one side of it the iron was one-fourth, on the other one-eighth of an inch in thickness. On one side it was incrusted by a silicate of iron, magnesia, and lime.

The iron itself is of a grayish-white color, a hackly fracture, and breaks easily into fragments of an irregular shape, which are crystalline, without, however, showing signs of any distinct planes. It is soft, and scratches fluorspar with difficulty. Lustre, eminently metallic. Dissolves readily in nitric acid. It was found to contain —

Iron,	99·790
Nickel, with a trace of cobalt,	·140
Magnesium,	0·022
Calcium,	0·121
Silicium,	0·075
	100·148

About a year after I had examined the mineral from Knoxville, I received the *same* substance from northern Alabama, as an alloy of gold, platinum, silver, copper, etc., with the request to advise a plan for the separation of these metals.

I have endeavored to obtain more of this interesting substance from both localities; but the parties, probably not being satisfied with the results of my examinations, did not comply with my request; and I hope others may be more successful than I have been.

ON AN EXAMINATION OF THE MATTER OF A SUPPOSED SHOOTING STAR THAT FELL ON THE EVE OF NOVEMBER 16TH, 1857, AT CHARLESTON, S. C.—BY PROF. C. U. SHEPARD.

In calling attention to the matter of a shooting meteor, I am conscious that the evidence of its genuineness is not absolutely perfect; nevertheless, it falls so little short of entire satisfaction, as to make it fully worthy of notice. No instance of the kind at least has yet been recorded, entitled to so much confidence.

Mr. S. R. Scriven, a clerk in a dry-goods store in King's Street, Charleston, was the principal observer of the phenomenon. He returned to his residence near King's Street, in Charleston, at half past eight, on the evening of Nov. 16, 1857, when he saw a red, fiery ball, of the size and shape of an orange, slowly descending through a distance apparently of twenty or thirty feet, to the ground. Its fall was scarcely more rapid than that of a soap-bubble, giving him time to call his sister, a little girl, to see it strike a high wooden fence, distant about fifty or sixty feet from the portico, and which separated the door-yard from a church-enclosure adjoining. It seemed to adhere for an instant to the board against which it struck, and then separated into three parts, and disappeared. The evening was dark, it having followed a rainy afternoon, though at the time of the fall, it had ceased to rain and become very foggy.

Nothing further would probably have been heard of the phenomenon but for the accidental reading, by an elder sister the next day at the breakfast-table, of a paragraph from a newspaper, relating to a meteoric fall, where the specimens picked up were said to have possessed a strong odor of sulphur. This induced young Scriven, who had never before heard of meteoric falls, at once to examine the fence against which the ball had struck. The fence was eight feet high, and formed of long strips of horizontally disposed boards. It was near the extremity of an uppermost board, that had been detached and bent around so as to present its flat side uppermost, that the body had been seen to impinge. And here it was that he discovered adhering a small bristling mass of black fibres. These he detached and carried into the house. As it had rained again during the night, he was led to suppose that the rest of the matter had been washed away. He searched the ground among the dead grass, but not until after the second night, when much more rain had fallen. He could find no more of the same material, though he gathered up numerous small fragments, which proved to be ordinary charcoal.

Mr. Scriven (the father) was so much struck with the appearance of the black fibres, together with the circumstances under which they had been found, that he requested his son to call on Dr. William Pettigrew, the family physician, and describe to him what had happened. Two days, however, elapsed, before Dr. Pettigrew heard of the case. He immediately repaired to the house, where he was informed of the particulars as above described, and shown a mere pinch of the matter that had been detached from the fence, — the principal portion of it having unfortunately been given to a young man of the neighborhood, an engineer, who wished to exhibit it to his friends.

Dr. Pettigrew immediately called to acquaint me of the case; but not finding me at home, we did not meet until the forenoon of the 20th, when he presented me the specimen gathered by Scriven, and took me to the spot.

I heard the statements repeated from the different members of the family, corroborative of those above presented, and examined the place upon the board from whence the fibres had been gathered. It presented no discoloration or appearance of having been heated or charred, though for many inches on either side, it was slightly blackened in spots. This, perhaps, was not strange, as heavy rains had fallen since the occurrence; and it might fairly be presumed that all foreign matter would have been effectually detached. I examined the grass and soil on both sides of the fence, without finding anything beyond little fragments of charcoal, which are common enough in most places about the premises of houses. We then took pains to find the individual to whom had been given the principal portion of the fibrous matter obtained from the fence; but had the mortification to discover that, having worn it in a paper wrapper for several days in his vest pocket, he had finally mislaid or lost it. Thus little more than a microscopically visible specimen of the shooting star remained for study and examination. Its entire weight is probably less than one-tenth of a grain. When viewed by a single pocket lens, it seems to be a confused aggregate of short clippings of the finest black hair, varying in length from one-tenth to one-third of an inch. Each portion is straight, or only slightly curved. Except in color, they remind one most of that variety of pumice-stone from the Sandwich Islands, known as volcanic hair, or as "*Pele's hair.*" They do not seem very prone to break in handling, and appear slightly elastic.

They have been examined under compound microscopes of high power by several persons accustomed to the use of this instrument; but hitherto no one has ventured to suggest a relationship in their properties to any known form of organic or inorganic matter. The following description is from a note handed to me by my friend, Dr. F. W. Porcher, of Charleston. "Black elongated bodies, perfectly opaque, round and solid; amorphous, not properly smooth surfaces, often furnished with warty dots or projections; rather glossy."

I could spare only a few of them for a chemical trial. These were introduced into a small glass test-tube (previously well dried), and heated by contact with the flame of the blow-pipe. They suddenly glowed with a brilliant light, at the same time emitting an odor most nearly resembling the bituminous. A distinct grayish skeleton of each fibre was left adhering to the glass. Barytic water being thrown into the tube, was instantly rendered milky, thereby proving the existence of carbonic acid; and the subsequent addition of hydrochloric acid, slowly caused the separation of the skeletons from the glass, which led me to infer the presence of silica as a part of the earthy residuum. The little bodies, however, were not annihilated by the process; but, greatly to my surprise, were easily seen, by the aid of a single lens, still floating through the clear liquid, preserving in a great measure their original form, with the exception only of being rendered here and there transparent, as if about one-half of the black matter had been eaten out and dissolved, leaving the remainder sufficiently connected to maintain the original figure of the body.

This is all that I have been able to ascertain concerning the origin, structure, and chemical composition of these singular bodies. They appear to be inorganic, though composed in part of carbon. A large proportion of earthy matter also enters into their composition.

It will be remembered, perhaps, in this connection, that Berzelius detected what appeared to him to be an organic residuum (resembling burnt hay) in the French meteoric stone of Alais, that fell March 15, 1806; and bearing more distinctly still upon our subject, are the highly interesting results recently obtained by Prof. Wöhler on the unknown substance of an organic nature (resinous) in the meteoric stone of Kaba, Hungary, that fell April 15, 1857; and those again arrived at by Prof. E. P. Harris, in the Göttingen laboratory, concerning the carbonaceous matter in the stone that fell Oct. 13, 1838, at Cape of Good Hope, — a meteorite originally described by Sir John Herschel and Prof. Faraday. Prof. Harris states, in his valuable thesis on meteorites (Göttingen, 1859), that he finds a quarter per cent. of bituminous matter in the Cape stone, which is soluble both in alcohol and ether, and fusible in a glass tube over a spirit-lamp. It finally burns, with a bituminous odor, and the deposition of carbon.

Is the matter of the Charlseton shooting star analogous to that of the Alais and the Cape meteoric stones? And if so, may the more complete combustion of its carbonaceous ingredient have been prevented by the humind state of the atmosphere at the time of its fall? These are questions that naturally suggest themselves, but to which we are not in a condition to return satisfactory replies at present.*

It is reasonable, perhaps, to suppose that many aggregates of meteoric matter — such, for example, as those made up wholly of one or more of the following meteoric elements: carbon, phosphorus, and sulphur — would, owing to their easy combustibility, burn out, even in the upper regions of the atmosphere, and, being resolved into gaseous compounds, fail of transmitting to the earth's surface any material proof of their existence. Others, again, may not be recognized at the surface of the earth, owing to the dispersion of their oxides in the condition of an impalpable dust, or in solution in water. But, however this may be, the facts seem thickening about us of the occasional arrival out of the air of anomalous earthy bodies, whose

* As having possibly a close connection with the subject in hand, may be mentioned, two instances recorded in Chladni's list of ancient meteorites. The first of these refers to the fall at Rockhausen, near Erfort, July 5, 1582, (?) during a frightful tempest, of a large quantity of a fibrous substance, similar to hair. The second occurred March 23, 1665, (?) at a place near Lancha, not far from Naumburg, in which case, the matter that fell was likewise fibrous, and resembled a bluish silk. It was also abundant.

descent is unaccompanied by the explosions belonging to the true meteorites, and the precipitated matter is uncharacterized, also, by the possession of a thin, well-fused coating or crust.

The study of these pseudo or doubtful meteorites, as they have been called, is worthy of a much closer attention than has hitherto been devoted to them; and it is to be regretted that they continue still to be treated much as the true stones and iron masses were, prior to the time of Chaldni and Howard. Their study seems to be regarded as a field, exterior to the domain of legitimate science, — a region for the reception of all that is vague and contradictory. Much time and labor will no doubt be requisite to disentangle what is really entitled to scientific regard; but this desirable result will be yet longer postponed, if naturalists continue to dismiss as unworthy of investigation every reported meteoric fall that is unattended with the stereotyped accompaniments of the descent of the black encrusted stone and iron mass, the frequency of whose arrival has now so multiplied as to make the recital of their apparition almost monotonous.

Without here referring to many of the doubtful meteorites, of which I have from time to time given notices, I will venture to call attention to a few other instances, of which no scientific mention has yet been made,— not claiming for them, however, any other character than that of mere hints, intended to awaken regard to a fuller investigation of analogous cases, as they may from time to time present themselves.

It was not far from the month of August, 1834, that the newspapers announced the fall of a blazing meteor, in the night, in the town of Norwich, Conn. Its descent was unaccompanied by any report, and the mass of matter, in its course, came near falling upon the roof of a house, missing it only by the space of about two feet, and nearly burying itself in the rather soft earth of the door-yard. The phenomenon occasioned much fright to the occupants of the house, who were only females. It was seen, however, by others. The mass of matter occupying the cavity was of a flattened form, and nearly as large over as a man's head. It had the appearance (in the words of a neighbor who saw it, and who described it to me a few weeks after) of a mass of earth, stuck together by the infiltration of tarry matter. And such he took it to be, supposing that some mischievous persons had prepared a fire-ball, and projected it on fire into the air, with the intention of alarming the inmates of the house. I was shown the cavity said to have been produced by the ball; but the specimen had been given to a medical student, who had sent it to his preceptor, residing in or near Albany, N. Y. The circumstances were on the whole so discouraging to the idea of its being a genuine meteorite, that I gave the subject no further consideration.

On the evening of the 23d of April, 1855, at Ochtertyre House, Crieff, in Perthshire (Scotland), a young woman saw, from the third story, a shooting star or meteorite, falling, with a brilliant light. It struck the gravel walk near to the house. She instantly called two other females, "who saw, as it were, a bright object on the gravel, like the sun shining on a large diamond." Two of them ran out of the house and round a court-yard to the spot, taking matches and a candle with them. As soon as they got to the spot, one of them picked up two cindery fragments, which were too hot to hold, and which emitted a strong sulphurous smell. The other felt something hot under her foot, which she also picked up. It had a similar character with the other fragments. At first it was believed that these masses had actually fallen from the heavens; but a closer investigation into their character left little doubt that they were merely fragments of ordinary cinder, derived from a neighboring furnace, situated upon a stream, whence gravel had been obtained for dressing the walks. Being in Sheffield, in England, when the subject was undergoing investigation, I was favored by Sir William Keith Murray, at whose residence the occurrence took place, with an inspection of one of the specimens, and was satisfied that a correct general view had been taken of their character. Nevertheless, as the confidence of the gentleman referred to was full and entire in the integrity of the witnesses of the phenomenon, it would seem to be an instance in which the sulphurous matter of a shooting star was not completely consumed before reaching the ground, and that much of the residuum suffered oxidation after it struck upon the cinder of the walk.

My meteoric cabinet has contained for many years a few grains of a mixture of carbonaceous and earthy matter in a pulverulent state, sent to me in 1845 by Mr. Black, of Elizabethtown, Essex County, N. Y. (then a member of the Legislature of New York), as having fallen in his wood-yard during the winter of 1844 and 1845. — *Silliman's Journal*, Sept. 1859.

BOTANY.

ARABLE AND FOREST LAND OF THE UNITED STATES.

UNDER the direction of the Smithsonian Institute, a map has been constructed, designed to represent at one view the extent and location of the arable and forest land of the United States. The work has been intrusted to Dr. J. G. Cooper, a naturalist, who has been engaged in government explorations in the western part of the United States, and who has critically examined all the authorities to be found on the subject. The facts presented at once to the eye by this map, are in striking accordance with the deductions from the meteorological materials which have been collected by the Institution, and serve to place in a clear point of view the connection of climate with the natural productions of different parts of the earth — *Smithsonian Report for* 1858.

NEW GENERA OF AMERICAN PLANTS.

At a recent meeting of the Boston Society of Natural History, Dr. Gray presented specimens of a new genera of rosaceous plants, Neviusia Alabamensis (Gray), recently discovered in Alabama by Rev. Mr. Nevins.

That a new genus of plants should be detected at this late day, and that one a large, ornamental, conspicuous shrub, is certainly rather surprising in so well explored a locality.

THE ABSENCE OF TREES FROM PRAIRIES.—BY D. VAUGHAN.

In tracing the influence of the several causes which are concerned in giving plants their geographical position, a very decided part must be ascribed to certain meteoric conditions, which have hitherto received little attention. The health and longevity of trees depend, in a high degree, on the manner in which they are invigorated by seasonable supplies of rain during every period of their growth; while the long droughts to which they are exposed in many localities are productive of diseases which may cause the forest to lose the dominion of the land. The extermination of trees on many vast plains, is generally regarded as the work of man; but, on a more careful investigation, the phenomenon seems to correspond to what may arise from the agency of unassisted nature.

The fall of rain on different parts of the earth's surface depends not only on their latitude and the proximity to large bodies of water, but also on the presence of mountains. Although mountainous districts do not invariably receive a greater annual amount of rain than other places equally near to the equator and the ocean, it may be considered a general rule, that they are visited by more numerous showers, and are more exempted from the occurrence of long-continued droughts. Very extensive plains, on the contrary, generally receive their supply of rain in a few excessive showers, and very frequently suffer much from the long continuance of dry weather. These different peculiarities seem to show that mountains serve not only to cool the air, but also to neutralize the insulating power of its lower stratum, and to prevent the accumulation of electricity in the region of the clouds. As we have reason to believe that the violence of storms is, in part, due to electrical action, which serves to maintain ascending currents in the air, and to cause the condensation of vapor to take place more abundantly, mountains must evidently have the effect of preventing excessive showers, and of dispensing the aqueous resources of the atmosphere with more economy for the purposes of vegetation.

It is to the growth of perennial plants that long-continued droughts are most detrimental. Though the grass may be parched on a dry summer, the injury is scarcely felt during the following year, if rains be abundant; but in the vegetation of trees the result is different. The imperfect layer of wood formed under such unfavorable circumstances, will have a great tendency to decay prematurely; and, as the decay must quickly extend to the whole vegetable structure, the droughts of a single summer may destroy the work of a century. From several facts it appears that the lignifying process in trees is dependent on feeble currents of electricity, which are made to circulate along their tissues by the evaporation from the leaves, combined with the chemical changes transpiring in the soil; and accordingly, when this evaporation is checked on account of the want of rain, an imperfect formation of wood will be the inevitable consequence. The health of trees will therefore depend on the frequency of rain, on the extent of foliage which they possess, and also on the fertility of the soil; for when the vegetable nutriment is more abundantly supplied, a greater amount of elaborating energy is required to convert it into wood.

Whatever opinion may be formed respecting these theoretical views, the characters of arborescent vegetation in different regions exhibit the effects of the meteoric conditions which I have noticed. The most durable timber and the oldest trees are to be found in islands, in mountainous districts, in lands contiguous to the sea, and in other places where they are favored by the frequency of rain. It is well known that the oaks of the British Isles are much superior in strength and durability to those produced in the interior of Europe; and many trees in England are remarkable for their great age, which in some cases is known to exceed one thousand years. More extraordinary instances of vegetable longevity are to be found in the island of Teneriffe, in Sicily, and on the coast of Africa. The mountains on the Syrian coast have been celebrated for the great age of their cedars. But perhaps no forests furnish a greater abundance of trees, or more durable timber, than those of Guiana; and scarcely any region on the globe is visited by more frequent rains. Doubtless the age and durability of trees depend on the species to which they belong; but when the comparison is confined to trees of the same species, it will be seen that they are affected, in a very serious degree, by the meteoric influences to which they are exposed.

That the absence of mountains is unfavorable to the health of arborescent vegetation, especially at great distances from the sea, is proved by several facts. European Russia is a vast plain, resembling in geographical structure the prairies of the West, and, like them, subject to long droughts, which cannot fail to operate injuriously on the vigorous development of trees. Accordingly, the Russian forests, though very extensive, furnish no durable timber; and the Russian ships are remarkable for their great liability to decay. The dry-rot which invariably attacks them is ascribed to the peculiar character of the waters of the Baltic and Black seas; but, as it does not seem to operate very injuriously on British vessels which enter the same ports, we can only attribute the effects to the great difference in the durability of the wood used by both nations for shipbuilding. On this continent, the mountainous districts and the lands near the sea coast produce the most durable timber; while in the inland states and territories, and especially in the Mississippi Valley, arborescent vegetation displays less vigor, and hollow trees become more numerous.

It is not surprising that, where the gigantic forms of vegetation are exposed to such enervating influences, they should be incapable of contending successfully with the herbaceous plants for the possession of the soil, and that the forest fails to maintain its ground in such localities. Accordingly, trees are absent from prairies, except on the banks of rivers, where they are favored with copious dews, or in barren soil, where their growth is slow, and the supply of nutriment is not too copious for the energy of vegetative power. As the steppes of Central Asia and the pampas of South America exhibit the same peculiarity, we may reasonably suppose that natural causes alone are sufficient to establish permanent boundaries between the dominions of the trees and those of the herbaceous plants, and to prevent the forest from acquiring the exclusive possession of all lands.

To cultivate trees successfully on prairies, and to prevent their degeneracy, it would be necessary to introduce seed from regions more favorable to their health; for seeds, to a certain extent, receive and transmit the infirmities of the plants which produce them. The oaks raised in England from German acorns are found to be much inferior to those generally grown in the British forests. In prairies, also, it will be necessary to plant the trees a considerable distance apart, in order to permit the utmost expansion of their foliage, and thus cause the elaboration of the sap and the formation of woody fibre to take place in a more effective manner. The character of the wood of all trees is always impaired by the removal of their leaves or branches; and, according to Loudon, pruning has been abandoned in the cultivation of the British forests, as experience proved its deleterious influence on the durability of the timber.

But, notwithstanding this result, pruning serves to maintain the sap in a condition suited to the nutriment of fruit; and it becomes more necessary in climates where rains are frequent, and the tendency to form woody fibre very great. In dry climates it should be pursued with more caution, and many diseases to which fruit trees are subject proceed from over-pruning. During the dry summer of 1851, it was observed in Southern Ohio that the unpruned grape-vines were most productive. On a farm near New Richmond, Ohio, were some grape-vines which were never pruned, and, after being unproductive for many years, they bore grapes in abundance in the summer of 1851, while the rest of the vineyard, which was cultivated in the usual way, afforded only a small crop. These facts show that a deficiency of rain and a deficiency of foliage operate in the same manner to check the formation of woody tissue, and to promote the development of fruit.

From this theory many practical inferences may be deduced, in regard to the culture of forests, orchards, and vineyards. The pruning of fruit trees should be wholly regulated in accordance with the opportunities which their geographical position gives them for receiving supplies of rain. The pruning of forest trees should be confined to the removal of decaying branches. If trees are to be felled in summer, the operation should be performed, not after a long period of dry weather, but after copious rains, when, by the constant evaporation from the leaves, the sap contains little organic matter unconverted into wood.

ON THE MOTIONS OF CERTAIN WINDING PLANTS.

The following are the results of a series of observations on the motions of certain winding plants (*i. e.*, the common Lima bean, *Phaseolus lunatus*, L., and the common Morning-glory, *Convolvulus purpureus*, L.), made by Prof. W. H. Brewer, of Washington College, Pennsylvania, and communicated by him to *Silliman's Journal*, March, 1859.

1st. That during the day, winding plants, like others, grow towards the light.

2d. That they possess the property of turning towards some solid support.

3d. That this is more manifest by night than by day, and the most so on cool nights following hot days.

4th. That this is not controlled by any influence of light or its absence, exerted by the support.

5th. That heat is the controlling cause, and that such plants will only turn (unless it be accidentally) towards a support, the temperature of which is higher than that of the surrounding air.

6th. That the color and material of the support exert no influence further than that they influence the radiation and absorption of heat; and,

7th. That when such plants are in actual contact with some support, the tendency to wind spirally around it is much greater than they manifested in order to reach it.

In the *Proc. of the American Academy* (Vol. IV., p. 98), August 1858, we also find the following communication on the same subject, by Prof. Asa Gray, of Cambridge.

As much as twenty years ago, Mohl suggested that the coiling of tendrils "resulted from an *irritability* excited by contact." In 1850 he remarked that this view has had no particular approval to boast of, yet that nothing better has been put in its place. And in another paragraph of his admirable little treatise on the Vegetable Cell (contributed to Wagner's *Cyclopædia of Physiology*), he briefly says: "In my opinion, a dull irritability exists in the stems of twining plants and in tendrils." In other words, he suggests that the phenomenon is of the same nature, and owns the same cause (whatever that may be) as the closing of the leaves of the Sensitive-plant at the touch, and a variety of similar movements observed in plants. The object of this note is to remark that the correctness of this view may be readily demonstrated.

For the tendrils in several common plants will coil up more or less promptly after being touched, or brought with a slight force into contact with a foreign body; and in some plants the movement of coiling is rapid enough to be directly seen by the eye; indeed, is considerably quicker than is needful for being visible. And, to complete the parallel, as the leaves of the Sensitive-plant, and the like, after closing by irritation, resume after a while their ordinary expanded position, so the tendrils, in two species of the *Cucurbitaceæ*, or Squash family, experimented upon, after coiling in consequence of a touch, will uncoil into a straight position in the course of an hour; then they will coil up at a second touch, often more quickly than before; and this may be repeated three or four times in the course of six or seven hours.

My cursory observations have been principally made upon the Bur-Cucumber (*Sicyos angulatus*). To see the movement well, full-grown and outstretched tendrils, which have not reached any support, should be selected, and a warm day; 77° Fahr. is high enough.

A tendril which was straight, except a slight hook at the tip, on being gently touched once or twice with a piece of wood, on the upper side, coiled at the end into $2\frac{1}{2}-3$ turns within a minute and a half. The motion began after an interval of several seconds, and fully half of the coiling was quick enough to be very distinctly seen. After a little more than an hour had elapsed, it was found to be straight again. The contact was repeated, timing the result by the second-hand of a watch. The coiling began within four seconds, and made one circle and a quarter in about four seconds. It had straightened again in an hour and five minutes (perhaps sooner, but it was then observed); and it coiled the third time on being touched rather firmly, but not so quickly as before; viz., $1\frac{1}{4}$ turns in half a minute. I have indications of the same movement in the tendrils of the grape-vine; but a favorable day has not occurred for the experiment since my attention was accidentally directed to the subject. I have reason to think that the movement is caused by a contraction of the cells on the concave side of the coil; but I have not had an opportunity for making a decisive experiment.

POMOLOGICAL USE OF SULPHATE OF IRON.

M. Dubreuil has produced much larger fruits than usual by moistening the surface of the green fruit with a solution of sulphate of iron, twenty-four grains to a quart of water. This was done when the fruit first set, when it was half, and when it was three-quarters grown, taking care never to do it when the sun was shining. It has long been well known that this solution greatly stimulated absorption.

INSECT AND VERMIN EXTERMINATING POWDERS.

The various termed insect and vermin exterminating powders (Persian, Lyon's, etc.), now in general use, are composed essentially of the same material, which has long been known to the Trans-Caucasian populations under the name of "Guirila." In that paradise of vermin, it is an article of a very considerable commerce, and is not only carried inland through Russia, in large quantities, but is also exported to Germany and France. A large dépot exists at Vienna. It is a coarsely-ground powder, of a green color, and penetrating odor, formed of the flowers of the *pyrethrum*, *carneum*, and *roseum*, which grow in the Trans-Caucasus at a height of five thousand or six thousand feet. This powder possesses the peculiarity of rapidly stupefying the insects, which soon afterwards die. Strewed about the room or the bed, it proves a poison to fleas, lice, flies, etc. In the military hospitals, in hot countries, it is an invaluable preventive of the formation of maggots in wounds, and the more so inasmuch as its use is attended with no disadvantages, unless employed in large quantities in closed bedrooms, when it may give rise to confusion in the head, such as is produced by flowers or new hay. It has been long used as a means of preserving insects; and cannot be too strongly recommended to those who have the care of herbarian and other natural-history collections, liable to the depredations of insects. Unfortunately, the demand for the powder has been so great of late, as to lead to its adulteration, by the addition of the stalks and leaves of the plants to the flowers, and to the mixing of the new with stale powder. As a general rule, the powder purchasable in Germany is very different from the Asiatic in color, smell, and efficiency. — *Buchner's Report.*

ON THE ACTION OF GROWING VEGETATION IN NEUTRALIZING MIASMA.

Lieutenant Maury, of the National Observatory, in an article communicated to the *Rural New-Yorker*, maintains that the growing of sunflowers around a dwelling located near a fever-and-ague region, neutralizes the miasma, in which that disease originates; and seems to support the theory by successful experiment. He was led to make the experiment by the following circumstances. The dwelling of the superintendent of the observatory at Washington, is situated on a hill on the left bank of the Potomac, in lat. 38° 39′ 53″. It is ninety-four feet above low-water mark, and about four hundred yards from the river. The grounds pertaining to it, about seventeen acres, are enclosed by a wall on the east, south, and west, and with a picket fence on the north. The south and west walls run parallel with the river, the Chesapeake and Ohio Canal, and a row of sycamores, of some twenty years' growth, separating the wall from the river. In fact, the river, with its marshes, encircles about half of the grounds. The house is, therefore, in the bend of the river; and the place is so unhealthy, that the family of the superintendent are compelled to vacate it five months out of the twelve, — the marshes being covered with a rank growth of grass and weeds, which begin to decay early in August. A knowledge of these facts led Lieut. Maury to the following process of reasoning:

If it be the decay of the vegetable matter on the marshes that produces the sickness on the hill, then the sickness must be owing to the deleterious effects of some gas, miasm, or effluvium, that is set free during decomposition; and if so, the poisonous matter, or the basis of it, whatever it be, must have been elaborated during the growth of the weeds, and set free in their decay. Now, if this reasoning be good, why might we not, by planting other vegetable matter between us and the marshes, and by bringing it into vigorous growth just about the time that that of the marshes begins to decay, bring fresh forces of the vegetable kingdom again to play upon this poisonous matter, and elaborate it again into vegetable tissue, and so purify the air?

This reasoning appeared plausible enough to justify the trouble and expense of experiment; and I was encouraged to expect more or less success from it, in the circumstance that everybody said, "Plant trees between you and the marshes — they will keep off the chills." But as to the trees, it so happens that at the very time when the decomposition on the marshes is going on most rapidly, the trees, for the most part, have stopped their growth to prepare for the winter; and though trees might do some good, yet a rank growth of something got up for the occasion might do more. Hops climb high; they are good absorbents, and of a rank growth; but there were objections to hops on account of stakes, poles, etc. I recollected that I had often seen sunflowers growing about the cabins in the West, and had heard, in explanation, that it was "healthy" to have them.

The theory of this is as follows: The ague and fever poison is set free during the process of vegetable decay, which poison is absorbed by the rank-growing sunflower, again elaborated into vegetable matter, and so retained until cold weather sets in. The result of the experiment is thus narrated:

Finally, I resolved to make the experiment at the risk of spoiling the looks of a beautiful lawn. Accordingly, in the fall of 1855, the gardener trenched up, to the depth of two and a half feet, a belt about forty-five feet broad around the observatory on the marshy side, and from one hundred and fifty to two hundred yards from the buildings. The conditions of the theory I was about to try, required rich ground, tall sunflowers, and a rank growth. Accordingly, after being well manured from the stable yard, the ground was properly prepared, and planted in sunflowers in the spring. They grew finely; the sickly season was expected with more than usual anxiety. Finally it set in, and there was shaking at the president's house, and other places, as usual; but, for the first time since the observatory was built, the watchmen about it weathered the summer clear of chills and fevers. These men, being most exposed to the night air, suffer most, and heretofore two or three relays of them would be attacked during the season; for as one falls sick, another is employed in his place, who, in turn, being attacked, would in like manner give way to a fresh hand.

REGULARITY OF NATURAL FORMS.

A correspondent of the *London Athenæum* presents the following curious speculation on the above subject:

"This phenomenon has always appeared to me to be of a very astonishing nature, and its explanation has hitherto been unattempted. I would, however, endeavor to point out the ways by which the forms of plants, etc., can be determined, taking care, however, to avoid the error of endowing mere matter with the properties of mind — an obvious fallacy, and one which it behoves all rational physical inquirers to guard against. It is impossible that either gravity or electricity, or the union of the two, can alone regulate the various forms to be found in the simplest weed. Some other influence or influences must come into action, and what this or these must be I will now endeavor to show: 1. Different kinds of vegetable matter doubtless have different properties; and the vital force acting upon these may produce the forms we see, without any other influence; or 2. The atmosphere, or some far more attenuated medium, may act as a kind of mould in which the various parts of plants are formed, different vegetable substances penetrating this universal mould according to their various qualities, and thus assuming different forms, being expanded and propelled probably by the vital and solar forces respectively. It cannot, I think, be doubted, that all considerations on this subject are, however crude and hypothetical, of some value, inasmuch as our present knowledge respecting these matters is so very limited and unsatisfactory. It is found that the elements of future existence are more or less of a circular shape; all roots and bulbs, as also seeds, come under this law, and appear incapable of formation apart from forces which develop this form. We may, I think, take it for granted, that if atoms have an existence in solid bodies, they must be circular, or something very like it, the eccentricity arising from gravity and more imperceptible causes, because there is (and this is mathematically correct) no reason why any great variation from the circle should exist in the production of any independent form, seeing that the components of atoms approach each other in regular succession from the various points without the forming atom, and this for all composing the different kinds of solid matter. The same of course applies to the numberless components of atoms, which we may perhaps call particles, if indeed such either exist or are capable of rational supposition. Let us suppose, then, that all substances which, receiving various matter, produce different vegetable forms, are composed of almost circular atoms. This state can be imagined; and the idea that change of form as a whole will tend to alter the form of the components of the altered substance is reasonable, and probably true. All seeds, and whatever is the sensible origin of future development, have an axis of vitality along which elongation proceeds; thus: all seeds, etc., turn the point of this upwards, if they happen to fall into the ground with it in any other position, showing that the various properties of bodies cannot be overlooked without a complete attestation as to their necessity and existence. After remaining in the ground some time, elongation in the direction of this axis takes place, — it may be before any influx of external elements has produced a material conjunction, — and as the result of this the component atoms must assume an oval form, and consequently alter the shape of their interstices. I say nothing about the change which this must produce in the external covering (skin) of seeds, etc., merely assuming that it acts as a barrier to the extension of the enclosed matter, which is indeed very evident. We have then elongated atoms, which contour does not to any perceptible extent exist in their primitive condition, and results principally from the upward attraction of the sun, the solar gravity, the influence of which in the vegetable world is universal. The axis of vitality probably always coëxists with the sap, and the stems of plants are probably composed of atoms elongated equally to those just considered, because the great elongation into which the seed, by conjunction with external elements, resolves itself, would, if unaided by externals, greatly alter the form of the component atoms; but this not being the case, the material influx preserves, or nearly so, the form of the atoms existing in the elongated seed, supposing that the matter absorbed is composed of atoms similar (the same, except as to size and identity) to those forming it, which there is not, I think, much reason to doubt, except it can be shown why fluids should be composed of different sized or differently formed atoms to solids. This *à priori* problem has not been solved; and with regard to the difficulty arising from the mobility of fluids, I am inclined to refer it to electrical or the like conditions. If no influx were to take place, it is evident, seeing that a large portion of the seed remains undisturbed when the stem is put forth, that the already elongated atoms must receive a very extended form. The stems of plants decrease in breadth, probably from the diminishing force of the sap. It is obvious that an innumerable body of atoms touch equally numberless points of the inner surfaces of the coverings of plants (using the terms of quantity in this case restrictively), and that one and only one projects at the extremities of stems, where they give way to either flowers or leaves. Where then we have flowers or leaves, we may consider that what formed them has been more directly submitted to the various forces of nature, which I take to be occasioned by the removal of the outer covering, by which material influx is quickened, and the solar attraction caused to produce mightier developments. Thus it has appeared to me that leaves are produced by the expansion of single atoms which are not enclosed by the outer covering, and that every variety of floral form is the expansion of the same under various circumstances of extension and cleavage. Thus the form of leaves would be accounted for. If they are the extension of atoms, it is clear that they would, at all events to some extent, preserve their shape; and this would to a great extent explain their strong axial resemblance. It is true that objections, on the score of latitude, may be raised against this hypothesis, and much, if not all, that I have said; but, as I have before set down, such speculations are not entirely useless.

THE GENETIC CIRCLE IN ORGANIC NATURE.

The following is an abstract of a paper read before the British Association, 1859, by Dr. G. Ogilvie:

Parental derivation, he observed, was now generally allowed as the sole origin of organic beings; and the subject of discussion among physiologists was no longer the admissibility of spontaneous generation, but the nature of the derivation, as the case may be, from a single parent or a pair. The former mode of origin, by what has been termed "gemmation," or the "budding process," plays a very conspicuous part in the propagation of many of the lower species, and by its periodic recurrence in conjunction with the other form of reproduction, gives rise to the singular phenomena known as alternation of generations. All cases of alternation were not, however, to be regarded as precisely parallel; and it was the object of the present paper to point out certain differences dependent on the period of the life-history of a species in which the process of gemmation is interpolated. Three stages were distinguished in the life-history — the Protomorphic, or that prior to the first appearance of the organization most characteristic of the species; the Orthomorphic, or that marked by such typical organism; and the Gamomorphic, or that of the development of the reproductive organs. In each of these stages we may have a process of gemmation interpolated. The results contrast, especially as it occurs in the first and last. As examples of the former, the Trematode and Cystic Entozoa were referred to in the animal kingdom, and the Mosses among plants, in all of which certain provisional forms are interposed between the ovum and the embryonic rudiment of the typical form. The Polypifera and Cestoidea among animals on the other hand, and the Ferns among vegetables, furnish illustrations of alternation dependent on gemmation, in the gamomorphic stage, and arising from the reproductive organs acquiring the characters of detached and often highly organized structures comparable to independent animals or plants. The Hood-eyed Medusæ become in this way much more conspicuous organisms than the Polype stock, whose organs they really are. The Cestoidea are remarkable as presenting instances of a double alternation, from a process of gemmation occurring both in the cystic or protomorphic, and in the Tænioid or gamomorphic stages. The author concluded by indicating a parallelism between the phenomena of alternation and certain points in the embryogeny of the higher animals, and in the maturation of the reproductive organs. The formation of double monsters in the higher animals, the normal twin embryo of the Polyzoa, the variable number of Tænia heads budded off by the Cystic Entozoa, and the phenomena of development among the Echinodermata, were referred to as indicating a gradual transition from the implantation of the embryo on the germ-mass of the ordinary ovum, to cases of well-marked alternation — while the reproductive process in the Polyzoa and Hydraform Polypes, in the Salpæ and in some Annelides, and the phenomena of impregnation in the Coniferæ among vegetables, were brought forward in illustration of a similar transition from the development of the normal, reproductive organs, to the formation of conspicuous sexual Zooids; — and in proof of distinctions founded on the complexity of the structures themselves not being of essential importance, reference was made to the males of the Rotifera and Cirrhipeda, which, though animals with an individuality entirely distinct even from the ovum, are much more defective in organization than some of the sexual Zooids now referred to, as the Hood-eyed Medusæ. The paper was illustrated by tabular views of the relations referred to.

ON THE STRUCTURE OF PLANTS.

One of the earliest fruits of the application of the convex lens to the examination of minute bodies, was the discovery of the structure of wood fibre, and the arrangement of the minute vessels in which the sap of plants circulates. Anxious to ascertain whether or no these microscopic vessels intercommunicated with each other, Professor Faraday took a stick of considerable length, and having varnished one end, he cut his name through the varnish, and forced a colored injection into the pores of the wood; when, after some time, the name appeared at the other end, nearly in the same relative position as that in which it had entered, thereby proving that the sap vessels are completely separated from one another.

ON THE AMELIORATION OF PLANTS FROM THE SEED.

Among the valuable scientific publications, in France, of the past year, are a collection and reprint of several of Louis Vilmorin's important communications to the Central Agricultural Society of France, and to the Academy of Sciences; to which is prefixed a French translation of a memoir upon the Amelioration of the Wild Carrot, contributed by his father to the Transactions of the London Horticultural Society (but not before published in the vernacular of the author), which memoir, as the younger Vilmorin informs us, was the point of departure for his own investigations in this field, and even contains the germ of most of the ideas which he has since developed upon the theory of the amelioration of plants from the seed. These papers claim the attention of the philosophical naturalist no less than of the practical horticulturist.

Most of our esculent plants are deviations from the natural state of the species, which have arisen under the care and labor of man in very early times. New varieties of these cultivated races are originated almost every year, indeed; but between these particular varieties, the differences, however well marked, are not to be compared for importance with those changes which the wild plant has generally undergone, in assuming the esculent state. In this amelioration or alteration, as in other cases, *c'est la premiere pas que coûte.* For the altered race, once originated, has much less stability than the wild stock; it accordingly tends, not only to *degenerate* (as the cultivator would term it) towards its original and less useful state, but also to *sport* into new deviations, in various directions, with a freedom and facility not manifested by its wild ancestors. This explains the readiness with which we continually obtain new varieties of those esculent plants which have been a long time in cultivation, while a newly-introduced plant exhibits little flexibility. To detect the earliest indications of sporting, and to select for the parents of the new race those individuals which begin to vary in the requisite direction, is the part of the scientific cultivator. In this way, the elder Vilmorin succeeded in producing the esculent carrot from the wild stock in the course of three generations, — no addition to our resources, indeed, but significant of what may be done by art directed by science. By adopting and skilfully applying these principles, the younger Vilmorin has conferred a benefit upon France which (if she will continue to make sugar from the beet) may almost be compared with that of causing two blades of grass to grow where only one grew before, having, so to say, *created* a race of beets containing twice as much sugar as their ancestors, and indicated the practicability of its perpetuation. The mode of procedure, and the ingenious methods he contrived for rapidly selecting the most saccharine out of a whole crop of beets, as seed-bearers for the next season, are detailed in these papers.

Once originated, and established by selection and segregation for a few generations, the race becomes fixed and perpetuable in cultivation, with proper care against intermixture, in virtue of the most fundamental of organic laws, viz., that the offspring shall inherit the characteristics of the parent, — of which law that of the general permanence of species is one of the consequences. The desideratum in the production of a race is, how to initiate the deviation. The divellant force, or idiosyncracy, the source of that "infinite variety in unity which characterizes the works of the Creator," though ever active in all organisms, is commonly limited in its practical results to the production of those slighter differences which ensure that no two descendants of the same parent shall be just alike, being overborne by that opposite or centripetal force, whatever it be, of which ensures the particular resemblance of offspring to parents. Now, the latter force, as Mr. Louis Vilmorin has well remarked, is really an aggregation of forces, composed of the individual attraction of a series of ancestors, which we may regard as the attraction of the type of the species, and which we perceive is generally all-powerful. There is also the attraction or influence of the immediate parent, less powerful than the aggregate of the ancestry, but more close, which ever tends to impress upon the offspring all the parental peculiarities. So, when the parent has no salient individual characteristics, both the longer and the shorter lines of force are parallel, and combine to produce the same result. But whenever the immediate parent deviates from the type, its influence upon its offspring is no longer parallel with that of the ancestry; so the tendency of the offspring to vary no longer radiates around the type of the species as its centre, but around some point upon the line which represents the amount of its deviation from the type. Left to themselves, as Mr. Vilmorin proceeds to remark, such varieties mostly perish in the vast number of individuals which annually disappear, — or else, we may add, are obliterated in the next generation through cross-fertilization by pollen of the surrounding individuals of the typical sort, — whence results the general fixity of species in nature. But under man's protecting care they are preserved and multiplied, perhaps still further modified, and the better sorts fixed by selection and segregation.

Keeping these principles in view, Mr. Vilmorin concluded that, in order to obtain varieties of any particular sort, his first endeavor should be to elicit variation in any direction whatever; that is, he selected his seed simply from those individuals which differed most from the type of the species, however unlike the state it was desired to originate. Repeating this in the second, third, and the succeeding generations, the resulting plants were found to have a tendency to vary widely, as was anticipated; being loosed, as it were, from the ancestral influence, which no longer acted upon a straight and continuous line, but upon one broken and interrupted by the opposing action of the immediate parents and grand-parents. Thus confused, as it were, by the contrariety of its inherited tendencies, it is the more free to sport in various ways; and we have only to select those variations which manifest the qualities desired, as the progenitors of the new race, and to develop and fix the product by selection upon the same principle continued for several generations.

It is in this way that Mr. Vilmorin supposes cross-fertilization to operate in the production of new varieties; and even in the crossing of two distinct species, the result, he thinks, is rarely, if ever, the production of a fertile hybrid, but of an offspring which, thus powerfully impressed by the strange fertilization, and rendered productive by the pollen of its own female parent, is then most likely to give origin to a new race.

We cannot follow out this interesting but rather recondite subject in a brief article like this. But we are naturally led to inquire whether the history of those plants with which man has had most to do, and the study of the laws which regulate the production and perpetuation of domesticated races, may not throw some light upon the production of varieties in nature; and whether races may not have naturally originated, occasionally, under circumstances equivalent to artificial selection and segregation. — *Prof. Asa Gray, Silliman's Journal,* May 1859.

ZOÖLOGY.

USE OF THE MICROSCOPE IN NATURAL HISTORY.

THE microscope, as an adjunct to naturalists, has been of high service, which, however, has been overrated. Dr. Walker Arnott, in the Proceedings of the Royal Society of Edinburgh, observes:

Microscopic differences are by themselves of little importance. To see is one thing; to understand and combine what we see, another. The eye must be subservient to the mind. Every supposed new species requires to be separated from its allies, and then subjected to a series of careful observations and critical comparisons. To indicate many apparently new species, is the work of an hour; to establish only one on a sure foundation, is sometimes the labor of months or years. In microscopical natural history, as much scrutiny is required to prove a new form to be distinct from its allies, as in chemistry to discover a new alkaloid, or in astronomy to demonstrate the identity of two comets. A naturalist cannot be too cautious. It is better to allow diatoms to remain in the depths of the sea, or in their native pools, than, from imperfect materials, to elevate them to the rank of distinct species, and encumber our catalogue with a load of new names, so ill-defined, if defined at all, that others are unable to recognize them. The same object can be more easily attained by attaching them, in the meantime, to some already recorded species, with the specific character of which they sufficiently accord. In all such cases, the question to be solved for the advantage of naturalists is not whether the object noticed be a new species, but whether it has been proved such, and clearly characterized.

THE NERVOUS SYSTEM.

Dr. Brown-Séquard, in a recent lecture in Edinburgh, exhibited some Guinea-pigs which had been experimented upon some months ago, by cutting certain nerves; the hinder limbs became paralyzed, but in time the animals recovered the power of voluntary motion, attended, however, with a very curious result — the operator could put them into a fit of epilepsy whenever he pleased. It appears that by the cutting of the nerves, the animals lose sensation except in one cheek; and if that spot be irritated, a fit is the immediate consequence. Another noticeable particular is, that the lice which infest the animals, congregate on that spot, and nowhere else. Whether it be that there is more warmth or more perspiration than on other parts of the body, is not known; at any rate, physiologists are agreed as to the singular and suggestive nature of the phenomenon. It appears, moreover, that if the sensibility of the sensitive spot be destroyed, then the Guinea-pig ceases to be liable to epilepsy. Applying this fact to human physiology, Dr. Brown-Séquard says that there is in the human body a spot, discoverable, as he believes, by galvanism, which, if deprived of its sensibility, would, in like manner, completely prevent attacks of epilepsy.

PHYSIOLOGICAL KNOWLEDGE GAINED THROUGH CHLOROFORM.

The following is an extract of a letter addressed to the *Medical and Surgical Reporter*, London, by Dr. Charles Kidd, July 1859:

"It is only within a few weeks that it has been clearly proved that the endowment called *common sensation*, the great root of consciousness, as shown by Locke, Leibnitz, and Schlegel, is not psychologically the same as the sense of *touch*, with which Dr. Snow and others have confounded it. Thus a man may have a red-hot iron applied to his arm or leg under the influence of chloroform; he feels no pain, but he feels the iron as an affair of *touch* streaking out lines on his skin. The bearing of this fact on the phenomena of insanity, sleep and dreams, is most extensive. In the same manner, a woman in labor, with proper doses of chloroform, feels no pain, but is quite conscious of the process of parturition *quoad*, the muscular sense (that would be agonizing cramps otherwise) going on as usual. This has only recently been shown, by M. Brown-Séquard, to depend on the fact already stated, but not suspected by Dr. Snow, who chiefly experimented on rabbits and dogs. Indeed, a new world has, since his death, been opened up as regards the psychology of chloroform in relation to ordinary sleep, common sensation, touch, dreams, sympathetic action, emotion, reflex action of the sensorium or soul itself, on the body, etc., so that the subject is only in its infancy."

CELL DEVELOPMENT.

Virchow, the eminent German physiologist, in a recently published series of lectures, on what may be called "Cellular Physiology," defines the *cell* to be an exceedingly minute microscopic object, consisting of a membrane containing a substance in which is a nucleus upon which the action of the cell depends. All pathological processes proceed from changes in and multiplications of previously existing cells. A cell can only arise from a pre-existing cell, and never *de novo*. The germ of life is a cell transmitted and impregnating an ovum. The whole scheme of animal development, both physiological and pathological, is but a continuation of the process begun in the ovum upon the cell — the first step in gestation. He denies the formation *de novo* of "granules," or any other tissue form of the old pathologists, from a so-called *Blastema* or of homogeneous exudation. That is, since the creation of the first man and woman, the race has been kept up by, and every physiological and pathological phenomena has had its origin in, the division and multiplication of cells — the difference between the phenomena of physiology and pathology being only that of normal or morbid action in similar forms.

CHANGES OF THE BLOOD-CELLS OF THE SPLEEN.

The opinions of physiologists as to the functions of the spleen, have been various. Some, as Funke, Hewson, Bennet, etc., believe it to be a generator of blood-cells, while Kölliker and others maintain that it is a destroyer of them. Dr. Henry Draper states (*N. Y. Jour. Med.*, Sept. 1858) some microscopic investigations made by him on the blood of frogs taken from the splenic artery and splenic vein, and he found the latter to contain at least double the general average of imperfect cells; whence he infers that "the spleen must be an organ for the disintegration of blood-cells."

NEW FACT CONCERNING BLOOD.

M. Claude Bernard has communicated certain observations to the French Academy of Sciences, tending to show that the custom of applying the denomination of red blood to that of the arteries, and of black to that of the viens, is not in accordance with facts. Having had occasion to open the renal veins of various animals, M. Bernard found them to contain red blood, strongly contrasting with the dark blood issuing from the vena cava below. In order to ascertain whether the same was the case with other veins belonging to organs of secretion, he opened the vein of the sub-maxillary gland of a dog, and found the blood of the darkest possible hue. At that moment, however, the salivary secretion had stopped. In order to excite it, a few drops of vinegar were introduced into the throat of the animal. The secretion recommenced, and after a few seconds the blood was seen to change its color to the scarlet hue of arterial blood. As soon as the secretion ceased, the blood resumed its former dark color. Hence M. Bernard concludes that, although the name of red blood is correctly applied to that of the arteries, that of black blood cannot be, with equal generality, applied to that of veins; for that in the veins of the organs of secretion the color varies according as the organ is in a state of action or repose.

WHEN IS A TISSUE DEAD.

Some interesting experiments of M. Brown-Séquard have brought him to this conclusion: That a tissue is not of necessity dead when it has lost its vital properties or its natural action for a period of one or even several hours; and for the reason, that its properties and its actions may be restored through the aid of blood charged with oxygen.

ON THE PRODUCTION OF BONE.

At a recent meeting of the French Academy, Dr. Olivier read a paper, in which he endeavored to throw quite a new light on the production of bone. The conclusions at which he arrived, if supported by future experimentalists, will not fail to produce a deep impression on the minds of physiologists; while, at the same time, they will tend to enlarge and extend the system of "anaplastic," as applied to surgery. The experiments of Dr. Olivier were conducted entirely on rabbits of different ages, and different stages of growth, and were divided by him into three series. In the first series, long slips of periosteum were detached from the tibia throughout its entire length, one of the extremities only being left attached to the bone by a peduncle; these slips of periosteum were then pushed along the muscles, and twisted around them in a variety of ways. In the course of a certain time osseous matter was produced, assuming the shapes of the twisted and contorted membrane. In the second series of experiments, the slips of periosteum which had been treated in the same manner as in the first series, were, three or four days after the operation, completely detached from the bone, and, notwithstanding their isolation from their original source of life, the periosteum still continued to produce bone. In the third series of experiments the periosteal covering was completely and at once separated from the bone, and immediately inserted under the skin of the shoulder and back, and still, strange to say, the periosteum produced bone. Dr. Olivier found that age modified, to a certain extent, this peculiar property of the periosteum; advanced age, for instance, while it diminished the property, did not completely destroy it. The osseous tissue obtained in this strange manner he found to be real bone, similar to that of the rest of the body. The result of these interesting and curious experiments goes to prove that bone even can be obtained in whatever part of the body the periosteum can be introduced; and, further, that a membrane may preserve its properties, notwithstanding its removal from its original seat, and transplantation to another part of the economy.

VALUE OF A LIFE.

Mr. Charles M. Willich, of London, has published a simple rule for computing the probable value of property in life at any age from five to sixty. His formula stands thus: $E = \frac{2}{3}(80-a)$; or, in plain words, the expectation of life is equal to two-thirds of the difference between the age of the party and eighty. Thus, say a man is now twenty years old. Between that age and eighty there are sixty years. Two-thirds of sixty are forty; and this is the sum of his expectation of life. If a man be now sixty, he will have an expectation of nearly fourteen years more. By the same rule a child of five has a contingent lien on life for fifty years. Every one can apply the rule to his own age Mr. Willich's hypothesis may be as easily remembered as that by Dr. Moivre in the last century, which has now become obsolete from the greater accuracy of mortality tables. The results obtained by the new law correspond very closely with those from Dr. Farr's English Life Table, constructed with great care from an immense mass of returns.

POPULATION OF THE GLOBE.

The following tables, showing the division of mankind into races, branches, families, and nations, has been published by M. d'Halloy, in the Proceedings of the Belgian Academy:

I. Division into Races and Branches.

White Race.—	European branch,	289,586,000	
	Aramean "	50,390,000	
	Scythian "	30,747,000	= 370,723,000
Yellow Race.—	Hyperborean Branch,	160,000	
	Mongolian "	7,000,000	
	Sinic "	338,300,000	= 345,460,000
Brown Race. —	Hindoo branch,	171,100,000	
	Ethiopian "	8,300,000	
	Malay "	25,600,000	= 205,000,000
Red Race.—	Southern "	9,200,000	
	Northen "	400,000	= 9,600,000
Black Race. —	Western "	56,000,000	
	Eastern "	1,000,000	= 57,000,000
Hybrids, —	Mulattos, Zambos, etc.		12,217,000
	Total,		1,000,000,000

II. Subdivision of the White Race into Families and Nations.

1. *European Branch.*

Teutonic Family. —	Germans, including the Dutch	54,000,000	
	Scandinavians. — Swedes,	3,634,000	
	Norwegians,	1,563,000	
	Danes,	1,709,000	
	English, including the Scotch,	38,014,000 =	98,920,000
Celtic Family. —	Cymry. — Welsh,	650,000	
	Bretons,	1,000,000	
	Gaels. — Irish,	9,600,000	
	Highlanders,	500,000 =	11,750,000
Latin Family. —	French,	39,900,000	
	Spaniards, including the Portuguese,	22,865,000	
	Italians,	26,160,000	
	Wallacks,	7,095,000 =	96,020,000
Greek Family. —	Greeks,	2,990,000	
	Albanians,	1,480,000 =	4,470,000
Slavic Family. —	Russians, inc. Rusniaks and Cossacks,	49,874,000	
	Bulgarians,	3,387,000	
	Servians,	5,500,000	
	Slovenians,	1,306,000	
	Wends,	142,000	
	Chechs. — Bohemians	3,144,000	
	Moravians,	1,000,000	
	Hanaks,	280,000	
	Slovaks,	2,400,000	
	Poles,	9,304,000	
	Lithuanians. — Lithunians, properly,	1,217,000	
	Lettish,	872,000 =	78,426,000
	Total,		289,586,000

2. *Aramean Branch.*

Basque Family. —	Basques,		775,000
Lybian Family. —	Berbers. — Amazirghs,	4,700,000	
	Kabyles,	1,500,000	
	Tuarics,	300,000	
	Egyptians. — Copts,	150,000	
	Fellahs,	1,500,000 =	8,150,000
Semitic Family. —	Arabs,	14,650,000	
	Jews,	4,074,000	
	Syrians,	500,000	
	Maltese,	106,000 =	19,330,000
Persian Family. —	Tajiks,	8,775,000	
	Afghans. — Afghans, properly,	3,500,000	
	Belouchis,	1,500,000	
	Patans,	5,000,000	
	Kurds, including the Lures,	1,500,000	
	Armenians,	1,228,000	
	Ossetians,	32,000	
	Georgians, inc. Mingrelians & Lazians,	600,000 =	22,135,000
	Total,		50,390,000

3. *Scythian Branch.*

CIRCASSIAN FAM. —	Cherkessians,		800,000	
	Chetchents,		200,000	
	Lesghians,		500,000 =	1,500,000
MAGYAR FAMILY. —	Magyars,			5,000,000
TURKISH FAMILY. —	Osmanli,		9,500,000	
	Turcomans,		1,500,000	
	Tarekamehs,		1,000,000	
	Nogai,		1,470,000	
	Kirgis,		1,000,000	
	Usbeks,		5,500.000	
	Alatys,		30,000 =	20,000,000
FINNISH FAMILY. —	Finns of Siberia. —			
	Teleouts,	1,000		
	Sagais; Kachints, etc.	20,000		
	Woguls,	12,000		
	Ostiaks,	103,000 =	136,000	
	Finns of Eastern Russia. —			
	Bashkirs,	392,000		
	Teptiairs,	104,000		
	Metcheriaks,	80,000		
	Chouvasehs,	430,000		
	Cheremisses,	165,005		
	Morduins,	480,000		
	Permiaks,	52,000		
	Sirijänes,	71,000		
	Votiaks,	191,000	1,965,000	
	Finns of the Baltic.			
	Livonians,	2,000		
	Esthonians,	654,000		
	Kyrials; Ymes; Quaines,	1,490,000	2,146,000 =	4,247,000
		Total,		30,747,000

III. SUBDIVISION OF THE YELLOW RACE INTO BRANCHES, FAMILIES, AND NATIONS.

Hyperborean Branch.

LAPPONIC FAMILY,		9,000	
SAMOYEDIC "		15,000	
YENISEI, "		38,000	
YUKAGIR "		3.000	
KORIAK "	Koriaks,	8.000	
	Chutchis,	2,000	
KAMTSCHATKAN F.		5.000	
ESQUIMAUX FAM.,	NAMOLLOS,	2,000	
	Chugassics,	3,000	
	Kuskovintzes,	7,000	
	Aleouts,	3,000	
	Esquimaux,	20,000	
	Greenlanders,	5,000	
KURILIAN FAM. —	Aïnos,	40,000 =	160,000

Mongolian Branch.

Yakut Family.—	Yakuts,	90,000	
Mongolian Fam.—	Kalmucks,	170,000	
	Mongolians,	2,560,000	
	Burattish,	120,000	
Tungusian Fam.—	Tungusians,	60,000	
	Mantchurians,	4,000,000 =	7,000,000

Sinic Branch.

Chinese Family,	282,000,000	
Corean "	6,000,000	
Japanese "	25,000,000	
Anamitic "	12,000, 000	
Siamese "	4,300.000	
Peguan "	500,000	
Birman "	2,500,000	
Thibetan "	6,000,000=	338,300,000
Total,		345,460,000

IV. Subdivision of the Brown Race into Branches, Families, and Nations.

Hindoo Branch.

Hindoo Family.—	Hindees; Guzurats; Mahrattas; Bengalees; Oriyas; ? Taiganes, .	111,100,000	
Malabar "	Telingas; Carnatics; Tamils; ? Singalese; ? Gonds; ? Bhills; ? Paharias; ? Kacharis, etc. . . .	60,000,000 =	171,100,000

Ethiopian Branch.

Abyssinian "	Barabras; Tibboos; Abyssinians, Gallas, etc.	4,300,000	
Fellan "	Fellahs; Ovas, etc.	4,000,000 =	8,300,000

Malay Branch.

Malay "	Malays; Battas; Javanese; Macassars; Bugis; Turajas; Dayaks, Bissayis; Tagalis, etc.	24,600.000	
Polynesian "	New Zealanders; Tongas; Bougainvillians; Cook's Islanders; Tahitians; Paumotuans; Marquesans; Sandwich Islanders; Caroline Islanders; Mulgravians,. . .	1,000,000 =	25,600,000
	Total,		205,000,000

V. Subdivision of the Red Race into Branches and Families.

Southern Branch.

Aztec Family,	4,435,000	
Maya "	300,000	
Quichua "	2,620,000	
Antisian "	100,000	
Araucanian Fam.,	340,000	
Pampean Family,	250,000	
Chiquitean "	20,000	
Moxian "	30,000	
Guaranian "	1.105,000 =	9,200,000

Northern Branch.

FLORIDIAN FAMILY,	70,000?	
IROQUOIS "	5,000?	
LENAPE "	40,000?	
ATHABASCAN "	40,000?	
SIOUX "	35,000?	
PAWNEES "	80,000?	
KOLUSHEN "	50,000?	
WAKASH, "	20,000?	
CALIFORNIAN "	60,000? =	400,000?
Total,		9,600,000?

VI. SUBDIVISION OF THE BLACK RACE INTO BRANCHES, FAMILIES, AND NATIONS.

Western Branch.

CAFFRE FAMILY, HOTTENTOT " NEGRO "	A large number of nations, of whom the most are unknown,	56,000,000

Eastern Branch.

PAPUAN FAMILY,	Feejeeans; New Caledonians; New Hebrideans; Salomon Islanders; Papuas,	1,000,000
ANDAMANIAN FAM.	Andamans of the Andaman Islands, Indo-China, New Guinea, New Holland, Van Diemen's Land,	
Total,		57,000,000

From a paper recently published also by M. Dieterici, of the University of Berlin, on the "Population of the Globe," we derive the following statistics, which disagree materially with those of M. d'Halloy.

The author adopts three different modes of classification:

First, By totals of the several countries;
Second, By Races; and
Third, By Creed or Religion.

According to the first mode of classification, the mass of detail given, sums up in the following round numbers:

	Square Miles.	Inhabitants.	Average to the Square Mile.
1. Europe,	2,900,000	272,000,000	93
2. Asia,	12,700,000	755,000,000	60
3. Africa,	8,700,000	200,000,000	22
4. America,	12,000,000	59,000,000	5
5. Australia,	2,600,000	2,000,000	1
Round totals,	39,000,000	1,288,000,000	33

The greatest density of population of a kingdom is exhibited in Belgium, where it is 538 to the square mile; single districts in Rhenish Prussia show as high as 700 to the square mile.

Political economy has not yet found a gauge by which to determine how densely people can be crowded, and make a living. In civilized Europe, the density is steadily increasing. America promises a similar development in future. Civilized emigration to Polynesia may tend to a similar development in Australia. East India and China, although now densely peopled, incline, after a period of stability, toward a decrease rather than an increase, owing to the peculiarities of their civilization.

Dieterici's remarks on Distribution by Races is prefaced by an interesting sketch of Retzius's new system of craniology, with its two divisions of Oval Heads (*dolico cephalous*) and Broad or Cubic Heads (*bradry cephalous*) — the former including, in Europe, all the Latin and German tribes, 157 millions; the latter the Slavonic, Magyar, Turkish, and some of the Romance tribes of the south, 115 millions; in Asia, the Chinese, Hindoos, Arian Persians, Arabs, Jews, and Tungusians, are Oval Heads, 610 millions; all the rest Broad Heads, 145 millions. The estimate of America is, of course, based on aborigines only. In regard to them, the opinion is advanced that from the islands around Behring's Straits, along the west coast, including the Russian Colonies, Oregon, Mexico, Ecuador, Peru, Bolivia, Chili, Argentina, Patagonia, and Fire Island, the population consists principally of Broad Heads; while on the east coast, from Canada downward, including the United States, the Caribbean Islands, the West Indies, Venezuela, Guiana, and Brazil, the Oval Heads predominate. This would coincide with Humboldt's theory, that the west coast of America was peopled from Asia. The aborigines would now, probably, not exceed one million. All the rest are emigrants and their descendants, including perhaps half a million of Broad Heads; one-half of the aborigines being Oval Heads, one million is therefore the extent of the Broad Heads of America, to fifty-eight millions of Oval Heads. In Australia the Broad and Oval Heads are probably evenly divided, being one million each. The footings are therefore as follows:

	Oval Heads.	Broad Heads.
In Europe,	157,000,000	115,000,000
In Asia,	610,000,000	145,000,000
In Africa,	200,000,000	———
In America,	58,000,000	1,000,000
In Australia,	1,000,000	1,000,000
Total,	1,026,000,000	262,000,000

The same Swedish ethnologist makes still another division of the human race, according to the facial angle, into *Orthognathes* and *Prognathes* — the former with an erect face, the latter with protruding jaws and receding foreheads. Both classes are found both among Oval and Broad Heads. The footings are thus:

	Upright Faces.	Receding Faces.
In Europe,	272,000,000	———
In Asia,	224,000,000	531,000,000
In Africa,	———	200,000,000
In America,	58,000,000	1,000,000
In Australia,	1,000,000	1,000,000
Total	555,000,000	728,000,000

The excess of the latter is attributable to the population of Africa, which, although Oval Heads, must be classed entirely with the Receding Faces, the same as the population of China and Eastern Asia in general.

The preceding strictly scientific classification is followed by the popular classification of races, according to the color of the skin and the formation of the features, the hair, etc., established by Blumenbach. The five races thus established are distributed as follows:

1. The Caucasian —	(28·85 per cent.) — *In Europe*, the entire population with the exception of the Fins and Laplanders,	270,000,000
	In Asia — Turks 15; Arabs 5; Persians, etc. 11; Siberian, in part, 3; foreigners in Eastern Asia 2,	36,000,000
	In Africa — Foreigners in the colonies, and Arabs,	4,000,000
	In America — All except the Indian,	58,000,000
	In Australia — Foreigners on all Islands,	1,000,000
	Total,	369,000,000
2. The Mongolian —	(40·61 per cent.) — Principally in Asia, including China, the greater part of India, Central Asia, and part of Siberia,	522,000,000
3. The Ethiopian —	(15·08 per cent.) — The entire population, with the exception of the Caucasians, as above,	196,000,000
4. The American —	(0·08 per cent.) — The Indians of America,	1,000,000
5. The Malay —	(15·38 per cent.) — In the Indian Islands, 80; East India, 84; Japan, 35; and Australia, 1,	200,000,000
	Grand Total,	1,288,000,000

The division according to creeds is full of interesting detail. The leading footings, taken on the round number of 1,300,000,000, as the total population of the earth, are:

Christians,	335,000,000	or	25·77	per cent.
Jews,	5,000,000	"	0·38	"
Asiatic Religions,	600,000,000	"	46·15	"
Mohammedan,	160,000,000	"	12·31	"
Pagans,	200,000,000	"	15·39	"
Total,	1,300,000,000	or	100	per cent.

The 335,000,000 of Christians are again divided into:

Roman Catholics,	170,000,000	or	50.7	per cent.
Protestants,	89,000,000	"	26.6	"
Greek Catholics,	76,000,000	"	22·7	"
Total,	335,000,000	or	100	per cent.

The conscientious author of the very elaborate paper from which we have made these extracts, is of opinion, that although much uncertainty attaches to the positive numbers given under the various heads, yet so manifold have been his sources of comparisons, that the general results, in proportions of population, race, or creed, may be adopted as correct.

BLOOD-STAINS AND BLOOD-CRYSTALS.

At a recent meeting of the Philadelphia Academy, Dr. Mitchell made some interesting statements in respect to the importance of the study of blood-crystals in connection with the medico-legal study of the blood, and the examination of blood-stains. Dr. M. remarked upon the difficulty of discriminating between the blood of man and that of some other mammals, even when the blood was comparatively fresh and fluid. Here, he thought, the blood-crystal might serve to determine the point in question. Usually, in murder cases, only the dried blood was to be obtained, and here the possibility of making use of the varied forms of blood-crystals to determine the source of the blood, was a more doubtful matter. Several questions present themselves.

Can blood-crystals be obtained from the dried blood of man and animals? Dr. M. has so far been unsuccessful in obtaining the characteristic form from dried human blood. Some of the German observers have been more fortunate. The failure to obtain the human blood-crystal is not, or would not be, decisive as to the inutility of this mode of research, if the blood of other animals does not present a like difficulty. On this point, our information is not altogether complete, because the number of animals whose blood has been examined, is as yet rather limited. The blood of birds, whether in its wet state, or dried, has not afforded crystals under any method as yet employed. This is unfortunate as regards judicial questions, because it is often a question whether a blood-stain may not have been derived from pigeon or chicken blood. Dr. M. referred to such a case as within his own experience. The blood of fishes in general affords crystals with great readiness, even after the blood has been long dried. The forms are characteristic, and are not likely to be confounded with those of human blood. The blood of all reptiles is difficult to crystallize; Dr. M. would say, after many trials, impossible, were it not for the results which others have observed. At all events, no observer has obtained crystals by treating the dried blood of reptiles, nor is it likely that the blood of this class will ever play any part in a judicial investigation. In regard to birds, fishes and reptiles, it is to be observed that the form of the blood globule, and its nuclear condition, may be decisive as to its not being human, and that the production of blood crystals from the blood of these classes is not, therefore, so important as in the case of mammalia, and especially of the domestic animals. In some of these, as the cat, the blood affords good crystals when properly treated, either in a fresh state, or still better, when decomposing. Dr. M. was unable to obtain crystals by treating the dried blood of the bullock or sheep, but he obtained crystals easily from the dried blood of the opossum, and from several of the rodentia. It is probable that we shall be able at some future time to obtain crystals from the dried blood of any animal.

Dr. M. especially insisted on the greater ease with which putrescent blood yielded crystals. He thought that exposure to light and the decomposition of the blood, previous to its being dried, were the most favorable conditions. The disappearance of the fibrinous mass under these circumstances, placed the process of crystallization in the best circumstances by setting free the mass of blood globules. Dr. M. was accustomed to obtain crystals from dried blood by moistening the dried clot and occasionally supplying water until putrefaction began, when the blood was treated as though it was fresh. The blood thus moistened was examined for crystals by the usual method from day to day, but the best results were commonly observed at the period of decomposition.

Dr. Mitchell's remarks gave rise to an animated discussion of the medico-legal examination of blood-stains.

Dr. Woodward was of opinion, that it generally is impossible to state the particular mammal from which the blood of a dried blood-stain has come, by any mode of microscopic inspection. Dr. Schmidt had constructed tables of the relative size of the "dried blood globule in man and many animals." Dr. Woodward thought too much stress had been laid upon these measurements, and conceived that a question which it was very difficult to answer in regard to fresh blood, must become almost unanswerable with dried blood. He had himself been examined in a case where those concerned evidently expected that the microscope would enable him to say of the specimen of dried blood, this is the blood of man, or of this or that mammal. He had found himself unable to decide, and had stated as his fixed opinion, that no examination by the microscope of the blood globules, fresh or dried and re-moistened, would enable any one to swear as to the source of the specimen. He mentioned this, because in Philadelphia and elsewhere other opinions are held and taught by many medical men.

Dr. Leidy stated his opinion to be the same as that held by Dr. Woodward. He would feel it to be very unsafe to declare positively to what particular animal certain corpuscles belonged. He alluded also to cases where, when judicially examined, he had been obliged to correct erroneous opinions similar to those spoken of by Dr. Woodward.

Dr. Hammond agreed entirely with the opinions held by these gentlemen.

Dr. Hartshorne stated that he had come to the same conclusion as to the impossibility of deciding positively as to the source of blood-stains, with or without the use of the microscope.

Dr. Hammond declared that in only one class of cases did he believe that the microscope could be of any service; it would enable the physician to pronounce with confidence that certain stains did not come from the blood of a human being when the corpuscles contained therein were oval or nucleated.

Dr. Atlee stated that he had never observed any white corpuscles in specimens of dried blood. Drs. Leidy and Hammond added the remark, that, as far as their recollection served, they had not observed them.

Dr. Woodward declared that he had seen them very distinctly after six months had elapsed, when blood had been dried rapidly on a slide.

This difference of opinion was attributed by Dr. Morris to not using oblique lights, by which these bodies are much more readily distinguished.

RACES OF NORTHERN AFRICA (MEN WITH TAILS).

At a recent meeting of the Boston Society of Natural History, Dr. Bodichon, a French naturalist, residing in Algeria, gave an account of the various races of men occupying Algeria, from personal observations.

There are two white races; one, living in the mountains, the Mauritanians, Numidians, or Berbers; and the Asiatics, or Arabs, 1. Also called Kabyles, living in the mountains, — small in stature, warlike, democratic, dwelling in villages resembling the Swiss, planting trees, enjoying plentiful harvests, fruits, etc.; very independent and noble in their sentiments. They have no judges, often settling their disptues by an appeal to the first person who passes by; though polygamous, they prefer a single wife; they are fine soldiers, and are not afraid of European troops. He considers these as an indigenous race, and the same as the brown inhabitants of Southern Europe. 2. The Arabs, a tall, brown race, excellent horsemen, nomadic, possessing no permanent villages; they are very fond of fighting, and pass at least half their time in war; they have a strong religious sentiment, and are very fond of poetry; they are polygamous. 3. A mixed race of Turks and women of the different races of the country, which has begun to disappear since the dominion of the French. 4. In the interior of Africa there is a race like the Germanic, with light hair and blue eyes, which he believes to be descendants of the ancient Gauls or Carthaginians; they are polygamous, and present the curious phenomenon that the women are sovereign in the family and in the state, though the daughter of the queen cannot inherit the throne; they make long pilgrimages on very swift camels for the purpose of carrying off negro slaves — they are called Tuariks. 5. A mixed white and black race, the Fellatah, embracing many millions; a powerful people, of very social disposition. 6. Negroes, from Congo, Timbuctoo, etc.; the best are from the neighborhood of Labe Tsad; they are idolaters, making sacrifices to their gods of sheep, cocks, and other animals, and drawing from them various auguries. They are subject to a kind of periodic insanity, like some of the New Orleans negroes, in which they call on the spirits of their ancestors, and often fall insensible. The characters of these different races are not perfectly distinct; especially of some of those communities which gather about a well or oasis in the desert, a few hundreds together, which they often wall around, and form into small villages. The Kabyles have well-shaped heads; the Arabs have low, retreating foreheads. In answer to the question whether there exists in Africa any race of human beings with tails, Dr. B. replied that in the neighborhood of the Mountains of the Moon, there is said to be a large tribe of ferocious cannibals, having an elongated coccyx, projecting like a tail, from three to ten inches; when seen by other tribes, they are killed as if they were wild beasts. He had never seen any specimens, though it is generally believed that such a race exists.

SPONTANEOUS GENERATION.

Mr. George Henry Lewes, in an article contributed to "*Once a Week*," thus sums up the recent investigations and present state of our knowledge on the subject of "spontaneous generation."

It was as easy for the ancients to conceive that animals could be produced from putrefying matters, as it is difficult for the instructed physiologist of our day to conceive any generation whatever except that by direct parentage. Aristotle found no difficulty in believing that worms and insects were generated by dead bodies, and that mice could become impregnated by licking salt. The successors of Aristotle were even less skeptical than he. They were constantly observing animals and plants suddenly springing into existence where no animals or plants had been before. Every dead dog, or decaying tree, was quickly beset with numerous forms of life; how could it be doubted that the putrefaction, which was observed as an invariable accompaniment, was the necessary cause of these sudden appearances of life?

To the mind imperfectly acquainted with the results of modern science, spontaneous generation is as easy of belief as it was to Aristotle. Do we not constantly see vegetable mould covering our cheese, our jam, our ink, our bread? Do we not, even in air-tight vessels, see plants and microscopic animals develop where no plants and animals could be seen before, and where, as we think, it was impossible that their seeds should have penetrated? And when we hear that Mr. Crosse produced an insect by means of electricity, startled as we may be, do we really find any better argument than our prejudice for disbelieving such a statement? Where do parasitic animals come from, if not spontaneously generated in the body? These parasites are found in the blood, in the liver, in the brain, in the eye, nay, even in the excessively minute egg itself. "How *gat* they there?" is our natural question. This question, which is so easily answered on the supposition that generation can take place spontaneously, presents the most serious difficulties to science, because the massive weight of scientific evidence has been year after year accumulating against such a supposition; until the majority of physiologists have come to regard it as an axiom, that no generation whatever can occur except by direct parentage. This axiom, which a small minority has always rejected, has quite recently met with a formidable questioner in M. Pouchet, the well-known physiologist of Rouen; and his experiments and arguments having agitated the Academy of Sciences, our readers may be interested if a review of the whole subject be laid before them.

The first person who assailed the notion of spontaneous generation was Redi, the Italian naturalist, in his treatise "Experimenta circa Generationem Insectorum," in which he reviewed the facts, and proved that the worms and insects which appear in decaying substances, are really developed from eggs deposited in those substances by the parents. So masterly was the treatise, that no one since then has had the courage to maintain the production of worms and insects spontaneously. It has been held as preposterous to suppose that putrefaction could generate an insect as that it could generate a mouse — which Cardan believed. Driven from the insect world, the hypothesis has sought refuge in the world of animalcules and parasites; and there the hypothesis is not so easily defeated. Whoever turns over the pages of Leeuwenhoek, the first who extensively applied himself to microscopic observations, will see that the Dutchman steadily set his face against spontaneous generation, because the microscope showed him that many even of these minute animals had their eggs, and were generated like the larger animals. Since that time, thousands of observers have brought their contributions to the general stock, and each extension of our knowledge has had the effect of narrowing the ground on which the "spontaneous" hypothesis could possibly find footing; the modes of generation of plants and animals are becoming more and more clearly traced; and the necessity in each case of a parent stock is becoming more and more absolute. It is true that there are organic beings of which, as yet, we can only say that there is the strongest presumption against their being exceptions to the otherwise universal rule of generation. We do not know, for example, how the *Amæba* arises; no one has ever seen its eggs; no one has ever seen its reproduction — and, what is more, it is perfectly easy to make them in any quantities. I have done so repeatedly. Nevertheless, they can only be "made" under the conditions which would be indispensable for their birth and development if they were really generated from eggs; and that they are so generated is a presumption which has every argument in its favor, except the direct evidence of the eggs themselves. The question, then, comes to this: Is it more probable that a law of generation which is found to reach over the whole organic world should have an exception, or that our researches have not yet been able to detect the evidence which would bring this seeming exception also under the law? One after the other, cases which seemed exceptions, have turned out to be none at all; one after the other, the various obscurities have been cleared away, showing one law to be general; and it is therefore the dictate of philosophic caution which suggests that, so long as we remain in positive ignorance of the actual process, we must assume that in this case also the general law prevails.

Positive evidence would of course settle the dispute; but every one who has made any experiments, or has attentively followed the experiments of others, will admit that it is excessively difficult to devise any experiment which shall be conclusive, — the facts elicited admit of such different interpretations, the avenues by which error may enter are so numerous. I will not narrate here the experiments of Fray, Gruithuisen, Burdach, Baer, and others, since they cannot withstand serious discussion; nor will I adduce my own, for the same reason. But those recently made by M. Pouchet have a more imposing character, and demand the strictest examination.

The reader will observe that the cardinal point in the investigation is to be certain that no organic germs could by any possibility be present in the liquid which is to produce the animalcules. On the hypothesis that the animalcules, like other animals and plants, are produced from germs or eggs, these germs must be excessively minute, and easily overlooked. If they exist, it is in the water and the air, awaiting the proper conditions for their development. Supposing them to be floating about in the air, under the form of dust-like particles, they would fall into, or enter, any vessel containing organic matter in a state of decomposition, and there develop; as the deposited eggs of the insect developed in the decaying body of the dog. Now, inasmuch as the presence of atmospheric air is one of the indispensable conditions of vitality, and without it the animalcules could not develop and live, the initial difficulty is how to secure the presence of this air, and yet be sure that the air itself does not bring with it the germs of the animalcules which we find in the liquid. Schultze of Berlin devised an experiment which was thought to have finally settled this point, and to have refuted the hypothesis of spontaneous generation. An account of this experiment, to be found in the *Edin. New Phil. Jour.*, for October 1837, shows that an infusion of organic substances, supplied with atmospheric air, but not with an air containing living germs, was suffered to remain thus from the end of May till the beginning of August; but, during the whole of that time, no plant or animal was developed in the infusion. The apparatus was now removed from the flask, atmospheric air was allowed to enter freely — without first passing through acid or potassa solution — and in three days the infusion was swarming with animalcules.

This really looked like a conclusive experiment. No sooner were measures taken which would destroy the germs, supposed to be suspended in the atmosphere, than the infusion was kept free from animalcules; no sooner was the air allowed to enter the flask in the ordinary manner, than animalcules abounded. The proof did not, however, seem to me quite rigorous. It was by no means clear that the air, in its passage through sulphuric acid, would not suffer some alteration, perhaps electrical, affecting its vital properties; and this doubt seemed confirmed by the experiments of M. Morren, communicated to the French Academy, May 22, 1851; from which it appeared that air, having passed though sulphuric acid, was incompetent to sustain life, since the animalcules subject to it died in a few days. But M. Pouchet announces experiments which, if correct, not only scatter this doubt, and M. Morren's confirmation, but point-blank contradict the experiment of Schultze. He declares that in following Schultze's experiment in every particular, and also in repeating it with fresh precautions, he can constantly exhibit animalcules and plants developed in an infusion in which every organic germ has been previously destroyed, and to which the air has only access after passing through concentrated sulphuric acid, or through a labyrinth of porcelain fragments at red-heat. Nay, M. Pouchet goes further. Feeling the difficulty of satisfying his opponents that the atmospheric air really contained no germs, he determined on substituting artificial air. This he did in conjunction with a chemist, M. Hougeau. Artificial air, as the reader knows, is simply a mixture of twenty-one parts of oxygen gas with seventy-nine parts of nitrogen gas. This air was introduced into a flask containing an infusion of hay, the hay having previously been subjected for twenty minutes to a heat of one hundred degrees Centigrade (two hundred and twelve degrees Fahrenheit), a temperature which would destroy every germ. He thus guarded against the presence of any germs, or animalcules, in the infusion, or in the air. The whole was then hermetically sealed, so that no other air could gain access. In spite of these precautions, cryptogamic plants and animalcules appeared in the infusion. M. Pouchet repeated the experiment with pure oxygen gas, instead of air; and with similar results.

In presence of such statements as these, only two courses were open to the antagonists of spontaneous generation. They could deny or disprove the facts; or they could argue that the precautions taken were not sufficiently rigorous to exclude the presence of germs. I have already said how difficult it is for the modern physiologist to admit spontaneous generation, and the reader will therefore be prepared to hear that M. Pouchet has roused immense opposition; but the opponents have not disputed his facts; one and all, they accept the statements as he makes them, and, by criticism and counter-statement, endeavor to show that spontaneous generation is just as impossible as ever. These criticisms, and M. Pouchet's replies, may here be grouped in order, and with all possible brevity.

Milne-Edwards objected to the conclusions of M. Pouchet, saying: There is no proof that the hay itself had been subjected to the temperature of one hundred degrees Cent. (or the boiling-point of water), it being very probable that although the furnace was at that heat, the hay, which was in a glass vessel and surrounded with air at rest, was not at anything like that temperature.

To this M. Pouchet replied, that he and M. Hougeau ascertained that the hay was at the temperature of one hundred degrees, before they proceeded in their experiments.

Milne-Edwards is ready to grant that the temperature may have been reached, but argues that even that would not suffice for the destruction of all the germs, if they were perfectly dry. He refers to the observations of M. Doyère, which prove that the *Tardigrada* ("water-bears," microscopic animals common in stagnant water), when thoroughly desiccated, preserve their power of reviving even after having been subjected to a temperature of one hundred and forty degrees Centigrade (three hundred and sixteen degrees Fahrenheit). If, therefore, animals of so complex a structure as these water-spiders can resist the action of so high a temperature, there is no reason for supposing that the germs of the simpler animalcules would be destroyed by it. Not content with this argument, which is sufficiently forcible, Milne-Edwards narrates an experiment of his own, which is very similar, both in method and results, to one I have performed. Unhappily, it is an experiment the value of which is either destroyed by the argument just adduced, or else it destroys the argument. It is this: In two tubes a little water containing organic matter is placed, one of them hermetically sealed, the other left open to the air. They are then placed in a bath of boiling water, and kept there till their temperature has reached that point. After this, they are left undisturbed for a few days. In the tube which was exposed to the air, there were animalcules; in the tube which was excluded from the air, before the action of heat had destroyed all the germs, not an animalcule could be seen.

Is not this something like a proof? "Why, no, sir," as Johnson would have said. At least, not if the argument previously urged is worth anything. Because every one will see that if it be true, as Milne-Edwards maintains, that the temperature of boiling water is not by any means high enough to destroy the organic germs of animalcules, then it could not have destroyed those germs in the closed tube, and animalcules ought to have made their appearance there. If I could lay any particular stress on my own experiments (which I do not), they would lead to the conclusion that the organic germs do not resist the action of boiling water; for I found that a piece of fish, divided into three, and placed in boiling water in three different tubes, one closed and excluded from the light, the second closed but exposed to the light, and the third open and exposed to the light, gave me no animalcules at all: had there been any germs in the water or meat, these must have been destroyed. But all such observations go for nothing in the presence of M. Pouchet's assertion that he had found animalcules in the infusion, after subjecting the organic matters to a temperature of two hundred and fifty degrees Centigrade (five hundred and forty-six degrees Fahrenheit), and this, too, with artificial water. Unless the germs are supposed to be incombustible, it is difficult, he says, tó maintain, after this, that the animalcules were developed from germs.

Milne-Edwards being thus disposed of by M. Pouchet, let us see how M. Quatrefages will come off. He says that, having examined the dust remaining on the filter after some observations on rain-water, he found that the organic elements presented a confused assemblage of particles; and this continued to be the case for a few minutes after their immersion in water. But a few hours afterwards, he detected a great number of vegetable spores, infusoria, and those minute, spherical, and ovoid bodies, familiar to microscopists, which inevitably suggest the idea of eggs of extremely small dimensions. He also declares that he has frequently seen monads revive and move about after a few hours of immersion. The conclusion drawn is, that the air transports myriads of dust-like particles, which have only to fall into the water to appear in their true form of animalcules.

The reply of M. Pouchet is crushing. If the air is filled with animalcules and their eggs, they will of course fall into any vessel of water, and as water is their natural element, will there exhibit their vitality. But if half a dozen vessels of distilled water, perfectly free from animalcules, be left exposed to the air, beside one vessel of distilled water containing organic substances in decay, the half dozen will be free from animalcules and eggs, but the one will abound with them. Now, it is perfectly intelligible that, inasmuch as organic matter is said to form the indispensable condition for the development of the eggs, it is only in the vessel containing such matter that the eggs will develop; but why are they not also visible as eggs in the other vessels? why are not the animalcules themselves visible there, as they were in the water examined by M. Quatrefages? If both eggs and animalcules are blown about like dust in the air, it is an immense stretch of credulity to believe they will be blown into the vessel containing organic matter; but the opponents of spontaneous generation go further even than this, for they declare these dust-like animalcules will be blown into a closed vessel, if it contain organic matter, but not into several open vessels, if they only contain distilled water.

M. Quatrefages is on better ground when he rejects the evidence, long supposed to be so weighty, of parasitic animals. He refers to the modern investigations which have not only made the generation of these parasites intelligible, but in many cases have demonstrated it. M. Pouchet's reply is feeble, and unworthy of a physiologist of his eminence. He doubts the truth of the results obtained in Germany, Italy, and Belgium: "the monopoly of which," he adds, "has, by a strange anomaly, belonged to foreigners." Because France has not the honor of this splendid discovery, the Frenchman begs to doubt its value! Every physiologist, however, — not French, — will be ready to admit that whereas the parasitic animals formerly furnished the advocates of Spontaneous Generation with their most striking illustrations, the investigations of Von Siebold, Van Beneden, Küchenmeister, Philippi, and others, have entirely changed the whole aspect of the question, and given the opponents of Spontaneous Generation new grounds for believing that in time all obscurities will be cleared away, all contradictions explained.

In conclusion, I must say, that as far as regards the particular discussion, M. Pouchet seems to me to have the best of it. Their objections to his experiments are all set aside. If the facts are as he states them, — and his antagonists at present do not dispute the facts, — their criticisms go for very little. They have not shown it probable that any germs could have been present, under the conditions stated by him. Are we, then, to accept Spontaneous Generation as proven? By no means. It is very far from proven. The massive preponderance of fact and argument against such an hypothesis forces us to pause long before we accept it. What M. Pouchet has done is to destroy many of the arguments against Spontaneous Generation, and to have devised experiments which may finally lead to a conclusion. It is still on the cards that some source of error, as yet overlooked, vitiates his experiments; but until that error has been detected, he must be considered to have on his side the evidence of experiment, whereas we have on our side the massive evidence of extensive inductions. His experiment may be conclusive, and an exception to the general law will thereby be established. But it may also, on further investigation, turn out to be illusory; some little oversight may be detected, which will rob the experiment of all its force.

Perhaps you will ask why this suspicion should be entertained? Why ought we not to accept M. Pouchet's statement with confidence, although it does contradict our inductions? The reason can only be, that the massive weight of these inductions naturally predisposes the mind to believe that it is more probable the experiment which contradicts them should be misconceived, than that they should be contradicted. Two years ago, I became acquainted with an observation made by Cienkowski, the botanist, which seemed finally to settle this question of Spontaneous Generation, to place the fact beyond doubt, because it caught nature in the act, so to speak, of spontaneously generating. Cienkowski's statement is as follows: If a slice of raw potato be allowed to decompose in a little water, it will be found, after some days, that the starch grains have a peculiar *border*, bearing a strong resemblance to a cell-membrane. This shortly turns out to be a real cell-membrane, and is gradually raised above the starch-grain, which grain then occupies the position of a cell-nucleus. Thus, *out of a grain of starch, a cell has* *been formed under the observer's eye.* Inside this cell, little granular masses are developed, which begin to contract. Finally, minute eel-like animalcules are developed there, which bore their way through the cell-wall into the water.

Funke, in his report of this observation, which, he says, he has verified, asks, how is it possible to deny Spontaneous Generation here? Before our eyes a grain of starch becomes a cell, in that cell are developed living forms, which bore their way out.

The reader will imagine the sensation which such an observation created. He will agree with Funke, as I did, that if the fact were as he stated it, all discussion was at an end. But *was* the fact as stated? I tried in vain to verify it. Not less than twenty separate potatoes were employed, always in conjunction with ordinary starch, as a point of comparison; but although the animalcules were abundant enough, I never could satisfy myself of the first and all-important step, namely, the formation of a cell-wall round the starch-grain. This was the more distressing, because it is at all times unpleasant to be unable to verify an observation, especially one made by a careful and competent observer, and described in precise terms.

I could not reject what Cienkowski had positively affirmed, and Funke positively confirmed, and was willing to suppose that there was some necessary condition in the observation which I had not fulfilled. On the other hand, I could not reject a doctrine on the strength of a fact about which any doubt was permissible. In this state of suspense, I had the satisfaction of hearing from Professor Naegeli, the celebrated microscopist, that he too had been baffled at first in the attempt to verify this observation; but that, after nearly a hundred trials, he had succeeded. He positively confirmed all the statements Cienkowski had made. But, from that moment, my suspense vanished. If the phenomenon was of such rare occurrence, there were reasons for suspecting some other explanation than that of Spontaneous Generation. What the source of the error was, might not be easily divined; but it seemed very probable that error had crept in somewhere.

In a late number of the *Annales des Sciences Naturelles* (x. 140), there is a note which clears up the whole mystery. Cienkowski has himself discovered the source of his own error. The membrane which seemed to form itself round the starch-grain has had quite another origin. He has observed the little monads swimming about, and has noticed one of them *adhere to a starch-grain, spread its elastic body round it, and finally envelop it, as the Amœba wraps itself round its food.* This explains how the starch-grain comes to be inside a cell; and as this process was never suspected, and the starch-grain was seen with a cell-wall, the idea of natural formation was inevitable, the more so as the wall seemed to grow larger and larger.

Thus has even this, the most striking case in favor of Spontaneous Generation ever adduced, been finally cleared up; and the reader will probably agree in the conclusion to which the whole of the facts advanced in this paper lead, namely, that the Law of Generation is universal; the exceptions which have been hitherto urged, have, one by one, been found to be no exceptions; and the presumption is, that even M. Pouchet's cases will be likewise explained. It is quite *possible* that the generation of animalcules may take place spontaneously; but, although possible, it is not probable, and certainly is not proven.

In addition to the above communication by Mr. Lewes, the following remarks by M. Dumas, before the French Academy, on the subject of M. Pouchet's views, are given in *Silliman's Journal*, No. 82.

For thirty years he had had the question under examination, and had experimented on the subject. In these experiments he had assured himself that organized matter heated to 120° or 130° C., with water artificially made by means of hydrogen and oxide of copper, and with artificial air in closed tubes, the glass of which had been recently heated to a red-heat, produced neither vegetation nor animalcules. On opening these tubes, and allowing ordinary air to enter, there was soon an appearance of vegetation and animalcules. These results had surprised him, as he was disposed to think that the germs of these plants and animalcules might be distributed in the organized matter as well as in the air itself, and that certain of these germs might well be of a nature to resist a temperature of 100° C., or even a higher temperature.

As the Tardigrades,* when absolutely dry, resist 140° C., and the sporules of *Oidium aurantiacum* 100° C. in a moist medium, it will not suffice, in order to establish the hypothesis of spontaneous generation, that living beings should sometimes appear in boiling water, in contact with artificial air and with the presence of organic matters that had before been heated, especially if these matters were heated when dry. When, among these inferior animals and plants, life is suspended by absolute desiccation to return to action again on a return of humidity, the being so treated is in that state of latent animation which belongs to germs. It is hence a matter of astonishment that on putting heated organic matters into connection with oxygen and artificial water, we do not sometimes find living beings to appear Even such an observation as this would not therefore suffice to establish the theory of spontaneous generation, or prove that the germs of these beings were not previously deposited in the organic matters employed. But, in fact, whilst animalcules appear when the ordinary air has access, without this access, under the precautions mentioned, they do not appear.

On the same occasion, M. Claude Bernard also made the following statement:

Among a large number of experiments which I have made to ascertain the influence of saccharine substances in liquids where microscopic vegetation was developed, I will cite one, as it bears directly on this subject of spontaneous generation now under discussion.

On the 1st of September, 1857, I put into two glass flasks, each half a litre in capacity, about fifty cubic centimetres of a same dilute solution of gelatine in water, to which some thousandths of cane-sugar had been added. The liquid was then kept boiling in the two flasks for a quarter of an hour, the tubular neck of each having been previously drawn out, so that it could easily be sealed. Up to this point there was no difference between the flasks. Now, when the flasks were still boiling, and filled with steam, a difference was begun, by allowing ordinary air to enter one, and highly heated air the other. To accomplish this, while ebullition was going on, the neck of one of the flasks was connected with one of the extremities of a porcelain tube filled with fragments of porcelain, and brought up to a red-heat by a furnace; at the other extremity, the porcelain tube was terminated in a glass tube of fine bore, so that the air should enter gradually, and pass very slowly over the red-hot porcelain. Thus situated, the vapor of the liquid in

* The Tardigrade animalcules, are minute, worm-shape animals, about a fortieth of an inch in length, belonging to the Rotatoria of Ehrenberg, and therefore much higher in structure than the ordinary Infusoria.

ebullition rose into and filled the porcelain tube, and even passed out at the end of the fine tube. The lamp was then removed to arrest the ebullition; and by degrees the steam was condensed, and the outside air (air of the laboratory,) entered to take its place, passing through the red-hot porcelain tube above described. After the liquid had cooled, the flask was hermetically sealed at the neck.

The other flask was allowed to cool without any connection with the porcelain tube, and the atmospheric air entered freely. When the flask was cooled, it was sealed like the other.

The two flasks were then placed on the same conditions, exposed to the light and to the ordinary temperature. After ten or twelve days, at the surface of the flask containing the ordinary air, vegetation was visible — a well characterized mould; whilst in that which had received the heated air, the liquid remained perfectly limpid, and without anything on its surface. After a month, the mould had much increased in the former, while nothing had appeared in the latter, except that the water had slightly lost its clearness. After six months (March 4, 1858), the mould remained stationary in the former, while in the other the liquid continued the same, without any trace of mould. The extremities of the two flasks were now broken under mercury. In the case of the one with heated air, considerable mercury was absorbed, but none in the other. The air of the two flasks being analyzed, no oxygen was found in either. The air from the flask with ordinary air contained 13·48 per cent. of carbonic acid; that of the other, in which no mould had formed, 12·43 per cent. The liquid of the flask with ordinary air had a putrid and very disagreeable odor, while the other had none. M. Montagne, on examining these liquids, ascertained that the mould developed in the flask with ordinary air was the *Penecillium glaucum*, which was in full fructification; in the other he found no trace of any vegetable or animal organism.

The following note, on this subject of spontaneous generation, has also been published by Prof. Dana, of New Haven.

1. There is a well-known principle in the system of nature that deserves to be considered in this connection. The principle is so fully sustained by all research, both in chemistry and zoölogy, including the important experiments above mentioned, that it may well carry with it great weight, and quiet both apprehension and expectation on this subject. It is this: The forces in life and inorganic nature act in opposite directions, — the former *upward*, the latter *downward*.

The vital force, in the organic substances it forms, *ascends* through vegetable and animal life to an exalted height in the scale of compounds at an extreme remove from saturation with oxygen; inorganic force *descends* towards the saturated oxide. The former reaches a point which from its very elevation is one of great *instability;* the latter tends towards one of perfect *stability.* There is hence a counterpart or cyclical relation between the two great lines of action in nature.

As some readers of these remarks may not be familiar with chemistry, a further word of explanation is added.

When an element unites with its full allowance of oxygen, as determined by its affinities, it is in a sense saturated with it. Since the attraction of the elements for oxygen is the most universal, and, in general, the strongest in nature, the oxides as a class are the most stable of compounds; the rocks, the earth's foundations, are made of them. But evanescence and unceasing change are in the fundamental idea of the living structure; and, consequently, the material of the plant or animal contains only oxygen enough to give increased stability to the combination. Moreover, the compounds augment in instability, through this and other ways, with the rise in the grade of organic life, and reach probably their farthest extreme in this respect in the brain. Here, then, is the summit of the series of compounds which arise under the agency of life. The stable oxide is at the lower end of the series in nature, the material of the brain at the upper. Passing from the latter condition towards the former, is therefore a real descent; and it is the natural downward course of inorganic forces; while passing towards the latter is as truly an ascent; it is the counter-movement of life.

The plant through its vital functions may take carbonic acid, and from it continue to elaborate the organic products constituting vegetable fibre, until a whole tree of such material is made, and then produce the higher material of the flower and seed. The animal may then go to the plants and use them in making a still higher class of products, muscular fibre and nerve. After all this is done, now turn over the material to the action of chemical and physical forces, and the work of years of life is soon pulled down from its height, and one part after another descends towards that state of comparative inactivity, the condition of an oxide. Chemistry makes organic products by commencing with those of a higher grade than the kind to be made, but not otherwise. Albumen is a prominent material of the egg; and chemistry has not succeeded in making dead albumen, much less living.

The very relation of life to chemistry is therefore evidence that chemistry cannot make life; it works in just the reverse direction. And in this reciprocal relation one of the profoundest laws of nature is exhibited. It leads the mind to recognize one author for both, and not to imagine that one side in the cycle has generated the other.

2. There is another consideration, which, if it has not the force of demonstration, may help the mind to understand the extent of the transition from dead matter to living.

(*a*) In ordinary *inorganic* composition, there is the simple formation of inorganic particles, and, on consolidation, their aggregation into crystals, the perfect individuals of inorganic nature. With the enlargement of the crystal there is no gain of new powers or qualities: it simply exists. In fact, in entering this state of perfection, there is *a loss of latent force;* for the gas is the highest condition of stored or magazined force in inorganic nature, the liquid the next, and the solid the lowest, — this condition of power being related directly to the amount of heat.

(*b*) The *plant* grows from its germ, enlarges, accumulates force, storing it away in vegetable fibre, and accomplishes its highest functions in its blossoms and fruit. But there is here only *latent or stored force* generated, besides that which is used up in growth, and *no mechanical* force. The minute spore or reproductive cellule of some seaweeds has locomotive power, but it is lost at the commencement of germination; and the plant is ever after as incapable of self-locomotion as a rock.

(*c*) In the *animal*, there is not only a storing of force in animal products (the fifth and highest grade of stored force in nature), but there is also increasing *mechanical* force from the first beginning of development. It is almost or quite zero in the germ; but from this, it goes on increasing, until, in the horse, it gets to be a one-horse power; or in the ant, a one-ant power; and so for each species. And in addition to mechanical force, there is, in the higher group, the more exalted *mental force;* for the mind, while not itself material, is yet so dependent on the material, that its action draws deeply upon the energies of the body. To make an animal germ is, then, to make a particle of albuminoid substance that will grow and spontaneously develop a powerful piece of enginery, and continue a system of such generations through ages of reproduction. The creation of any such animal germ out of dead carbon, nitrogen, hydrogen, and oxygen, or any of their dead compounds, is therefore opposed to all known action or law of chemical forces; and as much so, the creation of a vegetable germ from inorganic elements. Moreover, it is seen that the two kingdoms, the vegetable and animal, have their specific limits and comprehensive reciprocal relations, and are obviously embraced as parts of one idea in a single primal plan:—not a plan involving the generation of one out of the other, or of either out of inorganic nature, but of the three, through some Creating Power higher than all.

ON APPARENT EQUIVOCAL GENERATION.

Mr. H. J. Clark, of Cambridge, in a communication to the American Academy, Boston, May 10, 1859, states that he has been fortunate in discovering the origin of several forms of these pseudo-animate bodies called Infusoria. Whilst watching the decomposition of the inner wall of the proboscis of a young *Aurelia flavidula*, our common jelly-fish, I observed that the whole component mass of cells was in violent agitation, each cell dancing zigzag about within the plane of the wall. If any one will shake about a single layer of shot in a flat pan, he can obtain an approximate idea of the appearance of this moving mass. In a perfectly healthy condition, these cells lie closely side by side, and do not move individually from place to place, but yet are active on one side, which constitutes the surface of the stomach, where they are covered by vibratile cilia. As the young Aurelia grows, this wall becomes separated from the outer one, but not completely, for the cells of the two adhere to each by elongated processes varying in number from one to six or seven. Each cell of the inner wall contains numerous red or brown granules, a few transparent globules, and a single large, clear mesoblast. When decomposition ensued, these cells became still farther separated from each other, and danced about in the manner which I have just described. The vibratile cilia were not observed to share in this movement; in fact, I could not detect their presence, because, no doubt, they had become decomposed and fallen away; but the elongated processes, which heretofore had remained immovable and stiff, lashed about with very marked effect upon the cells to which they belonged, and caused them to change place constantly. At last the inner wall fell to pieces, and every cell moved independently, and in any direction. If at this time they were placed before the eyes of Ehrenberg, or any one of his adherents, he would at once pronounce every cell with a single process a *Monas;* the red or brown granules would be recognized as the stomachs filled with food, the transparent globules as the empty stomachs, and the large mesoblast as the genital organ or propagative apparatus. Those with two processes would be to him a *Chilomonas*, or some other genus closely related to it; those with three or four on one side would be the *Oxyrrhis* of Dujardin; and those with six or seven processes the *Hexamita* of the same author. To complete the apparently truthful determinations of these microscopists, I would only have to place before them some of these cells which I have found in a state of self-division, each half possessing its genital-like mesoblast. In all their various shapes and actions, and in the mode of self-division, there is a remarkable and undistinguishable resemblance to numerous moving bodies which go under the name of Infusoria, and which may be found, unconnected with any living organism, in various kinds of infusions.

ON THE ORIGIN OF THE VIBRIO.

The following paper has been communicated to the American Academy by H. J. Clark, of Cambridge:

In connection with Pouchet's revival of the doctrine of equivocal or spontaneous generation, a discovery made by me may not be uninteresting, as it has more or less relations in its nature to his theory. There are certain well-known bodies, described as animals by Ehrenberg, under the name of *vibrio;* their peculiarity consists in that they are composed of a single row of globular bodies, resembling a string of beads, more or less curved, and move in a spiral path with great velocity, even faster than the eye can follow in many cases. They exhibit, by their activity, more plausible signs of animality than any of the Desmideæ or Diatomaceæ, and fully as convincing indications of life as the spores of Algæ, to which they were first referred by the late Dr. W. I. Burnet, and after him by Rudolph Wagner and Leuckart. They have always been spoken of as developing around decaying animal and vegetable matter. I was very much surprised to discover the manner in which they originate from such substances. I was studying the decomposing muscle of a Sagitta, a little crustacean, as I consider it, when I noticed large numbers of Vibrio, darting hither and thither, but most frequently swarming about the muscular fibres. I was struck with the similarity of these bead-like strings to the fibrillæ of the muscle; and, upon close comparison, I found that the former were exactly of the same size, and had the same optical properties as the latter. Some of these appeared to be attached to the ends of the flat, ribbon-like fibres, and others at times loosened themselves and swam away. I was immediately impressed with the daring thought, that these vibrios were the fibrillæ set loose from the fibres; but as this was a thing unheard of, and so startling, I for the time persuaded myself that they must have been accidentally attached and subsequently loosened. However, I continued my observation until I found some fibres in which the fibrillæ were in all stages of decomposition. At one end of the fibre the ultimate cellules of the fibrillæ were so closely united, that only the longitudinal and transverse striæ were visible; further along, the cellules were singly visible; and still further, they had assumed a globular shape; next, the transverse rows were loosened from each other excepting at one end; and finally, those at the extreme end of the fibre were agitated, and waved to and fro, as if to get loose, which they did from time to time, and, assuming a curved form, revolved each upon its axis, and swam away with amazing velocity. There was no doubting, after this, the identity of the vibrios and the muscular fibrillæ; but I thought such a strange phenomenon ought to have a second witness to vouch for it, and therefore went for the best that could be wished for, Prof. Agassiz. I simply placed the preparations before him, and, without giving him the least hint of the origin of the muscle, I was pleased to have him rediscover what I had seen but fifteen minutes before.

The number of ultimate cellules in a moving string varied from two to fifty; the greatest number of strings were composed of only three or four, often six to eight, and rarely as high as fifty. Very rarely the fibres split longitudinally, and in such instances the fibrillæ were most frequently long, and moved about with undulations rather than a wriggling motion. A single ultimate cellule, when set loose, danced about in a zigzag manner; but whenever two were combined, the motion had a definite direction, which corresponded to the longer diameter of the duplicate combination; and if only three were combined, the spiral motion was the result of their united action. What it is that causes these cellules to move, I do not profess to know; but certainly it is not because they possess life as independent beings. This much is settled, however, that we may have presented to us all the phenomena of life, as exhibited by the activity of the lowest forms of animals and plants, by the ultimate cellules of the decomposed and fetid striated muscle of a Sagitta. I do not pretend to say that everything that comes under the name of Vibrio and Spirillum it a decomposed muscle or other tissue, although I believe such will turn out to be the fact; but this much I will vouch for, and will call on Prof. Agassiz to witness, that what would be declared, by competent authority, to be a living being, and accounted a certain species of vibrio, is nothing but absolutely dead muscle.

ON THE LOWEST (RHIZOPOD) TYPE OF ANIMAL LIFE, CONSIDERED IN ITS RELATIONS TO PHYSIOLOGY, GEOLOGY, AND ZOOLOGY.

The following is an abstract of a lecture on the above subject, recently given before the Royal Institution, London, by Prof. Carpenter:

Among the unexpected revelations which the modern improved microscope has made to the scientific investigator, there is, perhaps, none more fertile in interest than that which relates to the very lowest type of animal existence; from the study of which both the physiologist and the zoologist may draw the most instructive lessons, whilst the geologist finds in it the key to the existence of various stratified deposits of no mean importance, both in extent and thickness. Though the doctrines of Professor Ehrenberg as to the complexity of organization possessed by the minutest forms of animalcules, have now been rejected by the concurrent voice of the most competent observers, working with the best instruments, yet the wonders of animalcular life are not in the least diminished by this repudiation of them. Indeed, as great and small are merely relative terms, it may be questioned whether the marvel of a complex structure comprised within the narrowest space we can conceive, is really so great as that of finding those operations of life we are accustomed to see carried on by an elaborate apparatus, performed without any instruments whatever; a little particle of apparently homogeneous jelly changing itself into a greater variety of forms than the fabled Proteus, laying hold of its food without members, swallowing it without a mouth, digesting it without a stomach, appropriating its nutritious material without absorbent vessels or a circulating system, moving from place to place without muscles, feeling (if it has any power to do so) without nerves, multiplying itself without eggs; and not only this, but in many instances forming shelly coverings of a symmetry and completeness not surpassed by those of any testaceous animals. As examples of this type of existence, the *Amœba* and *Actinophrys* were first described; and it was then pointed out that the only recognizable characters by which such beings are distinguishable as animals from vegetable organisms of equal simplicity, are to be found in the nature of their aliment, and in the method of its introduction. For whilst the *protophyte* obtains the materials of its nutrition from the air and moisture that surround it, and possesses the power of detaching oxygen, hydrogen, carbon, and nitrogen from their previous binary compounds, and of uniting them into ternary and quarternary organic compounds (chlorophyll, starch, albumen, etc.), the simplest *protozoon*, in common with the highest members of the animal kingdom, seems utterly destitute of any such power, and depends for its support upon organic substances previously elaborated by other living beings. Further, whilst the protophyte obtains its nutriment by simple imbibition, the protozoon, though destitute of any proper stomach, extemporizes, as it were, a stomach for itself in the substance of its body, into which it ingests the solid particles that constitute its food, and within which it subjects them to a regular process of digestion. Hence these simplest members of the two kingdoms, which can scarcely be distinguished from each other by any *structural* characters, seem to be *physiologically* separable by the mode in which they perform those actions wherein their life most essentially consists. The general character of the group of marine rhizopods, commonly termed *Foraminifera*, was next described; and the lecturer dwelt much on the importance of making great allowance, in the systematic arrangement of their forms, for the very wide range of variation that may present itself within the limits of one and the same specific type. It is very easy to select from any extensive collection of Foraminifera, recent or fossil, sets of forms having certain characters in common, but yet so dissimilar in other respects, that few naturalists would have any doubt as to their specific, or even generic, distinctness; yet, when the collection is thoroughly examined, such a series of intermediate forms is found to exist as connects all these by gradations so insensible as to prevent the possibility of any line of demarcation being satisfactorily drawn between them. Remarkable illustrations of this principle were adduced, not only from the lecturer's own researches, but from Prof. Williamson and Mr. W. K. Parker, on the groups which they have particularly studied; so that it would appear as if this type of animal existence were specially characterized by its tendency to such variations. And this will seem the more probable, when it is considered how little of definiteness there is in the form and structure of the sarcode-body that forms the shell; so that the wonder is, not that there should be a wide range of variation both in the form and in plan of growth of the aggregate body, and in the mode of communication of the individual segments, but that there should be any regularity or constancy whatever. But it is only in the *degree* of this range that this group differs from others; and the main principle, which must be taken as the basis of its systematic arrangement, — that of ascertaining the range of specific variation by an extensive comparison of individual forms, — is one which finds its application in every department of natural history, and is now recognized and acted on by all the most eminent zoölogists and botanists. There are still too many, however, who are far too ready to establish new species upon variations of the most trivial character, without taking the pains to establish the value of these differences, by ascertaining their constancy through an extensive series of individuals, — thus, as was well said by the late Prince of Canino, "describing specimens instead of species," and burdening science not only with a useless nomenclature, but with a mass of false assertions. It should be borne in mind that every one who thus makes a bad species, is really doing a serious detriment to science; whilst every one who proves the identity of species previously accounted distinct, is contributing towards its simplification, and is, therefore, one of its truest benefactors. Having noticed some of the most interesting physiological and zoölogical considerations which connect themselves with the study of this group, the lecturer alluded, in the last place, to its geological importance. Traces, more or less abundant, of the existence of Foraminifera, are to be found in calcareous rocks of nearly all geological periods; but it is towards the end of the Secondary, and at the beginning of the Tertiary period, that the development of this group seems to have obtained its maximum. Although there can be no reasonable doubt that the formation of chalk is partly due to the disintegration of corals and larger shells, yet it cannot be questioned that in many localities a very large proportion of its mass has been formed by the slow accumulation of foraminiferous shells, sometimes preserved entire, sometimes fragmentary, and sometimes almost entirely disintegrated. The most extraordinary manifestation of this type of life, however, presents itself in the nummulitic limestone, which may be traced from the region of the Pyrenees, through that of the Alps and Apennines, into Asia Minor, and again through Northern Africa and Egypt, into Arabia, Persia, and Northern India, and thence (it is believed) through Thibet and China, to the Pacific, covering very extensive areas, and attaining a thickness in some places of many thousand feet; another extensive tract of this nummulitic limestone is found in the United States. A similar formation, of less extent but of great importance, occurs in the Paris basin; and it is not a little remarkable that the fine-grained and easily-worked limestone, which affords such an excellent material for the decorated buildings of the French metropolis, is entirely formed of an accumulation of minute foraminiferous shells. Even in the nummulitic limestone, the matrix in which the nummulites are imbedded, is itself composed of minute Foraminifera, and of the comminuted fragments of larger ones. The remarkable discovery has been recently made by Professor Ehrenberg, that the green and ferruginous sands which present themselves in various stratified deposits, from the Silurian to the Tertiary epoch, but which are especially abundant in the Cretaceous period, are chiefly composed of *casts* of the interior of minute shells of Foraminifera and Mollusca, the shells themselves having entirely disappeared. The material of these casts, which is chiefly silex, colored by silicate of iron, has not merely filled the chambers and their communicating passages, but has also penetrated, even to its minutest ramifications, that system of interseptal canals, whose existence, first discovered by Dr. C. in nummulites, has been detected also in many recent Foraminifera, allied to these in general plan of structure. And it is a very interesting pendant to this discovery, that a like process has been shown, by Professor Bailey, to be at present going on over various parts of the sea bottom of the Gulf of Mexico and the Gulf Stream, — casts of Foraminifera in greensand being brought up in soundings with living specimens of the same types.

ON SOME UNUSUAL MODES OF GESTATION.

The following is an abstract of a paper communicated by Dr. Jeffries Wyman to the Boston Society of Natural History (see Proc. Sept. 1857), on some unusual modes of gestation, which have been made by him the subject of personal observation.

Among Batrachians, the circumstances under which the young are developed, though less varied than in some of the other classes of vertebrates, still present a considerable range. By most species the eggs are deposited in the water either upon aquatic plants or on the bottoms; by others, as in *Salamandra erythronota*, they are laid in damp places under logs or stones; with some the evolution of the embryo commences a short time previous to the laying of the egg, and is completed subsequently, while there are other species which are wholly viviparous.

The most remarkable deviations from the ordinary modes are to be found in those instances in which the eggs, after being laid, are brought into a more or less intimate relation with the parent, as in the "Swamp toads" (*Pipa Americana*) of Guiana, where each ovum is deposited in a sac by itself on the back of the female; in *Notodelphys* of Venezuela, where all the eggs are lodged in one large sac, also on the back, and is analogous to the pouch of the Marsupials, and in *Alytes*, the "Obstetric toad" of Europe, where the eggs are wound in strings around the legs of the male, who takes care of them until they hatch.

The species, the habits of which are noticed below, and which, in so far as I have been able to learn, have not attracted the attention of naturalists, adds another to the series just mentioned, though the relation of the fœtus to the parent becomes less intimate than in any of the preceding cases.

Hylodes lineatus (Dum. and Bib.) is very common in Dutch Guiana, and its peculiar habits are well known to the colonists.

In the month of May, 1857, during an excursion to the country inhabited by the Bush negroes, above Sara Creek on the upper Surinam River, I had an opportunity, for the first time, of seeing these animals carrying their young, and subsequently collected several specimens. In one instance the larvæ were retained permanently adherent to the back of the parent, in consequence of the coagulation of the mucus covering the surface of the body, and are still preserved in the Academy of Comparative Anatomy at Cambridge. The young, from twelve to twenty in number, were also collected upon the back of the mother, their heads directed towards the middle line. They were about three-fourths of an inch in length. No limbs were developed, and no special organ was found to aid them in adhering to the back of the parent. The adhesion may have been effected by the mouth; and this is rendered probable by the fact that all of them had the month in contact, either with the skin of the parent or with that of another larva. A viscid mucus covering the integuments, undoubtedly assisted in some measure to bring about the same results. However this may be, they retained their places perfectly well, and were not displaced when the mother, closely pursued, carried them through the grass.

On dissection of the young, nothing was found materially different to conditions of the larvæ of other anousa. Gills had disappeared, but were replaced by internal ones, which were arranged as usual on three hyoid arches. The development of the lungs had commenced, and these were represented by a slender conical mass of cells, but not permeable to air. The mouth was provided with finely denticulated horny jaws, and the intestinal canal was shorter and less spirally convoluted than in ordinary larvæ of frogs and toads. The stomach was not so much developed as to be distinguished from the rest of the intestine; but this last, after passing the liver, was somewhat dilated, and contained, as was shown by the microscope, large quantities of yolk-cells, which had not been absorbed, and which were adherent to its walls.

We have here, then, a larva, in all the details of its structure, especially in the existence of gills and of a flattened tail, adapted to aquatic locomotion and respiration, yet passing a portion of its time at least on the back of its parent, and at a distance from the water.

I was not able to ascertain whether the eggs were primarily deposited in the water or not; but it is well known to some of the colonists, that after the larvæ have reached a certain degree of development, they are carried about in the manner just described, and they do not know them under any other circumstances. The existence of yolk-cells in the intestine shows that, for a period at least, they may have from these a supply of nutriment. But after this is exhausted, and it appeared to be nearly so in those which I have dissected, how do they obtain their food? In the absence of limbs adapted to terrestrial locomotion, can they leave the body of the parent? and if they cannot, do they, as in the case of Pipa and probably in Notodelphys, depend upon a secretion from her?

Among fishes, as far as at present known, the external conditions under which the eggs are developed, are more varied than in any other class of vertebrates. There are scarce any known conditions of the higher classes to which there are not analogies at least in the class of fishes. Besides the ordinary mode of depositing eggs upon the bottoms, some of the Salmonidæ, like the turtles, bury their eggs, the Lampreys (*Petromyzon*), the Breams (*Pomotis*), the Hassars (*Callicthys*), the Stickle-backs (*Gasterostei*), etc., build more or less complete nests. Among some of the Pipe fishes (*Syngnathidæ*) the eggs, and subsequently the young, are carried in a pouch analogous to that of the opossums and other marsupial animals; and among some of the Sharks there is a vitelline placenta, analogous to the Allantoidian, one of the Mammalia.

Among the Siluroid fishes of Guiana, there are several species which, at several seasons of the year, have their mouths and branchial cavities filled with eggs or young, as is believed, for the purpose of incubation. The phenomena, which, when first stated to me by Dr. Cragin, of Surinam, seemed improbable, I found on visiting the market of Paramaribo, in 1857, to be correct. In a tray of fish which a negro woman offered for sale, I found the mouths of several filled with either eggs or young, and subsequently an abundance of opportunities occurred for repeating the observation. The kinds most commonly known to the colonists, especially to the negroes, are *Jara-Bakka*, *Njinge-njinge*, *Koepra*, *Makrede*, and one or two others, all belonging either to the genus Bagrus, or one nearly allied to it. The first two are quite common in the market, and I have seen many specimens of them; for the last two I have the authority of negro fishermen, but have never seen them myself. The eggs in my collection are of three different sizes, indicating so many species; one of the three having been brought to me without the fish from which they were taken.

The eggs become quite large before they leave the ovaries, and are arranged in three zones, corresponding to three successive broods, and probably to be discharged in three successive years; the mature eggs of a Jara-bakka eighteen inches long, measured three-fourths of an inch in diameter, those of the second zone one-fourth, and those of the third are very minute, about one-sixteenth of an inch.

A careful examination of eight specimens of Njinge-njinge, about nine inches long, gave the following results: The eggs in all instances were carried in the mouths of the males. This protection, or gestation of the eggs by the males, corresponds with what has been long noticed with regard to other fishes, as, for example, Syngnathus, where the marsupial pouch for the eggs or young is found in the males only, and Gasterosteus, where the male constructs the nest and protects the eggs, during incubation, from the voracity of the females. In some individuals the eggs had been recently laid, in others they were hatched, and the fœtus had grown at the expense of some other food than that derived from the yolk, as this last was not proportionately diminished in size, and the fœtus weighed more than the undeveloped egg. The number of eggs contained in the mouth was between twenty and thirty. The mouth and bronchial cavity were very much distended, rounding out, and distorting the whole hyoid and bronchiostegal region. Some of the eggs even partially protruded from the mouth. The ova were not bruised or torn, as if they had been bitten, or forcibly held by the teeth. In many instances the fœtuses were still alive, though the parent had been dead for many hours. No young or eggs were found in the stomach, although the mouth was crammed to its fullest capacity.

The above observations apply to Njinge-njinge. With regard to Jarabakka, I had but few opportunities for dissection, but in several instances the same conditions of the eggs were noticed as stated above; and in one instance, besides some nearly mature fœtuses contained in the mouth, two or three were squeezed apparently from the stomach; but not bearing any marks of violence, or of the action of the gastric fluid. It is probable that these found their way into that last cavity after death, in consequence of the relaxation of the sphincter which separates the cavities of the mouth and the stomach. These facts lead to the conclusion that this is a mouth gestation, as the eggs are found there in all stages of development, and even for some time after they are hatched.

The question will be naturally asked, how, under such circumstances, the fishes are able to secure and swallow their food. I have made no observations bearing on such a question. Unless the food consists of very minute particles, it would seem necessary that, during the time of feeding, the eggs should be disgorged. If this supposition is true, it would give a very probable explanation of the only fact which might be considered at variance with the conclusion stated above, viz., that we have in these fishes a mouth gestation. In the mass of eggs with which the mouth is filled, I have occasionally found the eggs, rarely more than one or two, of another species. The only way in which their presence may be accounted for, it seems to me, is by the supposition that, while feeding, the eggs are disgorged; and as these fishes are gregarious in their habits, when the ova are recovered, the stray egg of another species may be introduced into the mouth, among those which naturally belong to them.

CURIOUS FACT IN REPRODUCTION.

M. Von Siebold, in his recent work on parthenogenesis, states, among other extraordinary theories relative to the generation of bees and other insects, that the drones, or male bees, are invariably produced from eggs laid by unimpregnated females.

ASTRONOMY AND METEOROLOGY.

NEW PLANETS.

The fifty-seventh asteroid was discovered by M. Luther of Bilk, on the evening of Sept. 22, 1859. It has received the name *Mnemosyne.*

The asteroid discovered Sept. 10, 1858, by M. Goldschmidt, at Paris, has been named *Alexandra*, and is numbered as the fifty-fourth of the series. The asteroid discovered on the same night, by Mr. George Searle, at Albany, N. Y., has been named *Pandora*, and is numbered the fifty-fifth. In 1857, Mr. E. Schubert, of Washington, undertook a series of observations of the asteroid *Daphne.* On computing his observations, he was surprised to discover that he had not found Daphne, but had observed for it a new asteroid in the neighborhood. He has computed its elements, and it is to be hoped that the body will be redetected.

Numbering of the Planetoids, or Asteroidal Planets. — In numbering the planetoids, a difficulty has arisen from the fact, discovered by Mr. Schubert, that the planetoid detected by M. Goldschmidt, Sept. 9, 1857, and mistaken for *Daphne*, is undoubtedly a different body. In the *Annuaire* for 1859 of the French Board of Longitude, the planetoid detected Sept. 9, 1857, is numbered (47), and the numbers of all those subsequently discovered is increased by *one.* M. Leverrier objects to this proceeding, on account of the confusion which it occasions, and maintains that the planetoid of Sept. 9, 1857, should be numbered (56).

Which plan will finally be adopted by astronomers, remains to be seen. We incline to that of the Annuaire, as strictly conformed to the old rule of numbering in the order of discovery, and as likely, on the whole, to produce the least confusion. — *Silliman's Journal, July,* 1859.

Supposed new Planetary Bodies between Mercury and the Sun. — At a session of the French Academy, Sept. 1859, a paper was presented from M. Leverrier, on the subject of certain unaccountable discrepancies between the observations of the transits of Mercury over the disk of the sun, and the results of calculation. The facts are as follows: The theory of the sun having been carefully revised, and compared with the results of 9000 observations of that body taken at various observatories, the motion of Mercury had in its turn to be revised. Now, there are twenty-one observations of the inner contacts of Mercury's disk with that of the sun, taken within a period of 151 years, viz., between 1697 and 1848, and all reliable; yet in these transits there appears to be a progressive error, which amounts to as much as nine seconds of an arc in 1753. Now, can it be supposed, to explain such a constantly repeated divergence, that such men as Lalande, Cassini, Bouguer, etc., should have committed mistakes amounting to several minutes of time, and mistakes, too, progressively varying from one period to another? This would be absolutely impossible. But there is another curious circumstance, viz., that by increasing the secular motion of the perihelion by thirty-eight seconds, all the above observations are found to be correct to a second, and in some cases even to half a second! M. Leverrier then proceeds to show, that in order to explain this addition of thirty-eight seconds, we should have to increase the mass attributed to Venus by one-tenth of its amount. This mass, calculated to be the 400,000th part of that of the sun, has been however found, by other calculations, rather too large, so that increasing it is out of the question. Hence M. Leverrier concludes that the excess of the motion of Mercury's perihelion must be owing to some other cause as yet unknown to us, and this cause he supposes to be either a new planet, or a series of small bodies circulating between the sun and Mercury.

M. Faye, in commenting on this important communication, suggested that all the astronomers of Europe should now direct their attention to the smallest spots on the disk of the sun, in order to discover whether there were among them any minute planetary bodies which had hitherto escaped observation. Such bodies had often been looked after without success; but this proved nothing, such researches having been made at mere hazard; now, however, there were serious grounds for repeating such attempts, and total eclipses would be the most advantageous periods for observing any minute body in the immediate vicinity of the sun. A total eclipse, he added, would be visible in Spain and Algeria in July next. Suppose an astronomer at Campvey, for instance, to prepare himself exclusively for such an observation, neglecting everything else relating to the eclipse; if a quarter of an hour before the proper time he remained in a dark room, in order to guard his eyes from the dazzling influence of the solar rays, whose effects continue for several minutes, and cause vision to be indistinct at the decisive moment, he might, as soon as the eclipse has reached its maximum, observe the heavens with the greatest accuracy, and perhaps discover what had hitherto escaped notice under less favorable circumstances.

Mr. E. C. Herrick, of New Haven, in a note communicated to *Silliman's Journal* for Nov. 1859, says: In this connection it may be worth while to state that there are already on record observations which make it highly probable that there exists an intra-Mercurial planet with a satellite. Wartmann reports (*Bibl. Univ.* Avr. 1837, p. 400; *Quetelet: Corr. Math. et Phys.*, Aug. 1837, p. 141) that Pastorff, of Buchholz, an attentive observer of the solar spots, saw twice in 1836, and once in 1837, two round black spots of unequal size, moving across the sun, changing their place rapidly, and pursuing each time routes somewhat different. He found that the two bodies observed Oct. 18, 1836, traversed an arc of $12'$ from $2^h\ 20^m$ to $3^h\ 12^m$; that the two observed Nov. 1, from $2^h\ 48^m$ to $3^h\ 42^m$ traversed in this time an arc of $6'$; and that the two observed Feb. 16, 1837, traversed an arc of $14'$, between $3^h\ 40^m$ and $4^h\ 10^m$. In 1834, Pastorff saw two similar bodies pass six times across the disk of the sun (*Bib. Univ.*, t. 58). The larger was about $3''$ in diameter, and the smaller $1''$ $1''\cdot25$. Both appeared perfectly round. Sometimes the smaller preceded the larger, sometimes the contrary. The greatest observed distance between them was $1'\ 16''$.. The bodies were often very near each other, and their transit then occupied only a few hours. They had the appearance of a dull black spot, like that of Mercury in its transits.

On further search, the following statements were found, which may perhaps bear on the case. Flaugergues mentions (*De Zach: Corresp. Astron.*, vol. 13, p. 17, 1825) that Pastorff saw *two* remarkable spots on the sun, Oct. 23, 1822, and also spots, July 24 and 25, 1823. Olbers (in *Tilloch's Phil. Mag.*, vol. 57, p. 444, 1821) cites Gruithuisen's observations of three solar spots, June 26, 1819, viz., one near the middle of the sun, and *two small ones without nebulosity* near the western limb.

M. Leverrier's new Tables seemed (by the Report made to the French Academy, Aug. 4, 1845, C. R. 21 : 316) to show that Mercury suffered no unexplained disturbance. Nevertheless, in the hope of finding this presumed planet, I undertook, in the year 1847, in conjunction with Mr. Francis Bradley, to observe the sun's disk twice a day when practicable, and also to explore the neighborhood of the sun with a telescope, armed in front with a long pasteboard tube blackened inside. These efforts, made with an instrument badly mounted, in an inconvenient place, proved fruitless, and were finally given up on account of the pressure of other work. Such observations ought to be resumed by those who can command suitable means. The fact that for twenty years past no such bodies as those seen by Pastorff have been detected by the numerous observers of solar spots, may perhaps be due to the large inclination of the planet's orbit.

OBSERVATIONS ON BIELA'S COMET.

This comet was discovered to be periodical by M. Biela, in 1826; it revolves about the sun in six and three-fourths years, or two thousand four hundred and ten days, in a very eccentric orbit, which, however, so nearly intersects that of the earth, that at the return, in November 1832, if the earth had been one month in advance of its actual place, it would have gone through the comet; otherwise, the comet, which is small and hardly visible to the naked eye, was of little importance until its return, in the autumn of 1845, in the December of which year its form gradually elongated; and in the middle of January 1846, it actually separated into two comets, each with a short tail and a nucleus, each of which was alternately brighter than the other; moreover, the distance between them slowly but steadily inincreased, so that when they wholly disappeared, in April, it had become nearly as great as that from the earth to the moon.

At the next return of the comet, in 1852, it was therefore an object of great curiosity to astronomers, especially after it was ascertained that the distance between the two parts had become about a million of miles, but otherwise they had performed their long journey of nearly seven years almost side by side. Another return of the comet has occurred during the past year, its perihelion passage taking place on the 24th of May, at a distance of one hundred and sixty millions of miles from the earth. Unfortunately, however, its distance and position, nearly in a line with the sun, were unfavorable for observations on it, at any of the observatories of the northern hemisphere.

The following interesting communication from M. Faye, on the division of this comet, has been recently made to the French Academy.

M. Faye first examines whether this is the first occurrence of the kind recorded in history, or whether a similar fact has been witnessed before. Seneca, in his *Quæstiones Naturales* (Lib. VII., c. 86), mentions a case of the kind recorded by Ephorus, a Greek historian, whose works are lost; but he only does so to cast a doubt on the matter. "Ephorus," he says, "who is not very trustworthy, is often deceived, and often deceives. Thus he says that comet on which the eyes of all men were fixed, because on its rising it ushered in an immense event, namely, the swallowing up by the sea of Helice and Buræ, was seen to set under the form of two stars, — a thing which no one else has mentioned before. For who can have observed the moment when the comet split into two parts? And how, if any one saw it split asunder, does it happen that no one saw the junction of two bodies to form it?"

This comet appeared, according to M. Humboldt, under the archonate of Asteius, in the fourth year of the 101st Olympiad, two years before the battle of Leuctra, when the two towns of Achaia, mentioned by Seneca, were washed away by the sea in consequence of an earthquake. Kepler has already confuted Seneca's criticisms in his work *De Cometis*, 1619, pages 49 and 50; but the separation of Biela's comet in two, sets the question at rest, and shows that Ephorus spoke the truth; but the comet of Asteius separated suddenly and rapidly, since the separation was visible to the naked eye, whereas that of Biela's comet has been effected very slowly. According to M. Plantamour's measures and calculations, the distance of the two nuclei, equal to that which exists between the earth and the moon, remained nearly constant during the whole time of its appearance in 1846.

According to M. Alexander, it would be necessary to go back five hundred days in order to find the nuclei at one-tenth of that distance from each other, and it was not until the lapse of seven years that the distance became ten times greater. The two nuclei, in fact, follow the same route; there are but very slight differences in the elements of their orbits; they have the same inclination, the same longitude of the node, with the exceptions of a few seconds; the same eccentricity, and the same orientation of the transverse axis, so that the difference seems chiefly to bear on the diurnal motion, and even there it is very slight. Hence the two comets have been moving together for years side by side, so to say, and at so short a distance from each other that it was for a long time impossible to distinguish one from the other with the naked eye. M. Faye hence concludes that the separation of Asteius's comet was owing to causes different from those operating on Biela's comet.

Secondary nuclei, he observes, are not unfrequently seen in a course of formation in the principal nucleus of a comet, in the midst of the luminous sectors which are successively developing themselves around it. MM. Donati and Amici saw one in the dark space existing between two luminous aureolas of the large comet of 1858, and this phenomenon appears to be more frequent even in telescopic comets. These secondary nuclei are in most cases ultimately absorbed by the principal one when the intestine commotions, caused by the neighborhood of the sun, have ceased; but during the period of instability, the slightest cause might lead to the expulsion of one of these nuclei, or, in other words, the formation of two comets out of one. When the matter of the aureolas has been partially condensed into a nucleus, the latter, having attained a certain degree of density, ceases to form part of the principal nucleus, and then a small degree of force will enable it to separate from the parent comet.

M. Faye points to the tangential component of the solar repulsion acting on the comet, as the probable force which produces that effect. When Biela's comet, in its double state, again makes its appearance M. Faye confidently expresses a hope that observation will furnish data sufficient to confirm his theory. As to the instantaneous separation which was observed in Asteius's comet, M. Faye attributes it to a totally different cause, which he endeavors to explain by the following supposition, namely, that were the nucleus of Donati's comet suddenly to cease emitting the particles which form the tail, the latter would be rapidly separated from the nucleus, and form a second comet, which would follow a hyperbolical orbit, while the nucleus, surrounded only by a slight nebulosity, would continue its elliptical route. A commencement of such a separation took place in the great comet of 1813, and such might easily have been the case with the comet of Asteius, mentioned by Ephorus.

THE DIVISION OF BIELA'S COMET.—BY D. VAUGHAN.

The aëriform matter of which comets are almost entirely composed, must furnish a wide field for the play of those forces which occasionally disturb the tranquillity of our atmosphere. So light is the air we breathe, that its weight is considerably altered by electric action; and from this cause storms frequently arise. Whenever the prevalence of moisture causes the superfluous electricity to escape from the region of the clouds to the ground, the air is repelled, and forms an ascending current. As it undergoes expansion during the ascent, the cold which this occasions condenses the accompanying vapor; and descending drops of rain diffuse moisture through the medium which they traverse, and improve its conducting power. Accordingly the discharges of electricity are constantly repeated, and the aërial current continues to ascend; while the surrounding air presses into the scene of action, and participates in the movement. Such is Dr. Hare's theory of storms.

If the small quantity of dense matter which is required to hold together the rare cometary gases, contained a large proportion of water, or any other volatile fluid, much vapor should be generated on the approach of the comet near the sun. Whenever this vapor condensed, at the place screened from the solar rays, or at any other locality, a discharge of electricity would occur between the envelop and the central mass of the comet; while an ascending current commenced in the rare fluid, and determined the focus of a storm. Owing to its vast height, the greater part of the nebulous appendage would take part in the movement, and give it a degree of impetuosity which the feeble attractive power of the nucleus could scarcely control. If ascending currents of air on our own planet prevent condensed vapor from falling until it forms large drops of rain, hailstones of a considerable size, and in some cases waterspouts, the vapor returning to a liquid form in the vapor of a comet, whose gravity is very feeble, should be sustained by similar ascending currents, until it had collected into bodies as large as lakes or seas. Even large collections of the fluid, evaporated from the central nucleus, may be sometimes driven beyond the sphere of its effective attraction, and may separate forever from the comet, taking away its share of the aëriform appendage.

That the division of Biela's comet arose from a cause of this nature, is proved by a singular fact. The two parts into which this body divided were almost equal in size and brilliancy when nearest to the sun; but at a more considerable distance from him, one was about eight times as large as the other, and about four times as bright. This shows that they differed in their capabilities of affording material for evaporating; and it is precisely what should occur, if one were fluid and the other almost entirely solid matter. On approaching the sun, the nebulous appendage of the first would swell by the introduction of vapor; while the small amount of vapor contained in the other would be only rendered invisible by the solar heat. Other comets present indications of similar commotions, though not attended with such remarkable results; and we thus become acquainted with the relation between the agencies operating on our globe and in the more humble members of the solar family.

NEW PERIODICAL COMET.

The comet discovered by Mr. Tuttle, of Cambridge, on the 4th of January, 1858, has been found to possess elements identical with those of the second comet of 1790, discovered by Méchain. Mr. Bruhns, of Berlin, who discovered this comet seven days after Mr. Tuttle, has compared a great number of observations, made up to the month of March, in Europe and America, and has deduced from them an elliptical orbit of 13·66 years. The comet discovered on the 4th of January by Mr. Tuttle has therefore returned four times since 1790 without having been seen.

ON THE GREAT AURORAL DISPLAY OF AUGUST 28TH TO SEPT. 4TH, 1859.

On the evening of August 28th, 1859, was commenced an exhibition of Auroral or Polar light, which continued with varying intensity at different localities in North America, so far as is now known, up to September 4th. This auroral display was one of the most remarkable ever recorded in the United States, — remarkable not only for the great extent of territory over which it was observed, but also for its duration, for the intensity of the illumination, as well as the brilliancy of the colors, and the extreme rapidity of the changes. It was also equally remarkable for the magnetic disturbances which accompanied it, especially on the 2d and 3d of September. These electrical perturbations were recorded not only by the usual magnetic instruments; but over the whole system of telegraphic wires, especially in New England and the Canadas, the magnetic induction either greatly interfered with or prevented the working of the lines by the usual voltaic current, while in more than one case the north and south lines were worked solely by the atmospheric influence! — *Silliman's Journal.*

In some instances, lines were worked constantly for two hours in this way, the currents being variable, but always sufficient for the purpose. These phenomena had been previously noticed to some extent, and the telegraph operators were fortunately sufficiently well informed on the subject to observe and experiment intelligently. The following reported conversation over the wires between Boston and Portland, on the evening of Sept. 3d, will give an idea of the way in which they managed it:

Boston (to Portland operator). — "Please cut off your battery entirely from the line for fifteen minutes."

Portland. — "Will do so. It is now disconnected."

Boston. — "Mine is also disconnected, and we are working with the auroral current. How do you receive my writing?"

Portland. — "Better than with our batteries on. Current comes and goes gradually."

Boston. — "My current is very strong at times, and we can work better without batteries, as the aurora seems to neutralize and augment our batteries alternately, making the current too strong at times for our relay magnets. Suppose we work without batteries while we are affected by this trouble?"

Portland. — "Very well. Shall I go ahead with business?"

Boston. — "Yes. Go ahead."

It would further appear, from the observations of the telegraph operators, that while the lights are streaming up the heavens there are strong electric or electro-magnetic currents passing over the surface of the earth, which, according to a writer in the *Atlantic Magazine*, December, 1859, are frequently equal in strength to a current produced by a battery of two hundred Grove's cups. These follow the telegraph wires wherever they encounter them; and the observations made upon their influence during the recent auroral displays, show that the earth currents pass in waves, alternately negative and positive. First comes a strong wave of positive electricity, which gradually subsides, and is succeeded by a negative wave. The average duration of each wave is about fifteen seconds. While the poles of the telegraph battery correspond with those of the earth currents the telegraph current is strengthened by them; and when they are opposed, the telegraphic current is neutralized.

This auroral display appears to have been witnessed from Cuba and Jamaica on the south, to an unknown distance beyond the Canadas on the north; and from Great Britain, France, Germany, and Central Europe on the east, to California on the west. Capt. Howe, master of the ship *Southern Cross*, from Boston to San Francisco, also reports, that the display off Cape Horn, on the night of the 2d of September, was grand beyond description, — the whole heavens being of a deep blood, which color was reflected in the ocean, upon which a fearful sea was running.

Mr. B. V. Marsh, in a communication to the *Journal of the Franklin Institute*, states, that from a comparison of a great number of observations on the aurora of August 28th, made in different localities, the conclusion seems warranted, that the luminous horizontal curtain observed "was in the form of a ring, the centre of which was probably situated in or near the northern part of Davis' Straits — its direction having been shown to be nearly north-west from England, a few degrees east of north from Philadelphia, and north-east from California; that this ring was about forty-three miles from the earth, and that its width, previous to half-past nine o'clock, was about three hundred and fifteen miles; and furthermore, that from various points on its surface, arose splendidly illuminated vertical columns several miles in diameter, and near six hundred miles high, and that these columns were at all times at very considerable distance from each other, one streamer for every five hundred square miles being more than sufficient to satisfy all observations."

REMARKABLE METEORS.

On the morning of the 11th of August, 1859, at 7 o'clock and 20 minutes, or thereabouts, thermometer 73°, air still and the sun shining brightly, a meteoric body of great size and brilliancy was observed throughout a large portion of Western New England and Eastern New York, and which, exploding violently, threw down to the earth at least one fragment of its mass, in the vicinity of Albany, N. Y.

The main facts connected with this interesting phenomenon, collected from numerous and widely separated observers, are as follows: By observers, generally, north of Albany, the meteor is described as appearing in the south-east, at an elevation of from 45° to 60°; thence passed rapidly to the south, and disappeared a little west of south at an elevation of from 10° to 15°. Its course, throughout its visible range, was marked by a heavy train, or trail of smoke, which continued visible for some little time after the meteor itself had disappeared; and, at two or three points in its course, large volumes of smoke were observed to form, as if the result of successive explosions. These volumes of smoke were noticed to be in a state of great agitation, and in size were compared to the cloud of smoke produced by the discharge of a six-pounder.

To observers, generally, south of Albany (twenty miles distant, or more), the meteor was first seen in the north-east, and disappeared in the north-west, — a fact which indicates the path of the body to have been nearly coincident with the parallel of Albany.

A few moments after the disappearance of the meteor, — the lapse of time being variously estimated, by differently located observers, at from thirty seconds to two minutes, — two or three loud and successive explosions or reports were heard, accompanied with prolonged echoes, and a violent concussion. These sounds have been compared by some to sharp and heavy peals of thunder, to the report attending the explosion of a powder-mill, or steam-boiler, and also to the heavy rumbling of carriages crossing a bridge. In the city of Troy, the concussion and jarring was sufficiently intense to suggest, generally, the idea of an earthquake; people walking the streets involuntarily stopped, and for a moment nearly every occupation was suspended. At Schaghticoke, N. Y., and Bennington, Vt., where powder-mills are in operation, the report was referred to explosions at the works; and at the former place, when the managers of the works ascertained that no explosion of mills had taken place, either in their own town or in Bennington, they at once concluded that a train of powder-wagons, which started some hours previously for Troy, had blown up on the road, and messengers were at once despatched in search of information. At Eagle Bridge, on the Troy and Bennington Railroad, the concussion was forcible enough to jar the windows and shake the seats of a train of cars in motion. At Greenbush, opposite Albany, numbers of people rushed to the docks, under the supposition that a passing steamboat had exploded her boiler. The noise and concussion also appear to have been noticed, to nearly an equal extent, at points sixty miles east of the Hudson; while the whole area over which the sound is positively known to have been heard with distinctness, was upwards of two thousand square miles.

The area of country, on the other hand, over which the meteor was *seen*, was, as might have been expected, much larger than the area over which the explosions were heard, being, at least, equal to six thousand square miles. Thus, observations were made upon it at Morristown, Lamoile County, Vermont, — twenty-five miles north of Montpelier, — and at South Manchester, Connecticut, a point nearly two hundred miles south; it was also observed at localities west of the Hudson River, and at various points from thirty to sixty miles east of the Hudson. Within a radius of thirty miles north-east and south-east of Troy, it was probably observed by every person out of doors, who was at the time looking in the southerly direction; yet such is the unreliability of human testimony as regards natural phenomena, that no two observers can be found to agree as to many important particulars, such as apparent size, period of visibility, direction, altitude, etc.

The estimates formed of its size are exceedingly discrepant — some observers comparing it to the sun, or full moon, and others to a sky-rocket, or the luminous ball projected from a "Roman candle." All agree, however, that its appearance, even in full sunshine, was exceedingly bright and dazzling; the light being at the same time of a reddish color. So bright, indeed, was it at Strafford, Vermont, — a locality nearly one hundred miles north of the probable point of explosion, — that its distance was estimated as not exceeding a half a mile from the point of observation.

A single fragment only of this meteor is positively known to have fallen. This was found in the town of Bethlehem, Albany County, N. Y., and at a point about ten miles west of the city of Albany. The circumstances connected with the phenomenon, as related by the illiterate Dutch farmer who noticed it, are as follows: While standing in the enclosure adjoining his house, his attention, and that of his family, were attracted by a loud sound overhead, which somewhat resembled thunder; and, a few moments after, a stone struck the south-east side of a wagon-house, and, bounding off, rolled into the grass. A dog, lying in the doorway, started up and ran to the place where the stone rested. When picked up, immediately after, it was found to be quite warm, and possessed of a sulphurous odor. The fragment in question was small — about the size of a pigeon's egg, and irregularly shaped. Nearly three-fourths of its superficies was covered with a black, non-lustrous, evidently fused crust, while the remainder presented the appearance of a fresh fracture, and was of a light-gray color, and of a granular, or semi-crystalline texture. Its composition was apparently silicious, and not metallic. This specimen was bought by the Regents of the State of New York, and is now deposited in the State Cabinet at Albany. Other fragments are reported to have fallen in the vicinity of the Hudson; but careful inquiry has, thus far, failed to discover them.

From the above facts, it seems evident that the meteor of August 11th was of immense size, — probably of tons weight, — and that it exploded violently at no great distance above the surface of the earth.

It is an interesting subject of speculation, as to what became of the other fragments; and also of what the smoke so abundantly developed during its course was composed. — *Editor.*

Meteor of Nov. 15th, 1859. — On the morning of Nov. 15th, about nine and one-half o'clock, a remarkable meteor was seen throughout South-eastern New England, Southern New York, at numerous places in New Jersey, and at Washington, D. C., and as far south as Fredericksburg, Va. At all these places it appears to have been seen at the same instant of absolute time; and at all the stations north of New York the appearance was almost identical, and the direction of the meteor was somewhat west of south.

In a communication to *Silliman's Journal*, January 1860, Prof. E. Loomis gives the following summary of facts connected with the phenomenon.

"In New York and vicinity, the meteor was so brilliant that, although the sun was unclouded and had an elevation of about twenty degrees above the horizon, the flash attracted the attention of well-nigh every person who happened at that time to be looking nearly toward that part of the heavens. The apparent diameter of its head was somewhat less than that of the sun, and it had an appendage like the tail of a comet, several degrees in length. Its apparent path was nearly vertical, with a slight inclination towards the west; and the length of its visible path was variously estimated from 15° to 25°. The entire period of its visibility did not exceed one or two seconds. No sound was heard at New York which could reasonably be ascribed to the meteor. By taking the mean of the estimates of several observers, I have determined that the point of the horizon where the meteor vanished was about 21° west of south."

At Washington, D. C., "the apparent path of the meteor was nearly perpendicular to the horizon, and its point of disappearance was estimated to be four degrees north of east. Those lines of direction, as observed at New York and Washington, intersect at a point a little north of Cape May; and, inasmuch as at each of these stations the apparent path was nearly vertical, the actual path must also have been nearly vertical, and the meteor undoubtedly struck the earth at some point not very remote from Cape May.

"This conclusion is confirmed by the reports of the meteor from New Jersey. The meteor was generally observed throughout the southern part of that State, and was everywhere succeeded by a very remarkable explosion. At Beeseley's Point, situated on the Atlantic Ocean, near lat. 39° 20′, the course of the meteor is said to have been from northeast to southwest. It was attended by a sudden flash of light, and left behind a curling track of a smoky or light cloudy appearance, which soon vanished. About a minute after the flash, there was heard a series of terrific explosions, which were compared to the discharge of a thousand cannon. These explosions continued for one or two minutes; they were very sharp and distinct, and shook the windows and doors of the houses. These noises occasioned considerable alarm, and by some were thought to have been produced by an earthquake.

"From these facts it seems almost certain that the meteor struck the earth at a point a little north of Cape May. As no account of its discovery, however, has been received, there is reason to apprehend that it may have descended into water, and probably into Delaware Bay. Analogy would lead us to conclude that this belonged to the class of iron meteors, of which we have numerous specimens in our cabinets.

"The velocity of this meteor was very extraordinary. It probably struck the earth at a distance of one hundred and ten miles from Washington, and is said to have been first seen at an elevation of 45°. This would make the length of its visible path one hundred and ten miles, and it is said to have described this path in two seconds, giving a velocity of fifty-five miles per second. A small portion of this velocity (seven miles per second) may be ascribed to the earth's attraction, and another portion was due to the motion of the earth in its orbit, for the earth was moving obliquely towards the meteor; but there still remains an independent velocity nearly double the velocity of the earth in its orbit. The path of the meteor in space could not therefore have been a circle with the sun for its centre; and the above velocity is too great for any elipse or even parabola; but such conclusions must be received with caution on account of the imperfection of the observations; for if we suppose the time of describing this path was three seconds, the independent velocity of the meteor would not have been much greater than that of the earth in its orbit."

Besides this meteor, there is reason to believe that other luminous bodies fell at different points on the morning of November 15th, at about the time above specified. The master of a sloop on the Hudson, states, in a communication to the *New York Tribune*, that a "ball of fire about as large as a man's hat, struck the water off Fort Washington, very close to the vessel, and disappeared with a hissing sound. A similar phenomenon was observed by the officers of a steamboat on the Hudson near Albany. At New Bedford, four or five luminous bodies were observed to strike the water of the harbor, at the same time, at as many different points.

On the subsequent day, Nov. 16th, a curious phenomenon was noticed by Edward L. Higgins, of East Killingly, Conn., and is thus described by him, in a communication to the *New York Evening Post*:

"On the afternoon of Nov. 16th, about three o'clock, I was walking from the mill (in Killingly) to the post-office. The day was cloudy, and a mist was slowly settling over the hills which skirt the horizon. A slight drizzling rain was falling, and I had just opened my umbrella, when I was astonished by a loud whizzing noise, somewhat like that produced by a sky-rocket on its ignition. I turned my umbrella aside, and looked up, when I perceived a phenomenon that very much surprised, and I may say, awed me. Out of the mist, from the hill-top, a bright band of flame seemed approaching that part of the upper air under which I stood, and for quite a distance on either side the mist was illumined by the light; but the centre of the luminosity was intensely brilliant, and very rapid in its motion. In a few seconds it was above my head, and, to my intense disgust, not very far above it either; and I was enveloped in a sheet of milky-white light, and became sensible of a very noisome smell, something between that of very coarse burning brimstone and sour garlic. I followed with my eyes the course of the centre of the bed of light, which passed just above the mill, and describing a parabola, descended to the earth, with a terrific explosion, about half a mile off. Business intervening, it was an hour and more before I could go in search of the exploded aërolite; and when I reached the spot where I had observed it fall, I was petrified with astonishment to perceive no trace whatever of its presence."

ON THE SPOTS ON THE SUN.

Father Secchi, of the Observatory at Rome, has recently published his researches on the spots upon the sun's disk. He commences by supporting the opinion entertained by Wilson, according to whom the feebler light of the penumbræ depends, at least partly, on the different angles of the surfaces emitting that light. He says "at least partly," because we must make allowance for the striated formation of the edges of the spots, or penumbræ, which is now established. Closer observation, aided by more powerful instruments, has proved that the penumbræ are composed of extremely fine, brilliant filaments, whose light equals that of the luminous solar envelope, or *photosphere;* but in consequence of the black lines which separate them, the total effect is that of half-tints. Powerful instruments have also enabled Father Secchi to discover in the darker portion of the spots semi-transparent veils, to which he gives the name of cirri, or clouds. He attributes them to some irruption of luminous matter having the filamentous aspect of the penumbræ. Wilson's theory supposes a real depression of level in the solar spots, and Father Secchi has accordingly attempted to measure this depression, and has arrived at the conclusion that the solar photosphere does not exceed half, or even one-third, of the earth's diameter in thickness. This would give a depth equal at most to the two-hundredth of the sun's diameter; but, notwithstanding the smallness of this estimate, Secchi believes he is not far from the truth, and he holds the frequent disruption of the luminous envelope to be itself an evidence of its comparative thinness. He considers that the faculæ are only the crests of parts of the photosphere which are elevated above the general level. According to this hypothesis, the faculæ are only more luminous relatively to the darker portions near the edge of the solar disk. Furthermore, he has arrived at the conclusion that the penumbra of a spot near the centre, seen with a feeble power, does not appear in reality to be blacker than the portions of the disk near the edge, the light from which is little more than half that of the brilliant central parts. From this he infers that the lower strata of the solar atmosphere must exert an enormous power of absorption, and produce a great diminution of light in the interior of the cavity formed by the photosphere. Lastly, Father Secchi has established, in a manner satisfactory to himself, from drawings of the positions and form of numerous spots, that the greater number of the faculæ show themselves in the regions where the spots appear, namely, above and below the equatorial zone. There is, therefore, reason to suppose, that, compared with the tropical regions, the solar equator enjoys a degree of calm similar to that which exists in the corresponding part of the terrestrial atmosphere. This latter fact agrees admirably with the observations of Carrington, who was the first to notice the motion, in opposite directions, of the spots situated above and below the solar equator. Father Secchi considers that the influence of the spots is towards raising the temperature of the earth.

MAXWELL'S THEORY OF SATURN'S RINGS.

Prof. Maxwell, of England, in a recent treatise on the stability of the motion of Saturn's rings, which gained the Adams prize at Cambridge in 1856, gives us the following as the result of his investigations of the subject:

"The result of the mechanical theory is, that the only system of rings which can exist is one composed of an indefinite number of unconnected particles revolving round the planet with different velocities, according to their respective distances. These particles may be arranged in series of narrow rings, or they may move through each other irregularly. We are not able to ascertain by observation the constitution of the two outer divisions of the system of rings; but the inner ring is certainly transparent, for the limb of Saturn has been observed through it. It is also certain that, though the space occupied by the ring is transparent, it is not through the material parts of it that Saturn was seen, for his limb was observed without distortion; which shows that there was no refraction, and therefore that the rays did not pass through a medium at all, but between the solid or liquid particles of which the ring is composed. Here, then, we have an optical argument in favor of the theory of independent particles as the material of the rings. The two outer rings may be of the same nature, but so exceedingly rare that a ray of light can pass through the whole thickness without encountering one of the particles."

OBITUARY

OF PERSONS EMINENT IN SCIENCE. 1859.

Alcott, W. A., a well-known American writer on health, physiology, etc.

Barratt, Dr. John P., a naturalist and scientific agriculturist, of South Carolina.

Bond, William C., a distinguished American astronomer.

Broderip, William John, an eminent English naturalist.

Brunel, Isambard K., the English engineer.

Brun-Rollet, a Sardinian explorer of Eastern Africa; died at Kartoum, on his return from the interior.

Cagniard de la Tour, an eminent French chemist.

Davis, Dr. James B., of South Carolina, an eminent agriculturist and naturalist.

Dibtrich, Dr., a distinguished German pathologist.

Dirichlet Lejune, an eminent German mathematician, successor to Gauss, at Gottingen.

Ellett, William H., an American chemist.

Grailich, Prof., an eminent mineralogist, of Vienna.

Henfrey, Prof. Arthur, a leading English botanist and naturalist.

Horsefield, Dr., a botanist, well known from his reseaches in Java.

Humboldt, Alexander Von.

Hunt, Walter, a well-known American inventor.

Jelachich Baron, Ban of Croatia, well known as a military commander, but also as a skilful chemist.

Johnson, Manuel, astronomer of the Radcliffe Observatory, Eng.

Lardner, Dr. Dionysius, the well-known scientific author.

Lassaigne, M., an eminent French chemist, formerly editor of the *Journal de Chemiè Medicàle.*

Loftus, Kennet, assistant in the geological survey of British India, and well known for his researches at Babylon.

Mather, William W., an American geologist.

Mitchell, D., an English naturalist, late Secretary of the Zoölogical Society.

Motley, Mr., an English engineer and naturalist, killed by the natives of Borneo.

Nichol, Prof. J. P., Professor of Astronomy in the University of Glasgow, and a well-known author of astronomical works.

Nuttall, Dr. Thomas, best known as an ornithologist.

Olmstead, Denison, Professor of Natural Philosophy, Yale College.

Ritter, Carl, the distinguished geographer.

Soubeirain, M. E., a distinguished French chemist and physicist.

Stevenson, Robert, the well-known English engineer.

Stewart, James, of N. Y., inventor of the seraphine, type-casting machine, etc.

Taylor, Richard, for many years editor of the London E. and D. Philosophical Magazine.

Tully, Dr. William, a well-known writer on materia-medicà.

Walker, John, a Scotch chemist, inventor of the lucifer match.

Welsh, John, an English physicist, Superintendent of the Kew Observatory.

Wilson, Dr. George, Professor of Technology in the University of Edinburgh, and a popular scientific author.

Wright, E. G., an English chemist, originator of the use of fulminating mercury in the percussion cap.

LIST OF BOOKS, PAMPHLETS, ETC.,

ON MATTERS PERTAINING TO SCIENCE, PUBLISHED IN THE UNITED STATES DURING THE YEAR 1858-9.

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