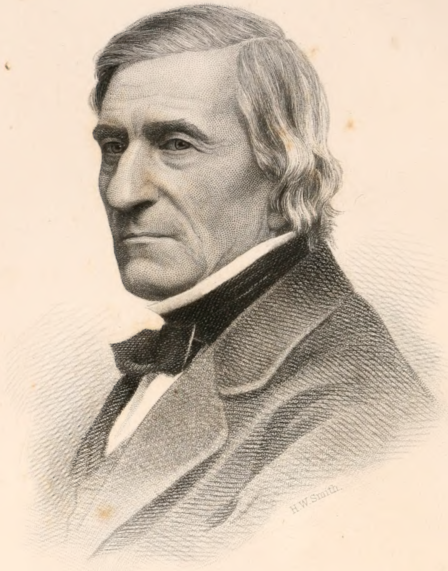
I, C, II, 3

livr 5" 10



William B. Rogers

Engᵈ for the Annual of Scientific Discovery 1868.

Gould and Lincoln, Boston.

ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1868,

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

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

TOGETHER WITH

NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1867; A LIST OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF EMINENT SCIENTIFIC MEN, ETC.

EDITED BY

SAMUEL KNEELAND, A.M., M.D.,

FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, SECRETARY OF AND INSTRUCTOR IN ZOÖLOGY AND PHYSIOLOGY IN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, ETC.

BOSTON:
GOULD AND LINCOLN,
59 WASHINGTON STREET.
NEW YORK: SHELDON AND COMPANY.
CINCINNATI: GEO. S. BLANCHARD & CO.
LONDON: TRÜBNER & CO.
1868.

Entered, according to Act of Congress, in the year 1868, by
GOULD AND LINCOLN,
In the Clerk's Office of the District Court for the District of Massachusetts.

ROCKWELL & ROLLINS,
PRINTERS AND STEREOTYPERS, BOSTON.

NOTES BY THE EDITOR,

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1867.

THE great event of the year 1867, as far as the application of science to the useful arts is concerned, has been the opening and successful issue of the great Exposition of the world's industrial products at Paris. It was, indeed, a most wonderful exhibition, bewildering the student by its vastness, and overwhelming even the casual observer by its complexity; yet, apart from and above the inevitable petty jealousies of rival producers, a grand and triumphant display of the power of civilization, and of the ability of human intellect to control natural forces for its benefit. It proved, on a scale of magnitude before unattempted and probably never again to be equalled, the true nobility and dignity of human labor, in every part of its vast space rich in the evidence of the magnificent results of the united works of the active brain and the skilful hand of man. The exhibition of the instrumentalities which philanthropy uses for the protection and relief of suffering humanity, and for the kind treatment of the domestic animals, taught the simple but grand lesson that the great industrial population is not only the head and the hand, but also the heart of the world, giving impulse to the irresistible current and forces of advancing civilization.

America, though laboring under the great disadvantage of separation by the ocean from the field of exhibition, and therefore unable to enter the lists on an equality with other competitors, by her small though well selected contributions did honor to herself. The first impression, on viewing the products of American industry at the Exposition, was one of disappointment; but a more extended examination led the careful observer to the conviction that, though more might have been exhibited, the variety in the

36118

American department was sufficient to vindicate the character of our country for unsurpassed inventive faculty, displaying original thought and the productive idea in mechanism. This was admitted by qualified and impartial observers, whether English, French, or German; and it was candidly confessed that mechanical engineers must go to the American department for novelties and bold inventions in this branch of practical science; so that the feeling of disappointment was soon changed into one of pride and admiration.

Dr. Playfair, in a letter published in the "London Times," draws attention to the fact that the evidences of progress in the mechanic arts, as illustrated in the Paris Exhibition, are much less marked in the English department than in the collections of some other nations. This difference he traces to the superior facilities offered in the latter for scientific and technical education. Professors Tyndall and Frankland, and Mr. Scott Russell, confirm the opinion of Prof. Playfair in this respect. The same sentiments are expressed in the "Journal of the Franklin Institute" for September, 1867, as the following extracts will show: "There seems to be overwhelming testimony, from the best authority, in proof of what is in itself eminently probable, namely, that they who know the most will learn the most in addition, and that the most valuable discoveries and inventions will be reached by those who, having a sound knowledge of general principles and of previous labors, can devote their whole force to the development of the *new* and the *possible*, and waste no energy on the redevelopment of what has been already exhausted, or the devising of combinations utterly ineffective, because ignoring the actual properties of matter and the essential laws of force. An hour's study of the patent reports, or of any publication announcing indiscriminately all new inventions, will show us that far more than half, even of those exhibiting considerable ingenuity and practical acquaintance with the special subject treated, would have been either abandoned or improved, had the deviser possessed even a very general groundwork of scientific knowledge.

"In our collegiate establishments more attention should be given to physical studies, even at the expense of a diminution in the classical departments. When universities and the like were first established, the only learning which existed and could be made the subject of study and instruction was the classical. Chemistry was unborn; geology, mineralogy, and like branches, not even imagined; the laws of light, heat, and electricity, utterly unknown and unsought. Exclusive devotion to classical studies was, therefore, at that time appropriate, natural, and necessary. But now, when these new sciences have developed an amount of material in comparison with which the whole mass of classical lore is but as an atom, and (except as a mental discipline) practically valueless, it is certainly neither appropriate nor necessary to keep in the old track, and to devote to these extensive, grand, and useful departments of human knowledge but a fraction of the time and attention assigned to the classics. We do not wish to disparage the advantages of classical education. While this is good, we cannot but believe that the same amount of time and effort devoted to physical studies, say to analytical chemistry and optics, or mechanics, would have been as useful an exercise to the mind, and at the same time would have furnished a far more valuable and practically useful store of information."

To meet this acknowledged want of instruction in applied science, we find educational establishments springing up all over the country, either as Polytechnic Institutions, Schools of Technology, or Scientific Schools attached to the older Universities. It is very important for the material prosperity of America that the energy and originality of her people should be directed properly, and that a good preparatory education should be furnished to those destined to take part in industrial pursuits. The necessity of the knowledge of this kind of instruction was apparent in the products of all nations, as amid much that was novel and good was much of crude invention which had no right to be there.

Though called a "Temple of Peace," and calculated to increase a friendly intercourse between the nations of the earth, the emblems and materials of war occupied a space far exceeding that of any other collection of the kind. Gigantic naval cannon from the foundry at Ruelle, France, weighing over thirty-two tons each, and the great gun from the establishment of M. Krupp, at Essen, in Prussia, contrasted strongly with the American system of ambulances and other apparatus for the saving of life.

The universal employment of iron in all the most important branches of human industry, and its general substitution for wood in public and private structures, both military and civil, rendered this portion of the exhibition of very great scientific and practical value. England, France, Prussia, and Belgium made the most complete display in this department. Such large establishments as those at Creusot in France, and Essen in Prussia, become, as it were, centres of civilization, where skilled laborers congregate and form peaceable, progressive, and permanent communities, in striking contrast with the disorderly, miscellaneous, and fugitive crowds rushing to localities of gold and silver discoveries.

From George Stephenson's locomotive, in 1824, which travelled at the rate of six miles an hour, to that of 1867, which has reached a speed of seventy miles an hour, what a wonderful advance ! This, in fact, is the emblem of the present era, abridging labor, facilitating commerce, and by rapid locomotion entirely changing the character and conditions of society.

Steel is now extensively used for locomotive boilers, fire-boxes and tubes, tires, piston-rods, and motion-bars, and for bridge construction. The age of iron is gradually passing away, and the age of steel is taking its place, the latter material being stronger and lighter.

According to Prof. Rankine, it is a law of thermodynamics that the utmost quantity of work that can be got by the expenditure of a given quantity of heat depends solely on the limits of temperature between which the engine works, and is independent of the nature of the fluid to which the heat is applied, such as water, ether, air, etc. The means of increasing the economy of heat in thermodynamic engines are of three kinds: 1. Working expansively, so as to obtain from the heat applied to the fluid all the work possible between given limits of temperature; this has probably been carried to the utmost extent practicable. 2. Increasing the range between the limits of temperature, to which bounds are set in practice by the conditions of durability and safety. 3. Diminishing the amount of heat wasted in the furnace by imperfect combustion, etc. It is in the last direction that the greatest improvements are now to be looked for; cast-iron boilers in sections with free circulation of water in thin films, the introduction of the air necessary for perfect combustion and the prevention of smoke, and the use of petroleum and other concentrated fuels, are now the points to which the attention of practical engineers is directed.

English agricultural journals speak highly of steam cultivation, though from inexperience, want of confidence, and want of capital, it makes slow progress. Its evident advantages, its economy, and the simplicity and perfection of the machinery and implements, must soon obtain for it a general adoption.

A great revolution in metallurgical processes is promised by the use of pulverized fuel, utilizing all the heat of combustion at the time and place where it is wanted, and bringing into profitable use a large amount of coal heretofore regarded as useless. In the Whelpley and Storer furnace, described on page 211, by the use of pulverized fuel in reducing the sulphides also in a state of fine powder, there is a great saving of metal. When we reflect upon the facts that the loss on the production of bullion in this country, from lack of economy in the reduction of ores, amounts this year to 25,000,000 dollars; and that the waste on coal, from the inability to burn the fine dust, amounts to more than twenty-five per cent. of the whole amount mined, — we may form some idea of the importance of a process which has thus far yielded signal advantages.

The problem of ascending mountains by railroads having steep gradients and sharp curves, by means of a third or central rail upon which run a pair of horizontal wheels, has been successfully solved by the passage over Mt. Cenis of a train of cars, with passengers and freight, from St. Michel to Susa, a distance of forty-eight miles. The summit of the pass thus ascended is more than 6,300 feet above the sea, and over 3,800 feet from the initial point on the French side. This was originally an American invention, patented many years ago in this country. This would seem to settle the question of the feasibility of ascending by rail such ascents as the Hoosac mountain.

The processes for making artificial stones for building and ornamental purposes have been so perfected that man's work in this direction surpasses that of nature, in that the artificial stones are more indestructible and compact than the natural ones; easily moulded to any form or applied to any surface; applicable in thin films to walls or wood-work, rendering them uninflammable and water-proof; multiplying correctly and cheaply the master-pieces of the sculptor's art as photography multiplies pictorial representations of objects; and opening a branch of artistic and profitable industry, the extent of which can hardly at present be estimated.

The use of petroleum as fuel for domestic purposes, and for the generation of steam in stationary, marine, and locomotive boilers, seems to combine economy of space, time and labor, safety, and cleanliness, as shown by carefully conducted experiments in Boston, New York, and Pennsylvania. The fuel is cheap, and the apparatus for its use simple, inexpensive, and durable. The question of the most perfect utilization of the heating power of fuel is of vast importance, in view of the occasional inadequate supply and high prices of coal; it involves the water and land transportation of the whole civilized world, and consequent commercial prosperity of nations. It seems most likely that the fuel of the future will be either liquid or pulverized, and not solid, according as it is used for domestic and steam-generating or for metallurgic purposes.

The proper material for steam-boilers has been much discussed by practical men during the past year, some advocating the return to the original material of cast iron, and others maintaining the superior advantages of steel. No boiler can be made strong enough to resist the explosive power of steam under high pressure, and the greater the strength of the containing chamber the more destructive will be the explosion if rupture takes place. The strength of a boiler being the strength of its weakest part, it is impossible, taking into consideration poorness of material, unskilful workmanship, and the numerous hidden sources of weakness in riveted wrought-iron boilers, to determine the actual condition of such a boiler as to strength. Cast iron is better adapted to undergo the ordeal of fire and water than is wrought iron, and in proper shape and proportions may be made as strong. The feeling of safety under high pressures has led to a general adoption of cast-iron boilers, as this material under improper treatment breaks at once without straining, unlike the destructive fracture of wrought iron, consequent on its very tenacity; the brittleness of cast iron, at first sight a defect, is the very element of its safety. In such boilers there is no weakening by rivets, and very little corrosion, and a free and rapid circulation is effected. Should a steel boiler explode, the effects would be destructive in proportion to its strength.

In naval warfare the struggle for superiority between cannon and armor plates at present seems to be settled in favor of the cannon, especially of the smooth-bore American heavy ordnance. The American system of large bore and spherical shot is acknowledged in "Engineering" to be superior to the English system of small bores and elongated shot. The American system uses cast-iron guns, which the comparatively low initial pressure allows to be employed with safety; it is, however, applicable to wrought-iron guns, which places before us a large field for increased power, while the English wrought-iron gun has already reached the highest efficacy compatible with the material. Recent trials at Shoeburyness have shown that the large American smooth-bore can send its 440lb. round shot through any armor-plate in the British navy. Twenty-inch guns have also been made, and no doubt their efficacy will prove superior to the resistance of any armor-plate which can be made available.

The lime light has recently been introduced into lighthouses, and from its size bids fair to rival even the electric light for some purposes. The light is white, and, according to the late Prof. Faraday, very easily managed, it being necessary simply to supply the oxygen and hydrogen gases which are directed against the lime; in Faraday's words, it is like the light of a planet, whereas the electric light is like that of a star. The electric light, however, the brightest, has also been brought to the notice of the scientific world by the magnificent electro-magnetic machines of Wilde and Wheatstone; it rivals the light of the sun, and cannot be looked at with the eyes unprotected. This has been applied to lighthouses on the coasts of France, giving a light which can be seen thirty miles at sea, and able to penetrate a dense fog. With Foucault's regulator, which, by a system of clock-work driven by the electric force, regulates the upward and downward movements of the charcoal points as they are consumed, and also keeps them in the focus of the lens, there seems nothing wanting to render this system the most advantageous for lighthouses, and to secure for it a general adoption for this purpose.

The Holtz electrical machine has been variously modified by practical physicists, until it now presents the simplest, cheapest, most convenient, most powerful, and most reliable form of apparatus for the generation of frictional electricity.

A discovery of very great importance to iron manufacturers is described on pp. 173–4, namely: a method of detecting faults in iron forgings by examination with a magnetic needle. Wherever a flaw exists in the iron, as proved by many experiments in England, it ceases to be one regular magnet, and the needle at once departs from its normal position and assumes a new direction at the place of the fault. This mode of testing detects the change called crystallization, so important to be known in the matter of railroad axles.

Chemistry during the past year has been eminently progressive, especially in the investigation of carbon compounds applicable in the arts; in fact the chemistry of carbon forms the predominating study of the present age. It is evident that the atomic theory of Dalton, which has been of signal service in chemical progress, must now be abandoned or fundamentally changed. Sir Benjamin Brodie has recently laid before the scientific world a calculus of chemical operations, in which the first systematic attempt is made to express the constitution of chemical compounds by a method in which the idea of an atom has no place. His starting-point is the comparison of the weights of different substances in the gaseous state which fill the unit of space at the standard temperature and pressure. Though the idea of atoms is excluded from this theory, it is not incompatible with them; though it may be convenient to consider matter in relation to space only, we must eventually come to the consideration of what Prof. Anderson calls "the unit of matter." The existence of a unit of matter, whether it be regarded as a hard, spherical particle, a centre of force, or a vortex produced in a perfect ether, appears to be indispensable; some kind of molecular hypothesis seems to be necessary for the explanation of physical phenomena, and it is difficult not to believe that some connection exists between the physical and the chemical unit of matter.

A few years ago the late Dr. Emmons persistently but unsuccessfully maintained that, below the lower Silurian system in northern New York and New England, there existed an extensive series of fossiliferous rocks, of which the Potsdam sandstone of the New York geologists was the upper member, constituting what he called the "Taconic system," and which was called in Europe by Barrande the "Primordial Fauna." This view he bravely maintained in opposition to all the best geologists of the land. The history of this contest reminds one of that between Cuvier and Geoffroy St. Hilaire in regard to the vertebral theory of the skull; the former, with great ability and brilliancy, denying and ridiculing this German idea; the latter, with truth and philosophy, as stoutly maintaining it. So did Dr. Emmons fight single-handed against the host of geologists, content, though silenced, to let the power of truth prevail in its own good time. The "vertebral theory of the skull" is now recognized, in spite of the bitter opposition of Cuvier; and the "Taconic system" of Emmons, since the researches of Barrande in Bohemia and of Marcou and Perry in this country, must be allowed its place in geological science.

The scientific world was startled a few months ago by the publication of several letters said to have passed between Sir Isaac Newton and the French philosopher Pascal.

Prof. Chasles brought before the French Academy this alleged correspondence between Newton and Pascal, which, if genuine, would transfer to the latter much of the glory that has been associated with the name of the former.

Prof. Hirst read a paper on the subject before the British Association at the Dundee meeting, at the request of Prof. Chasles.

Sir David Brewster followed, maintaining that the correspondence was a forgery unparalleled in scientific or literary history, giving his reasons therefor. The purpose of these documents is to show that Newton had relations with French philosophers, and that his views with respect to gravity, etc., were by no means so original as they were thought to be. This supposed correspondence is given in "Comptes Rendus," July to October, 1867, and seems to bear upon its face evidence that it is not authentic, and is unjust to the memory of both these eminent men.

London "Engineering" has the following on the lull of invention: —

"Several years have now passed without any really great invention, — an invention capable of adding millions to the national wealth. The most recent are the Bessemer process, the steam-plough, submarine telegraphs, and Ransome's artificial stone; and among discoveries the Australian gold mines, the Cleveland iron-stone, and the American oil-well.

"The great inventions, those which have not merely improved but revolutionized trade, are, within the last century, the steam-engine, with steam-navigation and railways, textile machinery, electric telegraphs, and steam printing, and we think that the four inventions named at the beginning of this article are those which, among our more recent acquisitions, are best entitled, by their real importance (although this is not fully developed), to the distinction we have given them.

"There are many fields of discovery which offer real promise of excellent results, and there are, beyond these, a host of glittering possibilities, or what we are willing to accept as possibilities, however remote, which hold out the attractions of the grandest rewards which practical genius can ever attain. Who can reflect upon the almost immeasurable forces of solar heat and lunar attraction exercised daily upon our planet, and with visible results, without hoping, and indeed to some extent believing, that human ingenuity will yet find means for penetrating nearer and yet nearer to these tremendous mysteries of nature, and turn them into new channels for the good of man? With countless millions of tons of hydrogen in the sea and of oxygen in the air, shall we not yet find means to burn the very waters of the globe, and literally set the river on fire? With millions of tons of carbon on the earth, shall we not yet convert it, by some means, into palatable and wholesome human food? And shall we not yet find cheaper and readier means of converting the vast stores of vegetable fibre, with which nature abounds, into comely clothing, than by the present infinitesimal spinning and weaving of thousands of yards of yarn to form a single yard of cloth? That we may yet navigate the air is hardly less likely now than was the navigation of the sea by steam seventy years ago.

"Future invention must give us cheaper food, cheaper clothing, and cheaper lodging. Past invention has not sufficiently secured these, and the condition of trade and of society is now such that a majority of the population, even when working almost continuously, can gain but a decent subsistence, without any practical advance upon their daily necessities.

"Among the great inventions of the future, we believe we may look for a highly scientific and artificial agriculture, which shall more than double the active productive power of the soil. We shall learn how to restore to the soil a great deal of the vitality of which we now rob it and turn to waste; we shall learn how to secure increased action of the sun and atmosphere, and even of stimulating gases within its substance; and we shall thus place it in a measure beyond the caprices of climate. The force of steam, and many artificial agencies, including artificial moisture, will be turned to account, and the production of food will become a great and elaborated manufacture, to be carried on with an amount of talent and cultivated skill corresponding to that now engaged upon railways or in the great textile and metal manufactures of the country."

We present the readers of the ANNUAL OF SCIENTIFIC DISCOVERY for 1868, a fine Portrait of PROF. WILLIAM B. ROGERS, LL. D., the eminent Geologist and Physicist, and the President of the Massachusetts Institute of Technology, etc.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

THE SIEMENS FURNACE.

THERE is a small collection of gas-furnace models exhibited at Paris by Mr. Siemens, and now distinguished with the highest prize of the international jury, namely, the "grand prix." It may be said with justice that the Siemens furnace in this present Exhibition holds much the same position which the Bessemer process held in 1862, namely, that of the most important and most successful metallurgic invention of the day. It is hardly less important than the Bessemer process, and, although its invention dates about as far back as Mr. Bessemer's patents, it has only lately attained commercial success. In the space of the last five years the Siemens furnace has not been very materially altered or improved, but it has been largely introduced and its success established in many different branches of industry. The first manufacturers in England who availed themselves of the new furnace were the glass-makers. For purposes of metallurgy, greater difficulties and prejudices required to be surmounted. Some of the steel-makers on the Continent led the way. Mr. Mayr, of Leoben, in Styria, we understand to have been the first to introduce the new furnace for crucible steel-making on a large scale. In this instance the unfavorable position of the Styrian iron works, with regard to the supply of mineral fuel, was the principal inducement to apply gas in the steel-melting furnace. The gas is made, at Mr. Mayr's works, from lignite, which cannot be directly applied for melting steel, as the heat from it, when burnt on the grate, is not sufficient to produce the high temperature required for this operation. Mr. Mayr erected ten gas-furnaces, and they have proved a complete and perfect success, enabling him to make crucible cast steel by means of the cheap and very inferior lignite which exists in his locality. Within the last two years the Siemens furnace has been adopted in all the larger Bessemer steel works in England. In France, it is gaining ground with equal rapidity, and there are now twenty furnaces in course of erection under Mr. Siemens' own superintendence at the Creusot Works.

There are two distinct principles embodied in the Siemens furnace, namely, the application of gaseous fuel, and the regeneration of heat by means of piles of bricks alternately passed over by the waste gases and by the gases entering the furnace before their combustion. The gas-producer is a brick chamber about 6 feet wide by 12 feet long, with its front wall inclined at an angle of 45° to 60°, according to the nature of the fuel used. The inclined plane is solid about half way down, and below this it is constructed as a grate with horizontal bars. The openings for introducing the coal into the gas-producer are on the top or roof of this chamber, and the air which enters through the grate effects the combustion of the coal at the lowest points of the chamber. The products of this combustion rise, and are decomposed by the superposed strata; they are, moreover, mixed with a quantity of steam which is drawn in through the grate from a constant supply of water maintained underneath the latter. The steam in contact with the incandescent coal also decomposes and produces hydrogen and carbonic oxide gas, which are mixed with the gases produced by the coal direct. The whole volume of these gases is then conducted to the furnace itself by means of wrought-iron pipes. The gases enter one of the regenerators. The regenerators are chambers packed with fire-bricks, which are built up in walls with interstices and air-spaces between them, allowing of a free passage of gas around each single brick. Each regenerator consists of two adjoining chambers of this kind, with air-passages parallel to each other, one passage destined for the gaseous fuel, and the other for the supply of atmospheric air required for combustion. Each furnace has two such regenerators, and a set of valves is provided in the main passages, or flues, which permit of directing the gases from the producer to the bottom of either of the two regenerators. The gases, after passing one regenerator, arrive at the furnace, where they are mixed with the air drawn in at the same time, and produce a flame of great heat and intensity within the body of the furnace itself. They then pass, after combustion, into the second regenerator, which forms a set of down flues for the waste gases, and ultimately leads them off into a common chimney. On their way from the furnace to the chimney, the heated products of combustion raise the temperature of the fire-bricks, over which they pass, to a very high degree, and the gases are cooled more and more the further they proceed through the regenerator. After a certain time the fire-bricks close to the furnace obtain a temperature almost equal to that of the furnace itself, and a gradually diminishing temperature is arrived at in the bricks of the regenerator proportionate to their distance from the furnace. At this moment the attendant, by reversing the different valves of the furnace, opens the heated regenerator for the entrance of the gaseous fuel and atmospheric air, at the same time connecting the other regenerator with the chimney for taking off the products of combustion. The entire current of gases through the furnace is thus reversed. The cold air from the atmosphere, and the comparatively cold gases from the producer, in passing over bricks of gradually increasing temperature, as they approach the furnace, become intensely heated, and, when they are mixed in the furnace itself, enter into combustion under the most favorable circumstances for the production of an intense heat. The principle of this so-called regeneration of heat, therefore, consists in storing up the waste heat in one set of fire-bricks, and afterward making use of that heat for elevating the temperature of the fresh gases introduced for combustion. The action of these regenerators is so perfect that, with a temperature of somewhat about 4,000° in the furnace, there is no more than about 300° to be felt at the base of the chimney; the escaping gases having a temperature no greater than is absolutely required for maintaining the draft.

This is the present state of this beautiful and important invention. It has supplied us with the power of maintaining an exactly regulated temperature in a furnace of any required size and shape; it has made us practically independent of the quality and nature of the fuel used for producing the required heat from the most moderate up to the very highest temperature. It has reduced the expenditure for fuel to a very great extent, and it has given us one of the greatest desiderata in so many metallurgical operations, namely, a *clean* furnace, free from ashes, dust and dirt, and perfectly suitable for the working of the more refined and purified materials which modern industry has produced, and is still constantly improving upon. We have further to name, as an important feature of the Siemens furnace, the possibility afforded by it of changing the nature of the flame at will, by altering the relative proportion of air and gas admitted through the flues. A surplus of oxygen in the mixture will produce an oxidizing flame, and will give all the corresponding effects upon the materials exposed to its action. By the admission of a surplus of gas, on the contrary, the flame can be made of a reductive character, and used accordingly for deoxidation. In metallurgy, and particularly in the treatment of iron and steel, this is of the utmost importance. There are already several new modes of manufacturing steel direct from the pig iron, patented and practically carried out in France and in Germany, wherein the Siemens furnace is made use of as an indispensable condition for their success. The Exhibition contains a collection of samples of very fine steel made by M. Berard's process. This is called "Acier à gaz," and is made in a Siemens furnace, direct from pig iron. M. Berard constructs a Siemens furnace with the bottom formed into two separate parts, each hollowed out like a dish, and with a bridge between them, upon which the pigs introduced into the furnace receive a preliminary heating. The flame is maintained with a surplus of oxygen, and a quantity of pig iron is melted in one of the chambers or dishes. The oxidizing action of the flame decarburizes and refines the pig iron, and after a certain time a second quantity of pigs is thrown into the second dish and melted there. The flame is now reversed in its direction; the oxidizing flame is made to enter at the side where the fresh pig iron is placed. In passing over this, and oxidizing the carbon, silicon, and other impurities in the iron, the flame loses its surplus oxygen, and becomes of a neutral, or, at least, only slightly oxidizing character. In this state it passes over the other bath of molten iron, now partly refined, and it continues to act upon the impurities without attacking the iron itself. At a certain moment this portion of iron is completely converted into steel, and that part of the furnace is then tapped, so as to make room for a fresh charge of pigs in that place. After that, the current of gases is again reversed, the second bath now entering into the position previously taken by the first; and so the process is carried on continuously with two portions of iron, — one freshly introduced and acted upon by the oxidizing flame, the other partly converted into steel, and exposed to the neutral flame passing away from the first. M. Berard states that by protracting his process, and by adding speigeleisen, he can remove sulphur and phosphorus from the iron, and make steel from inferior pigs. Such statements, however, have been so frequently made by inventors, without having been borne out by facts in actual practice, that we must be cautious in accepting them.

Messrs. Emile and Pierre Martin, of Sireuil, have also commenced steel-making in a Siemens furnace. They melt a quantity of pig iron, and introduce wrought-iron scrap, puddled steel, or other malleable iron, into the mass while exposed to the oxidizing influence of the flame. They have produced steel of excellent quality by this method, and are now about to introduce their process into several steel works in France. The great advantage obtained by them, and one which has not yet been arrived at by the Bessemer process, is the conversion of old iron rails and similar articles into steel. This is a great desideratum, — particularly at this present moment of transition of the permanent way from iron into steel, — and attempts have been made by Mr. Bessemer, Mr. Adamson, and several others, to effect the same thing in the Bessemer converter. The first trials, although they proved the possibility of converting old iron rails into steel in that manner, gave an unsatisfactory commercial result. It was found that the rails required to be heated to a white heat before being introduced into the converter; that no more than one-third of such rails could be added to the proportion of two-thirds of very graphitic pig iron, and, with all this, that there was a greater waste in the converter, and more "scull" in the ladle, than with pig iron. Messrs. Martin, on the contrary, are able to use a proportion up to two-thirds of old rails to one-third of pig iron; they can manage the fusing very completely, and without excessive waste, and with a moderate consumption of fuel, — advantages which are all due to the Siemens furnace which they employ. Mr. Siemens has himself very recently patented an application of his furnace to the manufacture of iron and steel direct from the ore, and he has exhibited a model of such a furnace in Paris, to which is added a small piece of steel produced in that manner direct from the iron ore. The furnace is constructed somewhat similar in form to the Rachette furnace, namely, with two parallel sides sloping downward so as to form a kind of trough between them. The ore is charged at both sides on the top of the furnace, and slides down the inclined planes of the two sloping sides. At the bottom of the furnace the gases from the producer and the necessary supply of air are admitted, and produce an intense flame, the products of combustion rising upward through the masses of ore, which are acted upon in a similar manner to that in the blast furnace. With very pure manganese ores it is possible to manage the process so as to decarburize the newly produced iron immediately after it is made, or rather the heat can be made sufficient for melting a metal which contains less carbon than common cast iron as made in the blast furnace, and at a lower temperature. This metal is natural steel, or "raw" steel, and, made from ores of sufficient purity, may have all the qualities of the best cast steel. Mr. Siemens' new process, if successful and economical, would do away with blast furnaces, and all other processes for making and refining iron now in use; but it is too little advanced at this moment to allow of a judgment of the probability of its practical success, to say nothing about relative economies. Its practicability remains to be established; but if we consider how much the same inventors have already established, how difficult it was to believe in the success of the Siemens furnace itself, when first brought out, and how completely they have succeeded in this respect, we may be justified in entertaining some hope that this new invention will ultimately prove equally successful, although at present it may appear very revolutionary, and contrary to adopted notions. — *Engineering.*

Every year this country becomes less indebted to the artisans of the Old World for mechanical products which the skill of our own workmen cannot supply. Our locomotive builders have hitherto relied upon English manufacturers for their steel wheel-tires, subjecting them to heavy expense and vexatious delays. Now, however, we shall be independent of the Old World in this respect, as the Nashua Iron Company have erected Siemens' regenerative gas-furnaces, for the manufacture of steel weldless tires. — *Editor.*

HOT-AIR ENGINE.

The hot-air engine is based upon the fact that the most economical mode of obtaining power from heat is by its direct application to the expansion of air, or other permanent gases, rather than by that of steam or any other vapor. The hot-air engine now described differs from the so-called "caloric engines" in several essential particulars as to its construction, so that it is free from those defects which have hitherto prevented the practical carrying out of the caloric theory. In this engine the motive power, instead of being derived from the expansion of air heated in a separate generator, as in former engines, is produced by the expansion of air heated by contact with the fuel itself, and, in addition to this source of the power, by the action of the expansive force of the gaseous products of the combustion of the fuel, which heretofore have been permitted to escape into the chimney without being in any way utilized in the production of power. This result is accomplished by placing the fuel in a grate which can be hermetically closed, and forcing the air required for combustion into it by means of an air-pump worked by the engine itself, so that no part of the heated air of the gases produced by the combustion of the fuel can escape without passing through the cylinder, and there doing duty in the production of force. It is obvious that by such an arrangement the employment of separate iron generators for the purpose of heating the air is dispensed with, and that thereby one of the chief difficulties of the old caloric engine is avoided; for in the hot-air engine the fuel is contained in a fire-clay furnace surrounded by an air-tight iron casing, which in this way is entirely protected from injury. The fuel, which may be anthracite, smokeless coal, or coke, is thus burned under pressure with great regularity, and with the production of a uniform temperature, and at a rate exactly proportionate to the duty the engine is called upon to perform, thus avoiding all waste of fuel, — a result which has not been attained with any form of engine yet introduced.

The heated air, together with the gases produced by the combustion of the fuel, passes from the fire-box directly into the cylinder, so that every unit of heat produced is converted into force. The piston consists of a hollow plunger, to which the piston-rod is attached; the packing is placed around its upper circumference, where the heat is so moderate as to permit of efficient packing and lubrication. By means of an air-pump worked by the piston, a supply of air is forced into the grate. It here comes in contact with the fire, and a portion of it, in maintaining combustion, combines with the carbon, producing carbonic acid, etc.; while another portion of the air in excess takes up heat, and is thereby expanded. The mixed heated air and gaseous products of combustion speedily accumulate such an amount of expansive force as to set the engine in motion, by pressing on the piston. At the end of the stroke the expanded gases escape by the waste-pipe, which may be connected by a common stove-pipe with an ordinary chimney. Each upward stroke of the piston produces a downward corresponding stroke of the air-pump, and forces a fresh charge of cold air into the grate to maintain the combustion of the fuel, thus keeping up a continual supply of heated air and gaseous products. The power is increased or diminished by dampers, which pass the air through or over the fire, according to the amount required.

The chief advantages of the hot-air engine will be found in the very important fact, that there is not the most remote danger in its use. The furnace is perfectly insulated, so that all risk of fire is entirely avoided, and the presence of water, whether in large or small quantity, is dispensed with; so that this engine can be employed under circumstances where it would be impossible to use a steam engine. The great difficulty in the way of using the hot gases from the fire directly in the cylinder has been the apparent impossibility of preventing the surfaces from cutting, by the combined action of the heat and dirt. Mr. Shaw seems to have obviated this by attaching to his pistons a drum of a diameter very slightly — say one-eighth of an inch — less than that of the cylinder, and a length equal to the stroke, and providing an arrangement by which, before each stroke, the annular space between the drum and the cylinder is filled with cold and clean air of the same pressure as that which comes upon it afterward. Having no way of escape, this air remains in the space during the stroke, and protects the working faces from injury by preventing the hot and dirty gases from impinging at all upon them. As a further and very important means of economy, regenerating surfaces of iron and brick are provided, for abstracting as much as possible of the heat remaining in the exhaust air, and imparting it to the incoming cold air. A trial was had lately with this engine, which showed an economy of coal superior to what has been obtained with the steam engine.

GAS ENGINE.

A new gas engine; by Mr. Hugon, substitutes a constant gas light for the electric spark, to explode the mixture of gas and air in the cylinder. The gas jets which fire the mixture, and are of course extinguished by the explosion, flow by flexible pipes through orifices in the ends of the slide valve, and as often as extinguished are relighted by constantly burning jets which they meet in their oscillations. A very small jet of water is also introduced into the cylinder at each explosion, which by its instant vaporization extracts heat and serves moreover as a partial lubricator.

HORIZONTAL SUBMERGED PADDLE-WHEEL.

At a recent meeting of the Massachusetts Institute of Technology, Mr. Peter Lear exhibited and explained a model of a submerged horizontal paddle-wheel, modified by himself. Some years ago Lieut. Hunter, U.S.N., invented a submerged horizontal paddle-wheel, which was placed in the middle of the vessel; but it was found that, when the wheels revolved rapidly, and the more according to the rapidity of the revolution, a vacuum was formed at the centre, causing a flow of water to fill it, and requiring great additional power to overcome this weight of backwater. Mr. Lear found by experiment that the simple admission of air to the centre of the wheels remedied the difficulty, and caused the flow of water to be uniform in the desired direction, saving power and increasing speed. He also placed the wheels in the run of the vessel, one of the chief objections to Hunter's wheels being the space the machinery occupied in the middle of the vessel. His wheels externally do not project beyond the line of the vessel, and internally are encased in boxes. Being always submerged, they possess advantages over the side-wheels and propellers, which in a heavy sea are more or less out of water. The wheels and machinery, being below the water-line, are safe from an enemy's shot, and, acting independently, may, in case of need, be used for steering purposes. He thinks they are especially applicable to vessels of war, and has received the approval of many naval officers and constructors. He has tested the wheels on a model boat about 9 feet long, showing the advantage of admitting air by a tube which can be opened and shut at will; the greater the velocity of revolution, the greater the advantage of this admission in the saving of power.

NEW ARRANGEMENT OF PROPELLER SCREWS.

The improvement consists in quadrupling the number of screws, —that is, instead of working a boat with a single screw at the stern, two screws are applied at either end of extra keels, which are set on both sides of the bottom, and directly under the craft.

It is claimed that a very great increase of speed is gained by this new arrangement, and, in the trial trip at Troy, the propeller certainly moved through the water with great celerity.

Another unique arrangement consists of three vertical blades placed equi-distant around an upright shaft at the stern of the vessel, the lower end of the shaft working in a step on the prolongation of the keel. The shaft by which the blades are driven works inside a hollow shaft, on which is secured a horizontal eccentric, which connects by arms with the blades, and feathers them as they rotate. No rudder is used with this propeller, the set of the eccentric and blades, by means of a lever, determining the line of the vessel's progress.

The performances of the model are quite surprising. The vessel was made to turn exactly on its centre repeatedly, without going ahead, and a slight turn of the adjusting lever would send it either back or forward in a direct line, or in any circle desired, all without reversing the driving machinery and without the aid of a rudder.

HYDRAULIC PROPULSION.

A feature in marine engineering, which has attracted much attention, is Mr. Ruthven's system of hydraulic propulsion. Among other advantages of this system, it gives a ship the power of discharging a great quantity of water, and of thus keeping afloat after she has sprung aleak or has been penetrated by shot. It gives also facility of manœuvring, while the propelling power is far less liable to injury in action than either the screw or the paddle. It has been successfully applied to the "Waterwitch," a vessel of the British navy, and it is confidently expected that it will prove of practical value. Though less exposed to shot than the paddle-wheel, the bulky machinery of the turbine, above or near the water-line, may be easily crippled. High speed has never been attained by it, and its proved advantages are in the direction of floating fire-engines, which have of necessity powerful pumping gear for other purposes; it also involves carrying a great weight of water in the ship, increasing its displacement. As applied to the "Waterwitch," it acts by the ejection of jets of water from the sides of the vessel, a short distance above the water-line, the reaction of which upon the water propels it forward in a direction opposite to the jets.

The accounts of the performance of this vessel in October last gave rise to a good deal of discussion in the leading engineering papers as to the value of this means of propulsion as shown by the trial and as indicated by theory, and the general conclusion arrived at by those who took part in it was that it was very wasteful of power. Since then further experiments have been made and slightly better results obtained. The nozzles which, on the former trip, were placed so as to discharge the water into the air above the level of the external water, have now been arranged so as to deliver below the water-line, thus avoiding the loss of power in lifting the water through a vertical distance, and no doubt checking somewhat the velocity of escape of the water.

Admiral Elliott, in a paper read before the Institution of Naval Architects, came out very strongly in favor of the "Waterwitch" principle as the future motive-power for ships of war. He was as strongly sustained in the ensuing discussion by Sir Edward Belcher, and by Mr. Scott Russell, while Mr. Reed, Chief Constructor of the Navy, and others, opposed. Mr. Russell predicted that with time and perseverance the plan would certainly succeed in the end, and supersede the screw for the purposes of warfare. The official result of the trial of the "Waterwitch" with the "Vixen" seems to show that with a very crude and wasteful arrangement of her water jets, — wasting power both in lifting and short turns of the water ejected, — she did quite as well as the steamer, making 9 knots with 750 indicated horse-power. At a subsequent trial with deeper draft she did better, and "the results, bad as they are," says "Engineering," have led to sanguine predictions as to the final success of the jet system."

NEW WATER PROPELLER.

Mr. James Parker describes in "Engineering" for Jan. 11th, an apparatus for propelling vessels by steam without an engine. The steam is issued in extremely small jets, each shooting into the centre of an open pipe a quarter of an inch in diameter, conducting into a hot-water chamber, into which the jet carries with it a current of compressed air. This compressed and heated air is admitted upon the surface of the water in closed tanks, by the ordinary slide valve, and its force is employed to eject the water through propelling pipes on the plan of the "Waterwitch" above described. The steam and compressed air may also be driven into a dry hot receiver and thence used in a large cylinder engine. The contrivance is a modification of the caloric or hot-air engine.

TELODYNAMIC TRANSMISSION.

This name is given to a system of transmitting power to incredible distances, perfected, after many years of baffling experiment and endeavor, by M. G. A. Hirn. It is applied to distribute the power of the Falls of Schaffhausen throughout the manufacturing district around, and is in use in more than 400 of the factories of Alsace. The method is very simple, yet the application has been attended with almost endless difficulty. The principle is that of transmitting the power in the form of velocity of motion. Endless steel wire ropes are employed for this purpose, running at great speed — 10, 20, 30, or 50 miles per hour — over end pulleys 13 or 14 feet in diameter for short distances, without intermediate support; or for long distances, over pulleys of 6 or 7 feet diameter, at intervals of 160 yards.

The first achievement of M. Hirn was to transfer 12 horse-power from a waterfall to a distance of 88 yards; the next, to transmit 50 horse-power 264 yards. In 1857, he transmitted 45 horse-power 1100 yards; in 1858, 50 horse-power 126 yards; in 1859, 100 horse-power was carried 1,080 yards, and 60 horse-power 1,320 yards; and altogether, he records more than 400 successful applications of this sort. He has now no hesitation in undertaking to carry power 12 miles, and calculates to lose not over 20 per cent. in the transmission.

The system which is in operation at Schaffhausen, as well as at a number of other places in Europe, — the invention of Mr. Hirn,— is to avoid the necessity for the construction of costly works, by the substitution of a single or a small number of large wheels, in close proximity to the waterfall, and thence to distribute the power in a cheap manner over the entire district occupied by the town. The means employed are remarkable, not so much for their novelty as for the patient thought and experience that have been expended in bringing the system into a practical form, — a task which now appears to be successfully accomplished. The town with its factories is located about two miles above the Falls of the Rhine. The river where it passes through the town is broken into a series of rapids, with a depth of water almost equal to that at Niagara, and a width of about 350 feet. In the midst of these, near the left bank of the river, is situated the wheel-house, which contains a single turbine wheel of large size, and giving sufficient power to drive all the mills in the town. The vertical shaft of this wheel carries a large bevel gear at its upper end, by means of which its motion is transmitted to a horizontal one by its side, the gearing being so arranged that the latter makes a little more than 2 revolutions to 1 of the wheel, the speed being about 100 revolutions per minute. On this shaft are placed 2 wheels of cast iron, about 14 feet in diameter, with a deep groove formed in their face. In this groove are secured segments of hard wood, with a slight depression for the wire rope to run in. The grain of the wood in some cases runs lengthwise, and in others across the face of the wheel. These wheels are made in 4 sections, so that they may be readily taken apart when required for repairs. They are free to turn on the shaft, and are driven by an equalizing coupling placed between them. It consists of a strong sleeve of cast iron, secured to the shaft at its centre, and having projecting from it, on opposite sides, 2 stout arbors, each carrying a heavy bevel gear. These gears take into similar ones secured to the large pulleys, and transmit the motion of the shaft to them. If the rope on one wheel pulls tighter than that on the other, the intermediate gear on the driving coupling will turn slightly, and relieve somewhat the tension on the one wheel, while the other will be revolved in the opposite direction until it comes under the same tension as the first. The ropes that run on these pulleys are a little over an inch in diameter. At the speed above mentioned for the pulleys, it will be seen that the speed of the ropes will be about 4,400 feet per minute, or say 50 miles per hour. The difficulty of providing practically for such a speed will be apparent to every one who has had any experience in similar undertakings; and, as a matter of fact, this has been the great difficulty to be met in carrying out this plan of distribution, and it is only after a long series of trials that this has been successfully accomplished.

As already mentioned, the driving and driven pulleys at Schaffhausen are of iron, faced with wood; in other cases, to be mentioned presently, another combination is used, which has given the most satisfactory results. On the opposite bank of the river, or rather a few feet from it, are built some solid stone piers, on which is placed a second shaft and pair of wheels similarly arranged to those in the wheel-house, and high enough to keep the ropes in their transit clear of the water. The shaft is about 12 inches in diameter in the body, and 7 inches at the journals, and is supported in iron housings firmly bolted to the piers. By a pair of bevel gears, the motion of this shaft is transmitted to another at right angles to it, carrying another exactly similar pair of wheels, running in a plane in the direction of the course of the river, instead of across it. Coupled to the end of this shaft is a small one, which takes off a portion of the power to some factories situated just at this point on the bank. From the large pulleys, a second pair of wire ropes carries the power to a third pair of wheels, about 400 feet up the stream; and from here again it is transmitted a similar distance to another pair, and again to another, the pulleys being made with double grooves in their faces to accommodate the two ropes that pass around each of the intermediate wheels. At any of these points a portion of the power may be taken off, and this is done in a variety of ways as may be most convenient under the particular circumstances; sometimes by gearing and shafting, or again by small pulleys carrying a smaller size wire rope, say half an inch in diameter. On the last span, but one rope is at present in operation, the coupling between the two wheels being locked to prevent it turning; but new piers and housings are being erected for the purpose of transmitting the power to a still greater distance, and then the second rope will be required. As a rule, the speed of all the successive wheels and branch lines of shafting is kept the same, namely, 100 revolutions.

This system of transmitting power to a distance has been a subject of great study during the past 10 years, and is now being applied to much greater distances than those here mentioned. Where longer intervals than, say, 450 feet between the large pulleys occur, it becomes necessary to provide pulley supports to sustain the weight of the rope. These are made 6 or 7 feet in diameter, and it is these in particular that have given so much trouble. With the high speed of cable used, it was soon found that the wheels were very rapidly destroyed; or, if made of any substance hard enough to resist the action of the cable, they in turn as rapidly destroyed the latter. This has at last been obviated by filling the dovetailed groove in the face of the wheels with gutta percha, driven in hard; and it is stated that wheels so constructed have been in use 7 years without injury. The inventor, and the constructing engineers, Messrs. Stein & Co., of Alsace, who have introduced the system, estimate that it is possible to transmit 120 horse-power 12 miles with a loss of but 21 horse-power. The cost is stated at £320 per mile for everything, including cost of erection, and £1 per horse-power for the terminal apparatus, which of course is small in comparison with that of any system of transmission of the water itself for similar distances; and the only question remaining is the relative cost of repairs. If the statement published may be relied on, these are not excessive with the new system. The comparison with the method of transmitting the water bodily, illustrates beautifully the theoretical principle which is involved in this means of working, namely, the reduction of mass and the increase of velocity, the quick-running rope carrying in itself all the power of the ponderous mass of water slowly flowing through an ordinary canal. The importance of some system for the transportation of power can hardly be overestimated, and it is a matter of surprise that more serious attention has not been given to it by engineers. It is certain that, looking forward at least to the time when our fuel-beds shall be exhausted, as they one day will, such immense supplies of power as exist at Niagara will not be permitted to run to waste, and the first steps toward the practical accomplishment of such a utilization of it are accordingly of peculiar interest.—*Scientific American.*

TUBULAR WELLS.

A new system of well-sinking has of late years proved very successful in this country. It consists in forcing an iron pipe into the ground, of a diameter of 1¼ inches and about 12 feet long, pointed at one end, and perforated with holes about 16 inches upward from the pointed end. A 56 lb. weight, on the principle of pile-driving, is let fall upon a movable iron clamp fitted round the pipe, which is thus driven into the ground. The earth and sand which first enter the pipe are pumped out, and the coarser pebbles on the outside form a natural filter. Surface water is never received in such a well, and the water is cold and fresh. The process is cleanly, quick, and cheap, the price averaging 1½ dollars per foot sunk; where no rock is to be drilled, a satisfactory well can be obtained in half an hour, at a very trifling expense. The system was applied with great success in the Federal armies during the late war.

THE DIAMOND DRILL.

The apparatus for boring rocks with diamonds was originally patented in France by Leschot, in 1864, and was rendered practical by Pihet, in 1866. It consists of an iron tube, the end armed with a series of black diamonds of Siberia, which are set in such a way that by turning the tube they excavate an annular groove in the rock, and leave in the centre a solid cylinder which enters the tube, and is easily broken off and extracted when the boring is finished. 15 such machines have already been manufactured. The progress is about three-quarters of an inch per minute. The diamonds wear very little; it is known that this also is the case with the glazier's diamonds, and that the black diamond is a variety much harder than any other. The expense of boring with a machine of this kind is not materially greater than boring in the old way, although more work is turned out; but the great advantage is, that in the same space where three borers were attached, 8 of these machines may work, requiring not more power to drive them. The expense of excavating tunnels with a single machine of this kind, in hard rock, was found in France to be 40 or 50 francs per cubic metre, which corresponds to $6 or $8 per cubic yard.

TANNIN-EXTRACTING APPARATUS.

At a recent meeting of the Massachusetts Institute of Technology, Mr. Langley described a machine in process of construction, on a large scale, at the South Boston Iron Works, for the purpose of extracting tannin from hemlock bark, for the purpose of tanning leather. It is well known that the usual process for tanning leather, so as to obtain a first-rate article, is long and tedious, in a measure owing to the slowness with which the tanning principle is obtained from the bark. The bark, in pieces of half an inch to an inch thick, is soaked for 15 minutes in water at about 200° F., and is then fed into a hopper, whence it passes into a machine like a three-rolled sugar or cane mill, passing between the rolls, and coming out torn and compressed to such a degree that most of the tannin-bearing cells are crushed and their contents available; the crushed product then falls again into a vat of hot water, where it is agitated thoroughly by a wheel; it is then raised by a series of buckets, somewhat as in a grain-elevator, made of wire netting, to allow the water to drip through; it is then raised to another hopper, whence it falls into another set of three rolls, coming out finally in flakes or sheets, like coarse paper, almost free from the astringent principle. The extracts thus produced, in a highly concentrated form, and almost saturated, are from four to six times too strong for tanning, and require to be diluted; they do not ferment, and may therefore be transported easily to parts of the world where tanning materials are difficult to obtain. They possess a beautiful crimson color, and, in the most concentrated form, deposit a soft solid substance resembling tannin, soluble in cold water. To obviate the blackening effects of the contact of iron, the rolls are covered with a coating of zinc. He drew on the blackboard the details of the machine, which can prepare a cord of bark per hour, equivalent to a barrel of the tanning concentrated extract. Whether leather can thus be made any quicker, is another question. The great practical value of the machine and process is this, that we can go to the woods and get our tanning extracts by the barrel, instead of carting away loads of bark; thereby securing great economy of time, labor, and space, and opening an immense field of profitable industry and commerce in supplying other countries where tanning materials are not indigenous.

VENTILATING FAN.

At a meeting of the Massachusetts Institute of Technology, Mr. S. P. Ruggles exhibited and explained a model of the Ventilating Fan or Blower, invented by himself, now in practical operation at the Institute, and about to be introduced into the State House. It consists of three floats, of which one remains for a short time stationary, while the other two are moving, each in turn becoming stationary. The object of the stationary fan is to act as a wall to prevent the air going back, and to cause the air brought by the ascending float to pass upward through the box which conducts it to the building. This action of the floats is produced by the shaft which carries them being made in three parts, one within two others, each carrying a float. From the condition of rest the first float begins to move slowly, and gradually increases for a quarter of a revolution, then carries the body of air at uniform speed for half a revolution, and then decreases in speed in the last quarter of revolution to the state of rest. When the first float has completed a half revolution, the second float begins to move, to follow in like manner; the third float begins to move when the first has completed its revolution, and follows in the same manner as the other two, — the action of the three producing a constant and uniform current.

This action is produced by an ingenious arrangement of wheels of irregularly oval shape, producing a crank motion. The fan at the Institute is vertical, 10 feet in diameter and 10 feet long; it makes about 12 revolutions per minute, forcing out 700 to 800 cubic feet of air at each revolution; this amount must go forward, and none can go back on account of the wall of the stationary float. It requires only about one-sixth the power of ordinary fans of this size to move it. In the great number of rotary aspirators and blowers in use in Europe and in this country, centrifugal action from rapid revolution is depended on. In the apparatus of Mr. Ruggles centrifugal action is not the motive force, but the mass of air is drawn in below and forced or bucketed up, and delivered to the discharge pipe.

Fan-blowers have been used in which the temporary stationary condition of a float had been employed, as in the apparatus of Mr. Ruggles; but these plans made use of only two floats, so that no provision was made against the backward flow of the air. In his own invention, by using three floats, he had rendered this retrograde action impossible, as all the air drawn in can pass in no other than a forward direction, where it is required for use.

THE PNEUMATIC DESPATCH IN PARIS.

The tube connects the telegraph stations at the Bourse and the Grand Hotel, and is the first instalment of a complete system throughout Paris. The method adopted is the reverse of our own, namely, the elasticity of compressed air in place of a partial vacuum, so that neither an air-pump nor a steam engine is required. The power used is water from the reservoirs of the city of Paris, which give an ascension of rather more than 50 feet. There are three vessels, made of iron plate, and measuring each about 1,200 gallons; the first of these receives the water and effects the compression, the two others are the receivers of the compressed air. As the water arrives, the air within the first vessel is of course forced into the other two, which are connected with it by a valve opening inward. When the first vessel is filled with water, another cock is opened, the liquid is allowed to run off and the air to enter by means of a valve provided for the purpose; the operation is then repeated, and the effect is the production in the two condensers of a pressure equal to about two atmospheres. The tube that connects the two stations is of cast iron, about 3,500 feet long, and 2½ inches in diameter, having its termini in two chambers with tightly-fitting doors, which allow the piston despatch-box to be placed or withdrawn from the tube without difficulty. This carrier is a small brass cylinder, 4 or 5 inches long, closed at one end, and with a movable cover at the other. It will contain about 40 despatches in envelopes. Five minutes are found to be sufficient in practice for the piston to make the double journey. The time occupied in the passage of the despatch-box in one direction is sufficient to produce the necessary pressure for the return. — *The Engineer.*

DAM ACROSS THE ST. LAWRENCE.

Damming the St. Lawrence is the topic of the day with the citizens of Montreal. Monstrous as the undertaking seems, engineers have laid it out, and capitalists are about to apply to parliament for a charter incorporating a capital of 2,000,000 of dollars for the purpose. The water-power to be obtained by a successful accomplishment of this work would be greater than any other in the world, and could not fail to build up a mighty manufacturing metropolis around the present nucleus called Montreal. At the same time, the city would acquire, what it must soon have by some means, a head of water and a pumping power adequate to its own supply.

The arrangements of nature to facilitate the gigantic work are quite interesting. The Lachine Rapids, just above the city, are said to afford a fall of 25 feet in about a mile. They are divided longitudinally by a series of islands running their entire length, and forming with the northern bank of the river a natural enclos ure, lacking only the proposed dam at its lower end to make an enormous basin and to convert the rapids into a smooth mill-pond or rather lake, with a semi-Niagara at its outlet, and a hydraulic power estimated as 2,000,000 of horses. There is also another natural channel running between the islands, which admits of being made into a mill-stream of 75,000 horse-power. To complete the work of nature in this way, requires a dam 2,800 feet in length, leaving the southern and only navigable channel open for commerce, and the shoal, rocky bed of the river below the dam, besides the shore, for the accommodation of a city of mills and factories. A great canal is also to be led inland from the new lake, to supply other factories and conduct an abundance of water to the city. — *Scientific American.*

A DAM BUILT IN MIDWINTER.

Among recent engineering operations, the construction of the dam at Turner's Falls, Mass., on the Connecticut River, in the depth of winter, is somewhat interesting. The channel being divided by an island, the work, a dam of 23 feet in height and 900 feet in length, was built in two sections, one after the other; an opening, 12 feet lower than the dam and 200 feet wide, having been left in the middle of the first section, for the passage of the current while the second section was building. But before the second section had been completed (which was done by the middle of December last) a freshet brought down a raft of timber against a wooden barrier, erected to guard the opening left in the first section, and to facilitate finally closing it, and, sweeping away this structure, tore out the foundations of the dam below the opening, down to the bed-rock, for a breadth of about 110 feet.

This breach must be repaired at once or the whole remaining work was liable to be swept away by a freshet at any time in late winter or spring. The ordinary flow of the river through the breach was 5 to 8 feet deep, with a velocity of 10 to 12 feet per second, and a volume, as estimated, of 5,000 to 10,000 cubic feet per second. To turn the water out of this channel, that the masonry might be laid in its bed, a provisional dam was constructed of timber cribs, bearing against the stream in the form of an arch, and spanning horizontally the breach. The first crib or pier was towed into position on the 31st of December, and sunk by filling with stone. Ten such piers were placed at equal distances, ends against the current, as radii in a segment of a circle, and the last was in position on the 16th of January, 1867; the current still flowing freely between them. The passages were now to be closed by a second set of piers, tapered to fit the convergence of the first set, and serving at once to key and fill the arch, which then presented a front to the current only consolidated the more the greater the pressure brought against it. The last of these plugs was put in on the 1st of February. Nothing remained but to fill in and tighten the barrier, after which the dam was laid in perfect security, commencing March 1st and finishing on the 22d of that month. The work of filling in was interrupted by high water for a few days in the middle of February, and two piers had been lost while floating them to their places, by the breaking of guys; but with these exceptions, no mischance occurred, and notwithstanding the severity of the season and the arduous nature of the work, no loss of life, personal injury, or unusual sickness was suffered among the 70 men employed. Both the process and the result reflect great credit upon the agent, Mr. Geo. W. Porter, and the superintendent, Mr. A. P. Richardson, who jointly devised and managed the plan. — *Scientific American.*

THE AMERICAN LATTICE BRIDGE.

It may be considered as a generally received opinion among engineers of the present day, that the open-web girder offers superior advantages, upon the whole, to the older and more solid-sided form. Were any proof required of the general favor with which they are now regarded by the profession, two out of three large bridges erected would bear witness to the fact. When, twenty years ago, a commission was appointed to inquire into the application of iron to railway structures, its verdict respecting the open-web form was that "lattice girders appear of doubtful merit;" and Mr. Fairbairn, in one of his works, expresses a nearly similar opinion. In spite, however, of all the cold water thrown upon the new claimant for engineering consideration, it has continued steadily to make way; and it is interesting to contrast its present position with that which was predicted for it. The disparaging statements and condemnatory arguments urged against all girders of the open-sided form on their introduction, serve to forcibly point out that men of scientific attainments are not exempt from those foibles and prejudices which some people imagine are confined to the less educated and instructed world at large. The commission was evidently wedded to the old system, and could not perceive that their favorite example embodied all the particular attributes and features of the ancient methods of construction. Any one who glances at the two different forms, beholds in the cumbersome, shapeless proportions of the solid-sided girder the presence of that solidity and massiveness which formed a distinguishing characteristic of the days when science was unknown, or at any rate unpractised, and when brute force was the sole power employed to counteract and resist the action of external agents. In the open-web beam we recognize a worthy offspring of scientific construction. It resists the action of the strains brought upon it, not *en masse*, as in the case of its older rival, but by that due proportioning and accurate adjustment of all its various parts, which can alone impart to a structure the appearance of lightness and elegance; while, at the same time, it bestows upon it all that strength and rigidity inseparable from the duties it has to perform. The open-web girder, which, in its widest signification, includes all those classed under the various denominations of triangular, trellis, lattice, and truss, was borrowed by us from our ingenious transatlantic brethren, who were first to erect some splendid timber bridges upon this principle. They possess, at the present day, numerous gigantic examples of this method of construction, embodying every principle, with the exception of that of suspension, which could possibly be introduced in the erection of timber spans. It must not be supposed that the form of girder in question sprung into full development upon its first appearance among us. Far from it. The earliest examples of wrought-iron open-sided girders were erected in Ireland. We may select, as a specimen of their original construction, a bridge carrying the Dublin and Drogheda Railway over the Royal Canal in Dublin. However worthy of commendation, as a pioneer of the new principle, this bridge may be considered, it cannot be otherwise regarded than as a miserably inefficient application of it, or rather as no correct application whatever. The web, wherein lies the especial value of the system, is composed of a series of thin bars closely interwoven and riveted together, so closely as to present a completely reticulated appearance, and without the slightest attempt at proportion or distribution of material, and constitutes a perfect mockery of all the laws laid down by theory for correctly designing girders of this nature. Curiously enough, about 30 miles further on, upon the same line of railway, we have in the Boyne Viaduct one of the finest existing examples of the lattice principle, where the laws of theory have been closely adhered to, and only received that modification which must always accompany their practical application. Comparing these two structures together, and contrasting the total absence of all scientific principles and theoretical requirements in the one with their full and accurate development and application in the other, it is scarcely possible to believe that the two designs could have emanated from the same individual. — *The Engineer.*

THE OHIO RIVER BRIDGE AT LOUISVILLE.

This is a Fink truss bridge, of which a number are built at different points on the Louisville and Nashville Railroad; the largest is at Green River, and it has been admired by many distinguished architects and engineers of this country and of Europe. It is the invention of Hon. Albert Fink, who will superintend the construction of the Louisville Bridge. The entire length will be 3,650 feet, with a pivot bridge across the canal of 280 feet. The location will be fixed somewhere between the Elm Tree Garden and Rock Island. It will be reached by a grade of about 70 feet to the mile on each side of the distance for nearly 350 yards. There will be 13 spans of 250 feet each, with one large span of 400 feet across the Indiana chute. The bridge will have an elevation of 90 feet above low water and 49 feet above the high water of 1832. The superstructure, which is entirely of iron, will be 152 feet above the foundation, while the floor of the bridge is elevated at 120 feet above the foundation. It will require about 756,000 cubic feet of stone; but the cost of the entire bridge will be at least one-fifth less than that of any other which would answer the same purpose. The suspension bridge at Cincinnati cost $2,000,000. It is 2,000 feet in length, and is only for a common road. The Ohio River Railway Bridge at Louisville is to be 1,650 feet longer, beside the pivot bridge across the canal, and the whole cost will not exceed $1,500,000.

THE CERE VIADUCT.

This fine structure, crossing the valley of the Cere and carrying the Paris and Orleans Railway at a height of 181½ feet from the water, is another and more complex and lofty specimen of the modern style of bridges supported on tubular piers. Each of these consists of 8 cast-iron columns, grouped in an ellipse, united by cross bracing, and resting on a base of brickwork. The piers taper upward from a base of about 8 x 16 feet, at a rate of 1 in 30 toward the major axis, and 1 in 15 toward the minor axis of the ellipse. There are 5 spans of lattice girders, the 3 central spans being 164 feet each, and the end spans 145 and 139. The abutments are of stone. The erection of this viaduct was conducted in the same bold manner as that adopted at Fribourg, the girders being first put together on the abutments, and then pushed forward until the overhanging ends were over the brickwork base of the first of the iron piers to be erected. They were then braced, and used as the jib of a crane for hoisting into place the successive joints of the tall iron limbs upon which they were to rest. When one of the piers was thus completed, the girders were again pushed forward until the foremost end rested on it and projected forward over the base of the second pier, and the same process as before was repeated until the structure was complete. The total cost was about $150,000.

SUSPENSION BRIDGE OVER THE OHIO RIVER AT CINCINNATI.

This, lately completed from the plans of Mr. J. A. Roebling, has a span of 1,057 feet, the largest existing span of a suspension bridge. It crosses the river with a clear headway of 100 feet above low water, the greatest variation between the summer low level and that of the spring freshets being 60 feet. The massive towers of masonry rise 200 feet above low water. The supporting members of the bridge are two cables of parallel wires, of No. 9 gauge, each cable being 12½ inches in diameter, and containing 5,250 wires, the breaking strength of the wire being over 60 tons per square inch of net section. Nearly half of the weight of the roadway and load is carried by diagonal wires, running straight from the tops of the towers to successive points along the floor, so that the main cables, stiffened by this arrangement, really carry but about half of the total weight of the roadway and load. Length, 2,000 feet; cost, $2,000,000.

NEW YORK AND BROOKLYN BRIDGE.

This contemplated bridge across the East River, on the plan of Mr. J. A. Roebling, with a headway of 130 feet in mid-channel, will have a great suspension span of 1,600 feet in the clear, nearly three times that of the famous Menai Bridge. This is to be approached, on either side, by a succession of arches, the whole length being more than 1½ miles, and the total estimated expense 6,000,000 dollars. The cables will be four in number, each 14 inches in diameter, of No. 9 wire, arranged one at each outer side of the platform, and two near the centre, the whole width of the platform being 80 feet. The platform will have six wrought-iron trusses, each 10 feet deep, for its whole length. There will be a footway along the centre, 10 feet wide, a horse-railroad on each side, each 16 feet wide, and a roadway on each outside of the platform, also 16 feet wide, with a projection of the cross-beams of 3 feet on each side, to receive the connections from the outer cables. The towers will be of granite, 350 feet high, and 150 feet by 90 feet at their base. As a whole, no work of the same character yet executed approaches this in magnitude.—*Engineering, July*, 1867.

A full description of the bridge by Mr. Roebling, may be found in the "Journal of the Franklin Institute," Philadelphia, for Oct. and Nov., 1867.

GREAT BRIDGES.

Bridge over Straits of Messina.—The width of the Straits which secures the least depth of water for the foundations of the (bridge) piers is 13,123 feet from shore to shore; the depth of the piers on this line would be 360 feet below the water level, while on a shorter line the depth is 70 feet greater. The height under the spans of the suspension bridge proposed by M. Oudry would be 164 feet, making the total height from foundation to flooring 524 feet; the length of the spans would be 1,000 metres or 3,281 feet each.

Bridge over the Mississippi at St. Louis.—This will accommodate two double tracks of rails for street-cars, beside sidewalks for foot-passengers, and will consist of three arches, the central arch having a span of 515 feet, and the two side arches 497 feet. One pier will be nearly 200 feet in height from the bed of the river and 110 feet in width, and the other 170 feet in height.

New Suspension Bridge at Niagara Falls.—Towers to be 105 feet high, span 1,250 feet, height above water 175 feet, and width of roadway 10 feet. Intended for carriages and pedestrians.

SUEZ CANAL.

Though the distance from the Red Sea to the Mediterranean is only about 70 miles, it is one of the most difficult engineering undertakings of modern times. After cutting this canal about 20 miles of the line to the requisite width, an obstacle, thought by many to be insurmountable, has been met with. It passes through a shallow lake for a considerable distance, and it is in this that the trouble has developed. The bottom is a quagmire, and, as fast as it is thrown out, fills up again, by oozing in from the bottom and sides. A difficulty under which the railroad company labor has also been found to threaten the canal-builders even more formidably than it has that enterprise. It is the drifting sand of the desert, that constantly moves with the wind, filling up and covering over every obstacle in its path. The railroad managers are obliged to be at work constantly to keep their track above ground; and it is claimed by many engineers to be practically impossible to keep the canal open, even if it ever is finished.

A recent report states that the work is progressing favorably, and will be completed in 6 years. It is intended to be 300 feet wide and 25 feet deep. The part near to Suez is being executed in the best possible manner, and if it all shall be finished equal to this section, the Suez Canal will be a work in the engineering line never before approached in the history of that science.

The line of the canal runs almost due north from a point opposite Suez, debouching at Port Said in the Mediterranean. It is already cut to a width and depth sufficient to permit the passage of boats from Suez to Port Said. From Suez north to a distance of 20 miles barges are towed by men or horses, and from that point to the sea small screw steamers ply back and forth. This is done by means of a small channel or ditch cut in the middle of the intended canal, and about 25 feet wide. The ship canal is being cut down on each side of this to the requisite width, but in no place has it reached a sufficient depth. The depth is to be obtained by excavations to a point where the water shall prevent this class of operations, and after that by dredging. The great canal has one feeder from this branch of the Nile to supply it with water, the balance coming from the lake and the two seas that it is intended to connect.

In the fresh-water portion on February 11, 1867, a vessel from Siam, with packages for the Paris Exhibition, took that route; and on February 17, a vessel of 80 tons, from Trieste, arrived in the Red Sea, having passed through Egypt by this canal.

CONTEMPLATED GREAT CANALS.

Canal des Deux Mers. — The French government contemplate a new and vast project, which if carried out will be of incalculable importance to that nation. This is to enlarge the "Canal des Deux Mers," so that large vessels may pass directly from the Atlantic Ocean to the Mediterranean, without passing under the guns of the fort of Gibraltar. At present the canal connects with the Garonne River at Toulouse, and falls into the Mediterranean near Agde; the river reaching the ocean at Bordeaux completing the chain of communication. In order to fill the canal when it is enlarged, it is proposed to intercept the innumerable mountain streams from the Pyrenees and mountains of Auvergne, and imprison them in huge reservoirs, whence the water can be drawn as needed.

Florida Canal. — It is said that a company has been formed, and will soon commence operations, for cutting a ship canal across the upper portion of Florida, connecting the Atlantic Ocean with the Gulf of Mexico. This would be of incalculable benefit to commerce, both in shortening the distance between the Atlantic cities and the gulf, and in saving many lives and much property annually lost on the dangerous coast of Florida.

NINE-INCH RAIL.

To the Rhenish Railway Company is due the credit of first introducing a rail 9 inches high, with the design of doing away entirely with sleepers, which in Europe forms quite an item in railroad repairs. The 9-inch rail rests upon a bed of plates which are covered with 5 inches of gravel, and on top is a 2-inch layer of earth well stamped down so that the top of the rail projects only an inch above the surface. The two lines of rails are connected every 3 feet, so that the track resembles a ladder lying on the ground and half buried in it.

STEEP GRADIENTS AND SHARP CURVES.

The report of Mr. Ashburner, on the practicability of building a railway over the Hoosac Mountain, alludes to the adoption of some exceptionally severe grades and curves on several successful lines of railway, not as an argument in favor of adopting these objectionable features, but to show their practicability for avoiding an unreasonable expenditure, and for expediting the opening of an important route that otherwise might be delayed for many years for want of funds for executing a more perfect system. The Baltimore and Ohio Railway, going west, ascends 11 miles on the eastern slope of the Alleghanies at an average of 116 feet to the mile; the summit level is 2,626 feet above tide. On the Virginia Central Railway, at Rock-Fish Gap, the average gradient on the east side was 257.4 feet per mile for a distance of 2.37 miles, the maximum 295.68 feet per mile, half a mile long; sharpest radius 234 feet, the grade on this curve being reduced to 237.6 feet per mile: on the west side the average was 223.1 feet per mile, for 2.02 miles; maximum 279.34 feet per mile; ruling curves 300 feet radius, on which the grade was reduced to 237 feet per mile.

The Pennsylvania Railway, across the Alleghanies, rises to an elevation of 2,176 feet above tide; the maximum grade extends for a distance of 9¾ miles, and is 96 feet per mile on straight lines; this grade is eased on curves; one curve is on a radius of 636 feet, and extends over 190 degrees. In Chili, South America, on the Santiago and Valparaiso Railway, occurs an incline of 12 miles, rising at an average of 113½ feet per mile to a height above the sea of 2,640 feet; the maximum is 118.6 feet per mile for 3½ miles, and on it there are 16 curves of 604 feet radius each.

In the passage of the Sœmmering Mountain, in Germany, on the Vienna and Trieste Railway, the height attained is 2,887 feet above the sea; the length of the incline 13¼ miles, and the average rise 112.3 feet per mile; the sharpest curve 625 feet radius; the greatest inclination 132 feet per mile, and for a distance of 2.53 miles. The Giovi incline, passing over the Apennines on the Turin and Genoa line, rises for 6 miles to an average of 146.6

feet per mile. An incline on the Great Indian Peninsula Railway of Hindostan rises to the height of 2,027 feet above the sea, having its own altitude 1,831 feet, and its length 15,85 miles; but the length is broken by short, flat slopes, so that the steepest gradient is 142½ feet per mile.

The intended summit of Mt. Cenis Railroad is 5.815 feet. In the contemplated railway from Vera Cruz to Mexico, the elevation to be reached is 8,400 feet, which must be climbed in a distance of 150 miles; the gradient is for great distances as much as 1 in 25, and this with many and short curves. The highest elevation in Great Britian, the Caledonian, is only one-fifth of the Mexican. — *U. S. Railway Times*, 1867.

LOCOMOTIVES AND WAYS FOR STEEP GRADIENTS.

In a recent patent obtained by Mr. Thomas Page, an English engineer, a tractive power for locomotives used for steep gradients, exceeding that of ordinary locomotives, is thus obtained. In addition to the ordinary rails, he places on the inside or outside broad tramways of stone or wood, roughened or serrated, to afford the bite required for the driving-wheels of the locomotive. These driving-wheels are made with peripheries of iron, wood, or other material adapted to hold or bite the tram, and are serrated for the purpose. To keep the engine on the track, flanged or guide wheels are used, disposed at an angle of 45 degrees, and bearing on the inner edges of the rails; these support none of the weight of the engine. By this means, on average ground, as on turnpike roads, he thus dispenses almost entirely with cutting and embanking. For a cheap line, properly seasoned and creosoted wood, 10 to 12 inches wide, and 6 inches deep, is a good material for the trams; on the inner edge of these trams are fixed flat iron or steel rails, on which the passenger and freight trains travel. The periphery of the wheels, though roughened, should be truly cylindrical; small diamond-pointed projections of slight elevation are a good form of roughening.

EAST INDIAN MOUNTAIN RAILWAY.

When the British government determined to construct a network of railways throughout India, considerable discussion took place as to the best means of connecting Bombay with Calcutta and Madras; for, as there was no break in the Western Ghauts, the idea of constructing a railway across them seemed utterly impossible. However, surveys were made, and at length it was determined to build the railway as it now exists; that is, run from Bombay to Callian, a distance of 30 miles inland, and there it forks into two branches, one going north-east to Agra, where it joins the East Indian Railway leading from Agra to Calcutta, and the other going in a south-easterly direction towards Poona and Madras. The first of these crosses the Thell Ghaut,—a mountain rising 1,912 feet above the level of the sea,—and the latter crosses another mountain, called the Bhore Ghaut, which rises to the height of 2,037 feet above the sea. The difficulties which the engineers encountered in the construction of this work were something stupendous; but as most of the ground over which the line passes is now cleared of jungle and levelled, and the all-but inaccessible mountain scarps, along which the track has been laid, have been well-nigh obliterated, the obstacles in many places are scarcely apparent.

The Bhore Ghaut incline, which is the larger of the two mountain ways, is 15 miles and 68 chains long. The level of its base is 196 feet above high-water mark at Bombay, and of its summit, 2,027 feet; so that the total elevation of the incline is 1,831 feet. Its average gradient is 1 in 48; its least, 1 in 330, and its steepest, 1 in 37. Throughout its length are 26 tunnels, ranging from 49 to 437 yards long, and forming a total length of 3,985 yards, or 2½ miles.. There are 8 viaducts, most of which consist of arches of 50 feet span, varying in length from 52 yards to 168 yards, and from 45 feet to 139 feet high; so that the total length amounts to fully half a mile.

The total quantity of cuttings amount to 1,623,102 cubic yards, and the embankments to 1,849,834 cubic yards, the greatest depth of cutting being 80 feet, and the maximum height of the largest embankment being 74 feet. Besides this, there are 18 bridges of various spans, from 7 to 30 feet, and 58 culverts, of from 2 to 6 feet span. The cost of the incline was £597,222, or £41,188 a mile; or, in other words, about $3,000,000. The works were commenced in 1855, and were finished about 5 years afterwards.

It is obvious that to make a train laden with freight, or full of human beings, ascend a gradient of upward of 1,800 feet, must require extraordinary locomotive power. Accordingly, when an ordinary passenger train approaches a station at the foot of the Ghauts, it is divided into two sections, and generally two exceedingly powerful engines are attached to pull, and a third to push each section up the ascent. Powerful brake vans are also attached, so that in case of accidents the train may be stopped and prevented from receding down the slope. In descending the Ghauts, similar precautions are taken to prevent the train from going too fast, and fewer locomotives and more brakes are despatched with each train. Even then, it requires the utmost caution to prevent the train getting too much headway, lest it run off the rails, and be dashed to pieces over some of the yawning chasms with which the mountains abound.—*Cincinnati Journal.*

MT. CENIS RAILROAD.

This great engineering work is at last completed, the first engine and train having passed from St. Michel on the French side, to Susa on the Italian side, a distance of 48 English miles, August 26, 1867. This will make the time between Paris and Turin 22 hours. The initial point on the French side is 2,493 feet, and the summit of the pass 6,322 feet, above sea level. For 6 miles before reaching the summit the ascent must be on an average gradient of 1 in 14. From this point to the Italian terminus of the road, there is a uniform gradient of 1 in 12. The existing travel across Mount Cenis averages 220 passengers and 120 tons of goods, daily, requiring 1,200 horses, or, allowing 10 miles a day to each horse, 12,000 miles of horse travel daily across the mountain. The time required is from 9 to 14 hours, but by the railroad the journey will be completed in less than 5 hours.

An English paper says: "After leaving the deep valley in which St. Michel is situated, the line passes by a gradient of 1 in 30 to the Pont de la Denise, where an iron bridge spans the river Arcq, near the site of that which was carried away by the inundations of last year. The first very steep gradient, of 1 in 12, was seen in passing Modane, and, foreshortened to the view, appeared on the approach as if impossible to surmount; but the engine, the second constructed on this system, had already proved equal to the task on the experimental line, and, clutching the central rail between its horizontal wheels, it glided quickly up, under a pressure of steam not more than 80 pounds to the square inch, without apparent effort.

"The progress was purposely slow, because no engine or carriage had previously passed over the line, and also to give opportunity for examining the works. The damages to the road on which the line was chiefly laid were found to be substantially repaired by the French government. The train entered Lanslebourg Station under a triumphal arch, having accomplished 24 miles of distance, and attained an elevation of 2,100 feet above St. Michel. From this point the zigzags of ascent commence, and the gradients over a distance of 4 miles were for the most part 1 in 12. Looking down from the train near the summit, as if from a balloon, four of the zigzags were visible at the same instant to a depth of 2,000 feet. The power of the engine was satisfactorily tested in this ascent, and the summit was reached under salvos of artillery from an improvised battery, and amid the cheers of French and Italians who had gathered to welcome the English on the frontier.

"The hospice, the lake, and the plateau of the summit, surrounded by snow-clad peaks and glaciers, rising to an elevation of from 10,000 feet to 13,000 feet, were passed, and the portion of the descent commenced from the Grand Croix. The railway here follows the old Napoleon Road, which was abandoned long since for diligence traffic on account of the dangers from avalanches. Masonry-covered ways of extraordinary strength had here been speedily provided for the railway. The descent to Susa was a series of the sharpest curves and steepest gradients, on which the central rail had been continuously laid. The confidence of the party was manifested by their crowding round all parts of the engine, and they thoroughly enjoyed the ever-changing scenes as they passed round the edges of the precipices. Susa was entered amid the acclamations of multitudes of spectators. Thus was completed a journey unexampled in its character, both as respects the steepness of gradients, the elevation of the summit level, and the difficulty with which the curves and precipices were overcome."

In the "Journal of the Franklin Institute," for November, 1867, at the close of an interesting letter on the opening of the Mt. Cenis Railway, Mr. Coleman Sellers made the following remarks: "The use of two outside rails, and one central adhesion rail, was patented many years ago by Mr. George Escol Sellers. Mr. Trautwine, the engineer of the Panama Railroad, advocated the use of this plan across the Isthmus. The engines were so built; but the engineer who succeeded him concluded to cut down the road and use common engines. An engine was run on this plan in New York, weighing 1,100 lbs., which was capable of drawing up a grade 250 feet to the mile with ease. The plan on which they were constructed was better than that at present used in Europe, as they were so constructed that the whole weight of the train should act in producing adhesion, so that the heavier the load the harder the grip on the central rail. I speak of this invention because I think it is due to America to say that it is purely American, and was advocated and used so long ago that the patent has expired; so that you can judge very well that we have precedence of any other country in this case."

CENTRAL PACIFIC RAILROAD.

According to Mr. George E. Grey, as given in "Engineering," the Central Pacific Railroad of California commences the ascent of the foot hills of the Sierra Nevada Mountains 7 miles from Sacramento (tide-water of the Pacific), and thence to the summit of the mountain pass, 7,042 feet, and 105 miles distant, there is a continuous series of heavy ascending grades and sharp curves. The maximum gradients on this portion of the line are 1 in 45½, of which, however, there is less than 6 miles, and the sharpest curves are 575 feet radius. The line is completed and in operation to within 12 miles of the summit, and the earthworks and bridging are nearly completed for 50 miles eastward to the eastern base of the mountains. From the eastern base of the mountains for about 575 miles, to Salt Lake, the construction is remarkably easy and cheap; the line follows the valley of the Truckee River down to the big bend, where the river turns abruptly to the north, and from there to the valley of the Humboldt River nearly to its source, thence to Salt Lake, and the initial point of meeting the Union Pacific Railroad from the east. The tunnelling is not of any great extent, and the material pierced is generally of such a character as not to require lining. The longest tunnel on the line is at the summit of the Sierra Nevada, and will extend 1,658 feet through a very hard, tough granite. Nitro-glycerine is used for blasting instead of powder, with rapid progress. All the other tunnels are completed.

NEW RAILWAY INVENTION.

At the Paris Exposition a Russian engineer exhibited an invention whose object is to save the power gained in a descent, now lost in the friction of the brakes, with wear and tear, and use it in the ascent. To effect this he attached two very heavy fly-wheels to the locomotive. Going down hill they act as a brake, and the force they gather will carry the train up an equal ascent, less the friction. A model train loaded with water ran down a sharp incline, the water ran off, and the force of the fly-wheel carried the train back to the starting-point. In this way a short railway, taking coal down an incline from the mouth of the pit, could be worked without any other power than that gained by each descent of the train.

THE CHANNEL RAILWAY.

In the volume of the "Annual of Scientific Discovery" for 1866–67, p. 31, the plans of Messrs. Hawkshaw and Remington for tunnelling the English Channel are alluded to. Mr. James Chalmers has recently published the second edition of a book on the same subject. Mr. Chalmers provides in his plan for an unbroken double line connecting the railways of England and France by easy gradients; by its means through trains could be run, obviating any change of carriage or locomotive. It offers no obstruction to navigation, and he computes the work might be completed in three years.

The principal feature of the work is new: 260 strong iron tubes, each 15 feet in diameter and 400 feet long, cased with timber and lined with brick in parallel series, each containing a single line of railway from shore to shore on the bottom of the channel. The displacement and weight of these tubes can be so nearly balanced, that both in submerging and in position they will not be subjected to any injurious lateral strains. The process for joining the tubes, at a depth of from 100 to 180 feet, is as follows: Each tube has a strong temporary bulkhead at each end, fixed a few feet inward, and provided with a valve, a man-hole, and a window of heavy glass. The first tube having been sunk empty, connected to the ventilator, and loaded down with anchor boxes, a sufficiently powerful wire cable, welded to a bolt through the outward end of the sunken tube, is now passed through a projecting ear upon the inward end of the next following tube, and serves to guide that end as sunk, into match with that to which it is to be joined. A ball-and-socket joint, it has been suggested, may be applied to guide the two ends into exact coincidence, and the fixed end is to be faced with an India-rubber packing. When the two ends are fairly in contact all around, which is ascertained by inspection through the window of the fixed tube, by the aid of an electric light, the valve in the inward end of the tube just lowered is to be opened, and the issue of the water from the chamber formed between the bulkheads, it is claimed, will leave a vacuum and secure the instant compression of the two ends together with immense force. The chamber may then be entered through the man-hole, and the joint perfected and secured permanently. The estimated cost is 12,000,000 of pounds sterling, and the time required for construction, from two to three years, allowing 120 days in a year to be placid enough for tube-laying. The tubes will be banked over, and when the rise and fall of the tide have silted up the embankment, it will have the appearance of a ridge extending from shore to shore, about 150 feet wide at the base, 40 feet high, and from 40 to 120 feet below the level of low tide. The tubes would be circular in form, made of iron plates double riveted and caulked as in high-pressure steam boilers, and of the same thickness as the skin-plates of the "Warrior." The tubes would be strengthened by outer iron girder frames, to the outer flanges of which the timber casing would be attached by bolts, the spaces between the casing and the tube proper being filled in with concrete. Three ventilators would be built up, one mid-channel, and one about a mile from either shore; the mid-channel one a circular mass of iron and stone, 100 feet in diameter, and 210 feet in height, 168 feet of which will be below the water-line; the others would be ordinary air-shafts, near the ends of the shore embankments, which would be run out, like breakwaters, about a mile from either shore, to a depth sufficient for navigation over the tubes.

Of the three classes of propositions for direct communication between England and France, namely, tunnels beneath the bed of the channel, subways through the channel along the bottom, and bridges over the channel, the second appears most reasonable, and, with a properly arranged system of submerged tubes, possesses many advantages over the others. — *Mechanics' Magazine.*

THE MONT CENIS TUNNEL.

From a recent report of the French and Italian Commissioners, it appears that of the total length of the 12,220 metres, equal to 7½ English miles and 235 yards, there were excavated on the 31st of December, 1866, 3,900 metres on the Italian or Bardeneche side of the mountain, and 2,435 metres on the Modane or French side; total, 6,335 metres. Between the 1st of January and the 30th of June of the present year, 774 metres were excavated, being the largest number by nearly 200 metres excavated in any one half year since the commencement of the works in 1857. Of the 774 metres, 456 are on the Italian, and 318 on the French side; making the total excavated at that date 7,109 metres. Ever since the commencement, the progress made on the French side has been slower than on the Italian, on account of a quartz vein; thus, while, on the 30th of June last, the latter had only to execute 1,754 metres, or about an English mile and a tenth, to accomplish its half, on the French side there remained to be excavated 3,357 metres, or nearly 2½ miles. If 3 metres a day could be excavated on the French side, the perforation of the tunnel would be accomplished in 3 years and 3 weeks; but as in all probability it will not be proceeded with more rapidly than 2 metres a day, it will require 4 years and 31 weeks to complete it. The tunnel will be lined in its entire length with stone quarried in the immediate vicinity of the two entrances. At the present time the excavations, or headings, are about 1,500 metres in advance of the amount lined. Each metre excavated and lined hitherto has cost, on an average, 11,000 francs, and various circumstances will tend to increase this expenditure as the works proceed further inward. The approach on the French side, to connect its entrance at Modane with St. Michel (the present termination of the railway system of France in the direction of the Mont Cenis), will be 12 miles long, through an extremely difficult and mountainous country. On the Italian side, the amount of railway to be constructed from Bardeneche to connect it, in the neighborhood of Susa, with the railway system of Italy, will be 22½ miles. The whole of these works will be of a very heavy and expensive character. The length of the railway, *via* the tunnel from St. Michel to Susa, will be 42 miles, or 6½ miles shorter than that now finished on the outside of the Mont Cenis Pass, and known as the "Fell Railway," from its being constructed in accordance with the patents of the gentleman of that name. As regards transit through the tunnel, in consequence of the average gradient on the French half being 1 in 45½, and the steepest gradient on the line being 1 in 28, it will not be possible for a train to go through from the north to the south in less than from 38 to 40 minutes. Coming from the south to the north, the ascent is much more gradual, but even in this case the transit will occupy from 30 to 32 minutes as a minimum. It has yet to be seen whether passengers would not prefer the outside line instead of being shut up in a tunnel so long as we have just stated. It is for this, among other reasons, that many persons expect the "Fell Railway," which only possesses a concession for working until the tunnel line is opened for traffic, will have its privileges extended so as to make it practically a permanent concession. On the last day of July, 7,263 metres had been successfully bored, and during August, 139 more had been accomplished. The progress made during the month of October was 61m. (3 feet 3½ inches each) on the north side, and 72m. on the south. The general state of the work October 31, was as follows: already executed, 7,665m.; remaining to be pierced, 4,555m. During the first 10 months of the present year 1,329m. have been finished, while during the whole of last year only 1,025m. were executed. The engineers still expect to see this great work terminated in the course of 1870. The expense of the tunnel is to be divided equally between France and Italy.

HOOSAC TUNNEL.

The excavation of the Hoosac Tunnel proceeded last year at the rate of from 43 to 56 feet a month. The dimensions of the bore are 24 feet height through the rock, and 26 feet where the work is bricked up; the width is equal to the height in both cases. The track is laid from 3 to 5 feet above the bottom; a passage being left for the drainage of water underneath. It will be about 4½ miles long, and its sectional area 459 square feet.

The tunnel commissioners give the following account of the progress of that work: At the east end of the tunnel, up to November, 1866, 3,431 feet of progress had been made into the mountain, of which 592 feet was the work of the year immediately preceding the time when the work was taken in hand by the present commissioners. During the year ending November 1, 1867, 1,043 feet heading has been made, at the rate of 71 feet a month up to last July, and at a rate of 119 feet a month since that time; thus making the east end heading 4,474 feet in extent.

The central shaft from the summit of the mountain to the line of grade is to be 1,030 feet in depth. Its size is 27 feet by 15, and is of an oval shape. Up to November 1, 1866, this shaft had been sunk 354 feet, of which distance 153 feet was in the previous year. During this time work was suspended for three months on account of necessary work upon machinery. From November 1, 1866, to October 19, 1867, the date of the sad accident which has cast a temporary gloom over the enterprise, this shaft has been sunk 227 feet, making the present depth 581 feet. The west shaft is 316 feet deep, is sunk to grade, and is being satisfactorily worked on both faces. At the west end of the tunnel, the distance from the west shaft to the instrumental pier, which stands at or near the west portal of the tunnel, is 2,447 feet. It can thus be seen that 6,791 feet of progress on the tunnel have actually been made, besides considerable other work which might properly be reckoned.

TUNNEL FROM NEW YORK TO BROOKLYN.

Since last winter, when, on account of floating or fixed ice, communication between New York and Brooklyn or Williamsburgh was either cut off for hours or rendered insecure and precarious for days, there has been a desire that some more certain if not more rapid means of intercommunication should be contrived. A charter for a bridge company was secured at the last legislative session, and preliminary surveys are now in progress on both sides of the estuary known as East River. The bridge to be constructed will probably be a suspension bridge, with one or two stories, and of a length between points of suspension exceeding that of any other on the continent. But vast as is this undertaking, the approaches to the bridge proper are hardly less in magnitude.

As long ago as 1857 we published (*vide* "Scientific American," Vol. XII., No. 30) a plan proposed by Mr. Joseph De Sendzimir, by which a passage across the East River could be secured without a structure exposed to gales, and without approaches entailing travel of three times the width of the strait. It was, in brief, similar to that now in progress across the Thames at London for the Pneumatic Despatch. It was a submerged tube of iron sunk in the bed of the river, the central portion level and the remainder rising gradually to either shore. In order to diminish the grade, the tube, on the Brooklyn side, where the natural descent is greater than on the other side, makes a curve or bend. The deepest portion of the river-bed is only 47 feet below the surface at low water, and the tube may be either supported on piles driven into the bed of the river or lie upon a bed scooped for it so that the top may reach only to the surface of the bed. That this plan is feasible cannot be successfully denied; that it will offer no obstructions to navigation and the tides, and that it would be removed from danger of disturbance from floating ice and from gales, is susceptible of proof. Its cost, estimated at only about $200 per running foot, is so much less than that of any bridge, that 12 of these tubes could be laid for the cost of a single bridge. Its approaches could be close to the shore, and therefore not interfere with the rights of property owners. In every aspect the submerged tube appears to be better than the aerial bridge.

Subsequently, as seen in No. 39, Vol. XII., 1857, "Scientific American," we published engravings of a similar plan, suggested by H. P. Holcomb, of Winchester, Ga., and the engravings represent a profile view and the entrances, style of tube, and a cross section.

The plan of building the tubes proposed is similar to that followed in the construction of the Pneumatic Tube in London; that is, that it be built in sections, the ends of which are made water-tight, and then the sections floated to place and sunk by admitting a sufficient quantity of water, to be afterward pumped out. The joints to be made by bolted flanges.

We see fewer objections to this style of crossing rivers, especially when very wide or where a bridge must be very elevated, than to any other. If the tube is sunk in a bed dredged for it there can be no reason why it might not last for generations, especially if, like that of the Thames, it is protected externally by courses of brick masonry. No objection to the submerged tube, except the fact of its situation, would seem to obtain which might not be equally valid when urged against the elevated bridge. Certainly teams and street railway cars could as readily traverse the tube as the bridge. In either case there must be an ascent and a descent. But, beyond the fact of less cost in favor of the tube, there is the superiority in case of approach and the consequent shortening of the distance. The two plans seem at least worthy comparison by those interested in the subject. — *Scientific American.*

A TUNNEL THROUGH A VOLCANO.

English engineers have nearly completed a railway tunnel through a volcanic range in New Zealand. The plains of the Canterbury settlement, in the southern of the two great islands of New Zealand, are divided from the port of Lyttleton by almost impracticable hills, and in May, 1861, the local government accepted an offer to complete a line of railway from Lyttleton to Christ-church in 5 years; the cost of a tunnel 2,838 yards long, and called the Moorhouse Tunnel, being fixed at £195,000. The works were at first carried on under great disadvantages, on account of the Otago gold fever and other causes.

This tunnel affords, it is believed, the first instance where a complete section of an extinct volcano has been opened out. The rock in the tunnel is a series of lava streams and beds of tufa, intersected by vertical dykes of phonolite. The lava streams generally consist of scoria, overlying a coarse pink trachyte, which passes gradually through shades of gray, purple, and blue, into a black, finely-grained rock, intensely hard and tough; the lightest and softest rock being at the top, and the densest and blackest at the bottom. Regarded from an engineering point of view, the work is considered eminently successful.

Wherever difficulties have been met they have been quickly and successfully overcome. A siphon 600 yards long was employed for the drainage of the upper half of the tunnel. The system of ventilation has proved perfectly adapted to the requirements of the case, and has been not only effective, but simple and comparatively inexpensive. The engineers of the Mont Cenis Tunnel have found it necessary to adopt similar means of ventilation in that famous work. In the first instance air was driven in by fans worked by horse-power, but this soon proved quite insufficient; and when the works extended some distance, much time was lost owing to the difficulty of getting rid of the smoke. To obviate this on the Lyttleton side, the upper portion of the tunnel was partitioned off by a floor or brattice, about 9 feet above rail level, forming a smoke flue connected with one of the shafts, at the bottom of which was placed a furnace, which, by rarefying the air, caused a steady current up the shaft, and drew the smoke away from the face of the workings.

A similar plan was adopted at the north end, the chimney of a forge being led into the shaft, and answering the purpose of a furnace; but the brattice was only continued for a short distance beyond the upcast shaft. On the Lyttleton side this system answered perfectly well, and the ventilation has continued good ever since; but on the Heathcote side, where the work for the last quarter of a mile has been driven by a top heading (the temporary floor being left above the permanent rail-level for drainage purposes), the ventilation at the close of the work became sluggish, and recourse was had to driving air on the face by means of four fans driven by an eight-horse steam engine. This proved perfectly successful.

The system employed to secure the correctness of the alignment of the two ends of the tunnel was very simple. A permanent mark was fixed in the centre line of the tunnel, on a tower built on the dividing range, nearly midway between the two ends. A transit instrument being placed on the meridian of the tunnel, as well as of the tower on the hill, it could be seen at once whether the flame of a candle in the centre line of the work inside the tunnel was in a vertical plane with the mark on the tower. It was also desirable, in case of error, to have the means, not only of correcting, but of calculating, the amount of such error, and this could be readily done. The permanent mark on the central tower consisted of a batten 6 inches wide, with a black stripe 1 inch wide down the centre. The eye-piece of the transit instrument being furnished with 5 vertical wires placed at equal distances apart, the value of the space between any two wires at a distance equal to that of the mark on the tower could be ascertained by reference to the width of the batten, which thus gave a scale by which the error in the position of a light placed in the tunnel under the tower could be rated with exactness. It has been by this means that the alignment has been tested from time to time, and the proof of the correctness of the system has been established by the present result. — *Scientific American.*

IRON STONE.

At a point in the Thames, where an eddy accumulates a shoal of sand, agglutinating iron springs rise from beneath, and progressively convert the sand into rock, which has to be removed, from time to time, by blasting. Bourne, the engineer, conceived from this circumstance the idea of turning quicksands to firm foundations by a similar process, and actually proposed to do this for the railway bridge over the Soane in India. Quicksands at this point, as deep as borings had been made, were to be converted into rock by injecting them, through perforated pipes, with sufficient iron water, from a hill of iron pyrites near at hand, to stick together the whole mass. The line of the road was eventually altered, and the bridge was built at another point; but Mr. Bourne still believes that an expedient of this kind will become a valuable feature in engineering.

DURABILITY OF TIMBER.

In situations so free from moisture that we may practically call them dry, the durability of timber is almost unlimited. The roof of Westminster Hall is more than 450 years old. In Stirling Castle are carvings in oak, well preserved, over 300 years of age. Scotch fir has been found in good condition after a known use of 300 years, and the trusses of the roof of the basilica of St. Paul, Rome, were sound and good after 1,000 years of service. — *The Builder.*

CEMENT TO FASTEN IRON IN STONE.

A German professor has found out a cement for fastening iron in stone, which in 48 hours becomes nearly as hard as the stone itself. This consists of 6 parts of Portland cement, 1 part nicely powdered lime, burnt but not slaked, 2 parts of sand, and 1 part of slaked lime. This, when well mixed and reduced to one mass of cement with the necessary quantity of water, is put into the crevices or openings of the stone and the iron, both being previously damped, and after 48 hours the iron will be found thoroughly and lastingly fastened in the stone.

RANSOME'S ARTIFICIAL STONE.

The process by which this durable and ornamental stone is made is exceedingly simple. Mr. Ransome, finding that the best sandstones were held together by silicate of lime, after repeated experiments made the unexpected chemical discovery that flints, when boiled in a caustic solution of soda, under pressure, will melt almost like tallow before the fire. With silicate of soda as a liquid, he mixed chloride of calcium in solution, and produced stone of flinty hardness. A bushel of completely dried, clean sand, mixed with a small portion of finely ground carbonate of lime (to closely fill the interstices), is worked up in a loam mill with a gallon of the liquid silicate of soda. When thoroughly mixed, the sand is of such a consistence that it can be moulded into any form. In this condition the solution of the chloride of calcium is poured upon the moulded sand; instantly the silicate of soda and the chloride of calcium mutually decompose each other, and reunite as silicate of lime and chloride of sodium or common salt; the former practically indestructible in the air, and the latter removable by washing. The setting takes place as quickly as with plaster of Paris. As the hardening goes on, the objects are immersed in the solution, for hours if necessary, rendered boiling by means of steam. The air is thus expelled. Though water washes out the salt, proving permeability, the stone, when once freed from the salt, is almost impermeable. This artificial stone has been exposed to the extremes of heat and cold, with sudden transition from one to the other, to acids, and to foul gases, with no effect on its structure. In fact, being nearly all silica, it is practically indestructible; having no oxidizable constituent, it is unalterable in the air; and being impermeable, it will not be injured by moisture or frost. It may be used for any purposes of construction or architectural ornament that natural stone can be employed for. It is a discovery of very great importance, and of very extensive application.

LIQUID STONE.

The following are extracts from a paper read before the Boston Society of Natural History, in March, 1867, by Prof. A. L. Fleury, of New York.

The liquefaction of stone, the dissolving of hard refractory quartz or flint, like sugar or salt in water, the preparation of a colorless, mineral, and permanent petrifying liquid by economical means, and on a large scale, is a problem, the solution of which seems to belong to the present progressive century.

The uses to which a perfect liquid flint, a hydrate of silica, could be turned, are numerous and interesting, provided the liquid possesses the property of becoming insoluble in water after having been deprived of its water of solution, keeping back its water of crystallization.

The first idea that suggests itself of the use of such a liquid is the preparation of *artificial stones for ornamental and building purposes*. Should it be possible to produce this petrifying liquid cheap enough, building-stones in all their variety could be made and cemented together with the same petrifying solution. The cost of cast flint-marble statuary, tombstones, baths, tables, mantel-pieces, and ornaments of all kinds, would be, of course, much less than if laboriously cut from the stone, and they come quickly into universal use. In a similar way, as photography now diffuses the masterpieces of the art of painting among all classes of society, and cultivates their taste, the art of *casting flint-*

marble would multiply and diffuse the masterpieces of sculpture, and adorn our public buildings, gardens, and parks. Bas-reliefs, cameos, cornices, columns, pillars, etc., might be produced at comparatively cheap prices. Should the liquid be of a kind to permit its application to outside or inside walls, like plaster, then we could cover our brick and stone houses with white or colored flint-marble fronts, and our churches, halls, theatres, parlors, and rooms with *glass-like walls* and ceilings, colored *ad libitum* with elegant frescos as durable as the still fresh paintings at Herculaneum and Pompeii; while the floors could be inlaid with beautifully colored stones in mosaic style.

Another important application for such a liquid would be the one to *render wood non-inflammable, rot and water-proof.* By making wood non-inflammable, we should greatly diminish the danger to which most of our old and new buildings are now exposed. This could easily be effected, and with not much cost, by impregnating the wood with a properly prepared solution of flint; for, if once the pores of the wood, which by their capillary action cause the communication of the fire to the whole structure, be stopped up by the incombustible and non-conducting silica, the wood becomes non-inflammable, and at the same time proof against water and decay. Not less important would be the partial silicification of railroad-sleepers and cross-ties, house, ship, and bridge timber: they would be stronger and last longer. Telegraph-poles would, when properly treated, become more durable, and be, in addition, better non-conductors of electricity. What a new field would such a petrifying fluid open to the manufacture of incombustible paints and varnishes! It might also be mixed with paper pulp, or cheap vegetable or animal fibre, and serve for the manufacture of a variety of useful articles, such as staircases, boxes, trunks, soles for boots and shoes, patterns, moulds, handles, parts of machinery, photographic instruments, piano-keys; and, further, it might be used as a coating for preventing the oxidation of iron or other metals. We must not overlook another important application in the use of the liquid flint, — the one for the preservation of old monuments and stone buildings. It might, perhaps, also serve as a medium for the preservation of meat, fruit, vegetables, eggs, etc. The linings of barrels, for oils and other liquids, the coating of tanks, tubs, sulphuric-acid chambers, etc., are other useful applications of this liquid.

Metallurgy could be very materially benefited by a process whereby quartz could cheaply and speedily be dissolved in water; for we could then take the gold quartz of Nova Scotia, New Hampshire, or Canada, and dissolve the quartz, and obtain all the gold as a precipitate. Of course, as the liquid flint could be used for so many useful purposes, and be sold for a good price, the extraction of the gold would be very cheap, and, so to speak, cost less than nothing, as the extraction price of the gold would be more than paid for by the amount realized from the sale or use of the liquid.

Omitting the detail of the numerous attempts that have been made since 1823, when Prof. Fuchs, of Munich, Germany, first succeeded in preparing the so-called water-glass, an alkaline solution of silica in water, we will shortly glance over what has been done during the past ten years. It was at first believed that the German water-glass would answer all the purposes above stated; however, it was soon found that the carbonic acid of the atmosphere, by its stronger chemical affinity for the alkali of the silicate, caused a gradual disintegration of the surface or compound. Numerous remedies were suggested to counteract this evil. Prof. Kuhlman, in Lille, France, and Mr. Ransome, in Ipswich, England, partially succeeded, by subsequent application of the solutions of chloride of calcium and hydrofluoric acid to the surface, or to the mass of the stones, to neutralize and extract the alkali; and Mr. Ransome, by the means of great pressure and proper manipulation, is preparing a concrete stone of considerable hardness and durability.

Prof. Graham, in London, by his beautiful discovery of dialysis, by which a crystallizable liquid can be separated from a viscous, or so-called colloid substance, first succeeded in separating silica from an alkaline silicate, and in keeping it in perfect solution in water. However, the slowness of the process, and the small quantity of silica thus kept in solution, left this very ingenious and otherwise useful method without practical results. It is only recently — since the eminent French chemist, Frémy, has made a thorough scientific investigation into the nature and properties of *silicium* and its combinations with chlorine, fluorine, and sulphur — that the existence of several distinct hydrates of silica has become known.

In this country, Mr. Benj. Hardinge, of New York, some twelve years since prepared, by a peculiar process not made public, a solution of silica in water, wherein the silica was largely in excess; and recently he has succeeded in producing not only a most perfect imitation of white and colored statuary marble, but also in making a snow-white flint of greater hardness and durability than the natural marble itself. He succeeded in mixing his compounds so that the exact amount of water of crystallization necessary for the formation of the stone was introduced, and the stone, cast cold, without pressure, becomes hard from the centre outward; thus insuring durability and compactness. This is a great step toward the solution of our problem. A new process has very recently been invented, by which a soluble hydrate of silica, entirely free from alkali or any other matter, can be prepared cheaply and on a large scale from sulphide of silicium.

NEW CEMENT AND BUILDING MATERIAL.

In a communication to the French Academy in July, 1867, M. Sorel describes a new cement, a basic hydrated oxychloride of magnesium, obtained by slacking magnesia with a solution of chloride of magnesium in a more or less concentrated state. The denser the solution the harder it becomes on drying. This magnesium cement is the whitest and hardest of all known to this day, and can be moulded like plaster, in which case the cast acquires the hardness of marble. It will take any color, and has been used by the inventor for mosaics, imitations of ivory, billiard balls, etc. It possesses the agglutinative property in the highest degree, so that solid masses may be made with it at a very low cost by mixing it on a large scale with substances of little value. 1 part of magnesia may be incorporated with upwards of 20 parts of sand, limestone, and other inert substances, so as to form hard blocks; while lime and other cements will hardly admit of the incorporation of two or three times their weight of extraneous matter.

By means of these artificial blocks, buildings may easily be carried on in places where materials for the purpose are scarce. All that is required is to convey a quantity of magnesia and chloride of magnesium to the spot, if there be none to be had there, and then to mix them with sand, pebbles, or other matter of the kind close at hand; blocks can be made of any shape, and imitating hewn stone. This magnesian cement may be obtained at a very low cost, especially if the magnesia be extracted from the mother lye of salt-works, either by M. Balard's process, whereby magnesia and hydrochloric acid are obtained at the same time, or else by decomposing the lye, which always contains a large proportion of chloride of magnesium, by means of quick-lime, which, by double-decomposition, yields magnesia and chloride of lime containing a certain quantity of chloride of magnesium, and which, with the various other cheap substances, may be used for whitewashing.

CEMENT FOR IRON.

An exhibition of a most interesting character (says an English paper) took place recently at the Albion Works, Battersea, England. The exhibition consisted of a number of practical illustrations of the uses to which a certain description of cement is applied, having for its principal ingredient more or less of a particular gum or substance called the zepipe or "zopissa," which for some years past has been identified with the name of Col. Scezerelmey. It appears to be a most protean substance, for it holds on with wonderful tenacity to timber, glass, brick, cement; and last, though by no means the least of its remarkable qualities, *it will unite iron surfaces together as completely as though they were welded.* The cement has the quality of being perfectly water and air tight. It can be conveniently used, and hardens with the greatest rapidity. About five minutes is the maximum of time required for it to harden thoroughly.

Of the value of such a material as this for engineering and building purposes, it is impossible to speak too highly. Our professional readers will at once perceive a variety of uses connected with railway and hydraulic works to which a material of this kind would be of the greatest possible value. Tunnels and bridges, docks and quay walls, could be constructed by its use in considerably less time and at greatly reduced cost; and with respect to sewers, an immense improvement would be effected in employing a material on which fluids produce no impression. Platforms and railway stations could be provided of equal strength to the present and with less consumption of materials. The invention is one of that character with respect to which there can be no mistake, and any person who sees may judge for himself of the properties of the cement, and we shall be greatly mistaken if some of our large contractors do not very shortly seek to test the practical value of this remarkable "iron cement."

On previous occasions we have described the remarkable preservative qualities of the zepipe composition on stone and brick, and the extraordinary effects which the application of one part of the process has upon paper, converting it into a substance harder and more enduring than oak, and capable of being substituted for metals in many of the uses to which they are applied in the arts and manufactures. Following out the line of investigation into the chemical constituents of the substances which he employs, he has now succeeded in producing some results, which, if they had not been shown under our inspection, we should have hesitated to believe possible. By combining various substances, which may be readily obtained in large quantities, and at almost nominal prices, the inventor has made what he calls this "iron cement;" and truly it is an iron cement. It is a cement which, easily applied, becomes in a few minutes as hard as iron, and, so far as we are aware, this is a quality which is not possessed by any other substance, — that of complete and perfect cohesion to iron. At Battersea we saw two large plates of iron held together so firmly as to defy all attempts at separating them. The plates had in several parts been fractured by the attempt to separate the two surfaces, but they still remained firm and immovable. Two plates of iron were cemented together in such a manner that the lower one could have suspended to it the weight of several tons; the projecting corners of the lower plate to which the weights were attached were bent and curved, and the upper and lower plates had "buckled," but they still remained held together by the thin layer of iron cement as though they were but one plate. By the side of this a plate has been made up of alternate thin sheets of iron and planks of timber, and the wood and the iron adhered as firmly as in the case when iron surfaces only were exposed to the action of the cement. A third test consisted of thin sheets of iron with alternate layers of paper, which had been previously coated with another kind of composition of Col. Seezerelmey's. There the same wonderful cohesion existed. A sheet of glass was fixed to the edge of an iron bar by this extraordinary cement, and was as firmly held as the iron or wood or prepared paper of the previous experiments with iron and wood.

CAUSE AND PREVENTION OF DECAY IN STONE.

At the 1867 meeting of the British Association, Mr. John Spiller stated his conclusion, from a long series of experiments and observations, that the corrosive action of sulphurous and sulphuric acids in the atmosphere, resulting from the combustion of coal as fuel, operates, in large towns especially, in a destructive manner upon dolomite and the usual limestones employed in public buildings. This chemical action, aided by the simultaneous attack of carbonic acid and moisture, and by the disintegrating effects of frost, will explain the fact of decay in stone. The best classes of coal contain more or less sulphur; and it has been estimated that a ton of coal of ordinary quality evolves during its combustion nearly 70 pounds of sulphuric acid. This is the origin of the sulphates always found in the loosened crust of calcareous and magnesian stones when in a state of decay. In dolomites the disintegrated stone often exhibits white crystals of sulphate of magnesia, which, alternately dissolving and recrystallizing in the pores, exerts a disruptive action sufficient to fracture and scale off the stone.

Mr. Spiller has succeeded in remedying the difficulty to a considerable extent by applying to the cleaned surfaces an aqueous solution of superphosphate of lime, a salt having a remarkable effect in hardening calcareous stones, acting upon the carbonate of lime and forming crystallized diphosphate of lime. Another method, especially applicable to dolomites, is to employ baryta with the hardening salt, so that a base may be presented capable of destroying the soluble sulphate of magnesia in the pores of the stone, forming with it the remarkably insoluble sulphate of baryta, and at the same time engaging the magnesia in one of its most difficultly soluble combinations. Stone thus treated acquires an increased strength to resist a crushing weight of nearly 50 per cent.; it is also very much harder and much less porous. The cost is trifling, 1 gallon of the solution being sufficient to cover 300 superficial feet, when two coatings are applied; the superphosphate must not contain any appreciable amount of sulphuric acid, and the specific gravity of the solution, when diluted for use, should be about 1,100.

PRESERVATION OF STONE.

This subject, which has attracted the attention of many chemists, seems now to have been brought to a very successful point by Messrs. Dent and Brown, of Woolwich, England. Their process consists in the application of a solution of oxalate of alumina to the stone. The experiments date from December, 1865, and the results they have now obtained are most encouraging. The process is applicable to limestone, dolomite, and chalk, and may, perhaps, be made subservient to the preparation of lithographic stones. Oxalate of alumina is readily soluble in water, and the solution, which is simply applied with a brush, is made of a strength varying with the porosity of the material to which it is to be applied. The physical characteristics of chalk so treated are lightness, the possession of a glazed surface approaching somewhat, in appearance, marble, and greatly increased hardness; in this respect, the stone is about equal to fluor-spar. Furthermore, the lime being transformed into one of the most insoluble and unalterable of its compounds, and the alumina being precipitated, the pores are filled with a substance almost unacted upon by water, or by the impurities present in the atmosphere of large cities. Their process may prove to be a rival to that of Mr. Spiller, before mentioned, which, according to present appearances, is likely to be the most successful of all the schemes now on trial for this purpose.

USE OF PETROLEUM AS FUEL.

A remarkable trial took place in Boston harbor in June, 1867, to test the use of crude petroleum instead of coal for steam vessels. The United States gunboat Palos, equipped with petroleum apparatus, left the Charlestown Navy Yard, made a trip of 25 nautical miles in 1 hour and 55 minutes, and used less than 4 barrels of petroleum to accomplish the work for which 6 or 8 tons of coal would have been required.

In this experiment, petroleum was supplied from two large iron tanks placed on deck, each tank having a glass gauge at its side, to indicate the height of the petroleum, and a vent-pipe on the top to permit the escape of vapor. From these tanks the petroleum was conducted by half-inch pipes into iron retorts heated by burners placed beneath them, being instantly vaporized. This vapor, in burning, was mixed with steam decomposed by passing through pipes partially filled with iron filings, and with air forced in by a common air-pump. The heat thus generated was intense, and the combustion so perfect that no smoke was perceptible. The oil is only supplied as fast as it can be converted into vapor. The supply of steam and air and oil is graduated by means of small throttle-valves, and the fire increased or diminished at will.

A great merit of this invention is its simplicity, cheapness, and durability, — there being no complicated machinery and no sulphur in the liquid fuel to affect the iron. Thus far, in the course of the experiments, the result obtained is highly satisfactory to all concerned. It is said that 3 men with the use of petroleum can do the work of 20 men in running the machinery. As a matter of room-saving the use of petroleum on board of vessels is very great. The Palos has capacity to stow away coal sufficient to last 6 days; petroleum enough can be stowed in the same vessel to last for 20 days, and that, too, in places inconvenient or unavailable for freight. The inventor is Col. Henry R. Foote.

A subsequent trial was even more satisfactory than the previous experiment. The rate of 12 knots was made against wind and tide, with a pressure of 32 pounds of steam. The vessel was 14 inches deeper in the water, and was in bad trim; steam was raised in 25 minutes, when it would have required 3 to 4 hours to have obtained a pressure of 35 pounds with a fire of anthracite coal.

Calculations of the relative economy of coal and oil, as fuel for ocean steamers, should take into account the item of firemen and coal passers, their wages and quarters, in addition to the difference in weight and space of furnaces and of boilers. In the experiments on board the Palos, it was found that with 3 of her 4 boilers, and the attendance of 3 men, 50 per cent. more revolutions of the wheels were obtained than heretofore with coal under all 4 boilers, with the attendance of 20 men. But the greatest difference may be realized from a more perfect utilization of the force contained in the fuel. It is well known that as yet but a small per centage of the theoretical power of fuel has been obtained through steam. Coal heat is mostly applied by radiation; oil, with proper apparatus, may be brought, in a state of combustion, mainly into direct contact with the boiler surface.

The interest and figures involved are enormous; they affect the water transportation of the whole world, whether by river, lake, or ocean, — reducing expense and time, and about doubling the freight capacity of sea steamers. It is equally applicable to locomotives, and especially available on the Pacific railroads.

Mr. A. C. Stimers, who witnessed the experiments on board the Palos, in a letter to the "New York Times," says, in regard to the source of the steam that is passed into the retort that generates the heat for raising steam in the boiler: "The introduction of superheated steam into the retort where the oil is vaporized is not essential to the making a fire and getting up steam, but it is to burning said vapor with the completeness of combustion necessary for it to compete with coal as a steam fuel. In burning the vapors of petroleum it is necessary that every particle of the vapors shall come into close contact with a corresponding particle of atmospheric air; but air and the vapors of the oils appear to have the same repellent qualities as oil and water, and do not mix enough to prevent the formation of a thick black smoke, and the heat developed is comparatively very small.

"All who have attempted the use of petroleum for a steam fuel, appear to have early learned the great advantage of introducing superheated steam to the vapors. When this is done, the air mixes readily with the compound, and a more complete combustion is effected.

"Although, as I have already stated, steam could be raised in a boiler from burning the oil vapor only, yet it is done much more quickly and pleasantly if a supply of steam can be had.

"The first experiments tried to test the practicability of employing petroleum for generating steam were by Shaw & Linton, in Philadelphia. I was member of a Board of Naval Engineers, ordered by the Department to conduct and report upon the experiments. They continued during 5 months, and our report is dated May 5, 1863.

"In that arrangement, 'the apparatus used was an ordinary tubular locomotive form of boiler containing 15 tubes, 2 inches in diameter and 56 inches in length; a small steam engine, in connection with it, operating a pump supplying water to the boiler; with an additional boiler, of very small dimensions, placed in a heating apparatus, to provide a steam jet, previous to firing up with the oil, in the absence of other means for procuring the necessary artificial draft until steam was raised in the larger boiler.

"This would be a good arrangement for Colonel Foote to employ with his process. The great merit of Colonel Foote's process over all those which have been tried in this country and in England, consists in his forcing the air, necessary for the combustion of the oil, directly into the retort where the latter is vaporized, and as superheated steam is introduced simultaneously, *the air becomes thoroughly mixed with the vapors before they issue from the burners*, and the combustion is consequently perfect when the proper proportions of air and oil are maintained. This desideratum is never attained in any other process yet brought to my attention."

The Titusville (Pa.) "Morning Herald" describes the fourth of a series of experiments to determine the value of petroleum as fuel for locomotives. It took place at the shops of the Warren and Franklin Railroad at Irvineton.

The apparatus used was Spence's burner. It is described as consisting of a pan covering the bottom of the fire-box in the locomotive, and taking the place of grates. On the pan are placed heaters or gas-generators, 6 in number, consisting of inclined plates of cast iron, supported at an angle of 45° ; opposite to each heater is an injector conveying the oil to the heater, where it is instantly converted into gases, oxygen being also furnished to the gases in their nascent state for combustion. The oil is contained in a tank on the tender, from which it is conveyed by feed-pipes to the injectors, each pair of injectors being controlled by a throttle by means of which the fire is regulated as readily as the light of a lamp.

The locomotive used weighed 31 tons, and was of 150 horse-power. No cars were attached. Under 85 pounds of steam the locomotive passed over 4 miles of track in less than 11 minutes.

At a late fire in Boston one of the steamers was run by petroleum oil instead of coal. The "Traveller" says: "When the alarm was given the steamer started in the direction of the fire, and, arriving at the scene of conflagration, her steam gauge indicated 100 pounds of steam. Only 3 minutes were consumed in raising this amount of steam. She remained on the ground 6½ hours, and during that time the steamer averaged 80 pounds of steam and 120 pounds of water-pressure, and 100 pounds of water-pressure with 2 streams. Another remarkable and important fact demonstrated was, that the steamer using oil gained 30 per cent. of water-pressure over any other engine at the fire, by reason of not choking the exhaust. This is regarded as a great desideratum gained. Another great point shown was, while the streets leading to the fire were choked up with smoke thrown off by the other steamers, scarcely any smoke came from No. 3, using the new fuel."

An interesting experiment was made at the Brooklyn Navy Yard, on August 8th, involving the feasibility of substituting petroleum for coal for steam boilers. The apparatus used to test the experiment has been for some time preparing, and is the design of Lieutenant Clark Fisher, First Assistant Engineer in the Navy.

The apparatus as used consisted of a pipe half an inch in diameter, rising from the floor, and bent towards the mouth of the furnace, somewhat like an elbow, and projecting 2½ inches beyond the grate. The opening in the end of the tube to let in the oil, regulated by a cock, is one-eighth of an inch in diameter around the end of the tube, and extending back 4 inches there was a larger pipe connected with the boiler. The tip of both these tubes, one within the other, and both not more than three-quarters of an inch in diameter, projected into a copper tube 6 inches long, one end within the furnace, the other without. This was the entire apparatus. The way it worked was this: The cock was opened in the oil-pipe; at the same time the steam was admitted into the other pipe surrounding the end of the oil-pipe. This steam passing out of the tube around the oil-pipe produced a suction, in obedience to which the oil began to flow. The steam, in passing through the copper tube which conducts it to the boilers, creates a strong current of air within it, and the oil, in passing out of it, goes into the furnace in the form of vapor; and when in this state it takes fire from wood previously placed there and ignited for the purpose. Yesterday only 5 pounds of steam were required in the boilers to work the apparatus. So soon as the oil is, in its vapory state, once lighted, it is self-sustaining, and so complete is the construction that no smoke at all is produced. The boiler used is an ordinary 200 horse-power gunboat boiler, with 2 furnaces. To each furnace there were 5 of the pipes admitting the oil, as already described. A barrel of petroleum was consumed in an hour, and 17 minutes were required to get up a full head of steam. It is claimed for this application of petroleum to steam boilers that it dispenses with a great part of the complex machinery usually necessary to raise steam, and by so much is a gain of power added directly to the propulsive force; that it obviates the friction, the loss of power, and the liability to explosion, as well as the wear to material, which the retort system of applying petroleum is likely to produce; that the fire can be extinguished at a moment's notice, and produces no smoke by which an enemy can tell the course and the approach of a vessel; finally, that it requires for an engine of 200 horse-power but the labor and presence of one man. The commandant of the yard and the other officers on duty witnessed the experiment, and pronounced it an undoubted success, whose results are at once to be brought to the attention of the department.

The experiments of Mr. Richardson and others in England afford similar encouraging results. In view of these and those in America, a correspondent of the "London Times" says: —

"I think there is little doubt that the fuel of the future will be liquid, and not solid. At present petroleum is dearer than coal; but the production will be constantly on the increase, and the cost will lessen. As steam-fuel, a pound of petroleum will produce double the steam that can be got from a pound of coal, and it can be burnt as neatly as a paraffine oil lamp by proper adjustment, without smoke and without waste; and, what is more, in steam vessels without dirt or labor, or the need of roasting the stokers alive, and, moreover, needing only half the stowage space in proportion to the steam-power. The firing a steam boiler with liquid fuel will reduce it to a process as simple as that of lighting gas in our houses, and, so far as our knowledge goes, petroleum can be more readily supplied than coal in the majority of the seaports we frequent. The first demand will be for war ships, then for express steamships, then for river boats, then for locomotive engines, then for the steam rollers that have yet to level our macadamized streets, then for traction engines, then for the road engines which will travel on sunk rails in single lines at 10 miles per hour on the highways and turnpikes, for the movable and portable will always demand a better fuel than the stationary, and will pay a better price. Gradually the factories will follow, and lastly the dwellings.

"But we have not yet got the petroleum in sufficient quantities. Quite true, and, as with gas-lighting, we have to begin. But the petroleum appears to be a drug in the United States, and it will come thence till such time as we can procure it more cheaply at home. As regards risk, there need be no more than with any ordinary fire. It is not like gunpowder, which explodes in masses; but simply an oil, which is only combustible in such quantities as may be sufficient to feed the fire; it involves less risk than ordinary house gas."

A recent report to the Navy Department expresses the belief that petroleum cannot compete with coal for use in vessels of war. It does not at present appear that it can be used with entire safety where two other dangerous explosives are necessary, namely, gunpowder and steam.

OVERHEATED STEAM BOILERS.

Notwithstanding the clearness of theoretical deduction, and the results of carefully conducted experiments, the opinion is still prevalent that a violent explosion must be immediately produced by turning on the feed water into an empty boiler with the plates even red-hot. To clear away any misapprehensions and doubts which may still exist, attention is called to the following experiments made in Manchester, England, by the chief engineer of the Manchester Boiler Association, the results clearly showing that the danger of injecting water into red-hot boilers has been greatly exaggerated, and that the explosion of boilers cannot be attributed to this cause. The boilers were three in number, and of the ordinary household circulating class.

The first was made of copper, weighed 62 pounds, and measured 14¼ inches in height, 11¾ inches in width, by 13¾ inches in depth at the bottom, and about 8 inches at the top, having an internal capacity of about 1 cubic foot. This was surrounded by a brisk fire, empty, and allowed to remain till the bottom became red-hot, and lumps of lead loosely laid on the top, the coldest part, freely melted. Then water was suddenly let in through a half-inch pipe. No explosion took place; the boiler was not stirred from its seat, nor did it evince the slightest sign of internal commotion; all that took place was a rush of steam through an outlet seven-eighths of an inch in diameter left on the top of the boiler. It was necessary to have this opening, or the water would not have found its way into the boiler at all, as was proved by actual experiment with it closed, when the first puff of steam generated forbade the entry of more water. This opening, however, could have in no way assisted to prevent the bursting of the boiler, if the views generally entertained with regard to the explosive effect of dashing water on red-hot plates were correct; the action of water under these circumstances is supposed to be as irresistible and instantaneous as that of gunpowder.

The second boiler, also of copper, weighed 44 pounds, and measured 11¾ inches in height, 11½ inches in width, by 10½ inches in depth at the bottom and 8½ inches at the top, having a flue tube running through it 6 inches in diameter, so that it had an internal capacity of about five-eighths of a cubic foot. This was treated just as the first had been, and, when nearly half of the boiler was red-hot, water was suddenly turned into it through a 1-inch pipe, connected to the boiler at one end, and to a tank affording a head of 6 to 8 feet in height at the other. It was supposed that an increased diameter of pipe would give a more sudden injection of water, and therefore prove more favorable to an instantaneous injection of steam. There was, however, no explosion. The boiler remained perfectly still, the only effect produced being the escape of a jet of steam through a hole in the top of the boiler, left open for the purpose.

In the third experiment a cast-iron boiler was used, which would possibly prove more favorable to explosion, both on account of the brittleness of the material and from its greater weight of metal, which would afford increased capacity for heat, and thus for the more rapid generation of steam. The boiler weighed 85 pounds, and measured 15¼ inches in length, 10 inches in height, by 11½ inches in depth at the bottom, and 8¼ inches at the top, having an internal capacity of less than a cubic foot, while the bottom was arched, which increased the heating surface. This was heated till the greater part became red-hot, when water was let on as in the second experiment; but there was no orifice left open on the top of the boiler as before, — a safety-valve, loaded to a pressure of about 35 pounds on the square inch, being substituted. On letting in the water, no result whatever was apparent; the safety-valve did not blow, and the boiler neither cracked nor trembled, but the feed-pipe got hot some 15 feet from the boiler, as if the steam was beating back and forbidding further entry of the water. Finding no result could be produced with the safety-valve, shut or open, this was removed, and an orifice 1¼ inches in diameter left open instead. On turning the water on again, a jet of steam escaped from the orifice as before, and, shortly after, the boiler cracked on one side from the top to the bottom with a sharp report. This was due simply to the contraction of the metal, and the rupture did not spread, neither did the boiler stir from its seat. This experiment was repeated, with the opening in the top reduced to three-eighths of an inch, with the same result. The capacity of these boilers was such that a pressure of about 150 pounds on the square inch would have been generated within them by the evaporation of a quarter of a pint of water in the two larger ones, and an eighth of a pint in the smaller one. It is clear that this pressure could never have been approached, as the light, flat-sided copper boilers did not bulge in the least, while the rush of steam from the outlet never appeared more than could be taken off by an ordinary safety-valve.

The foregoing experiments prove most conclusively the impossibility of exploding a red-hot boiler by the sudden injection of a stream of cold water. Every endeavor was made to succeed, and everything that glowing red-hot plates and cold water could do under the circumstances was done. Indeed, the test was much more severe than could occur in ordinary work, either in a household boiler or a boiler employed for engine power.

To meet the objections of those who would say that, inasmuch as steam-power boilers are ordinarily constructed of wrought-iron plates, with seams of rivets around and along them, they were not fairly represented in these experiments, an ordinary wrought-iron boiler, submitted to a similar test, some years before, gave the following result. The boiler was 25 feet long, and 6 feet in diameter, the safety-valve loaded to 60 pounds per square inch, and the empty boiler was then made red-hot, the feed suddenly let in, and the boiler filled up. The only result was a sudden contraction of the overheated iron, which caused the water to pour out in streams at every seam and rivet as far up as the fire-mark extended. The metallic plates of a steam boiler are not capable of containing sufficient heat to change a very large quantity of water into steam. The total quantity of heat which would raise the temperature of 100 weight of iron through 1 degree would impart the same additional temperature to only 12½ pounds of water; the quantity of heat which would raise the temperature of 100 weight of copper through 1 degree would raise that of 10⅝ pounds of water to the same extent. It is clear, then, both theoretically and practically, that overheating, with the sudden injection of water on red-hot plates, is not the cause of violent boiler explosions. — *Mech. Mag. May*, 1867.

EXPLOSION OF STEAM BOILERS.

Overheating cannot be assumed as the general cause of steam-boiler explosions, as these have taken place when there has been an ample supply of water; neither can the sudden pouring of feed water upon red-hot plates account for them; the electrical hypothesis, in a boiler in direct communication with the earth, is perfectly untenable; and the decomposition of water is equally unsatisfactory; the percussive force of steam alone is incapable of producing the destruction attending most steam-boiler explosions.

According to Mr. Zerah Colburn, the following are the successive steps of a boiler explosion, the action being, however, practically instantaneous: 1. The rupture, under hardly if any more than the ordinary working pressure, of a defective portion of the shell of the boiler, not much if at all below the water-line, from original unsoundness of the iron, bad riveting, corrosion or furrowing. 2. The escape of free steam from the steam-chamber, and the consequent removal of a considerable part of the pressure upon the water, before its contained heat can overcome its inertia and permit the disengagement of additional steam. 3. The projection of steam combined with water with great velocity upon the upper sides of the shell of the boiler, forcing it open and perhaps breaking it in pieces. 4. The disengagement of a large quantity of steam from the water now no longer confined within the boiler, and the consequent projection of the separated parts of the boiler to a greater or less distance.

This theory agrees well with the circumstances of boiler explosions, and receives support from the fact that they frequently take place at the starting of the engine, when there is a sudden withdrawal of pressure in the boiler and a violent disengagement of steam and projection of water along with it.

CAST-IRON STEAM BOILERS.

In the early history of steam, cast-iron boilers were generally used for high pressures, because the material possessed constructive advantages not to be found in wrought iron. It is well known, that cast iron is better adapted to undergo the ordeal of fire and water than wrought iron, and that by proper shape and proportions it may be made as strong. If cast iron can be put into such form as to be safe in case of rupture, it is doubtless the best material for steam boilers, as one of its qualities is to break at once without straining under improper treatment, unlike the destructive fracture of wrought iron, consequent on its very tenacity; the very brittleness of cast iron, at first sight a fatal defect, is an element of safety, and for this reason this material is preferable to wrought iron and to steel; the more tenacious the boiler, the greater are the destructive effects of an explosion.

Harrison Boiler. — The Harrison boiler, described in the "Annual of Scientific Discovery" for 1865, p. 36, is made up of spheres of cast iron, 8 inches in diameter and three-eighths of an inch thick, communicating with each other through curved necks 3¼ inches in diameter, and held together by bolts. These spheres are arranged in rectangular slabs, set side by side, about two-thirds of the number of spheres being filled with water, and the remainder serving as steam space. The slabs being placed in an inclined position, a free circulation of the water is effected.

Though the tensile strength of cast iron is not so great as that of wrought iron, the spherical form of each unit of this boiler gives it an equivalent strength; and to this form and the curvature of the necks the inventor has ascribed the property which this boiler has of casting its scale, as there is no abutment for the arch of the crystallized scale to spring from. Wrought iron is much more liable to corrosion than cast iron, and in proportion to its purity, while the mixture of a small amount of carbon increases the ability to resist corrosion. In the cast-iron boiler there is no weakening by rivets; and the units, if injured, can be replaced by new ones without diminishing the strength. The transmission of heat is greater in cast iron than in wrought iron of the same thickness, and hence greater economy in the generation of steam. From the construction of this boiler its shape can be suited to any place. The advantages of this boiler are, that it is secure from *destructive* explosions; that its parts, simple, few in number and small, are easily put together, repaired, or taken apart; that its strength depends on the material and its form, without the necessity of stays or braces; that it is not liable to corrosion or scale; that it affords a free circulation of the water and the external heat. For an account of experiments on the strength and durability of this boiler under very severe tests, see "Journal of the Franklin Institute," February, 1867.

Miller's American Boiler. — This, as explained before the Massachusetts Institute of Technology, in 1867, is also a cast-iron boiler made in the form of tubes of moderate diameter, put together in series, or in compartments of any desired size or shape. He uses cast iron for the reason mentioned above, as any imperfection in form or material will give timely warning by cracking, even under low pressure, when fire is applied, and when it does break it produces a fracture without explosion; hence, the giving way of one compartment acts as a safety-valve, relieving all other parts from pressure.

The great desideratum seems hitherto to have been to make a boiler exceedingly strong, as if that were the preventive of explosions. The strength of its containing-chamber no more makes steam safe than it would gunpowder or nitro-glycerine; the true way is to prevent the conditions of explosion, and not to strengthen the boiler. The strength of a boiler is the strength of its weakest point, and, as boilers are generally made of wrought iron, no one can tell where the weakest point is. A safety-valve is no safeguard against explosion in an ordinary steam or rather *water* boiler; but the case is different in a generator of *steam*, one that makes dry steam without superheating, simply changing the cohesive force of water into the repellant force of steam, leaving the water a dense mass free from steam. Boilers should be made to *make steam*, and not to *boil water*. By applying heat below a high column of water, the vapor must force itself through the dense medium and diffuse itself through the whole mass, not escaping until the whole is charged with as much steam as it can contain; and this is rendered more difficult by tubes placed at right angles with the rising steam.

Mr. Miller's improvement, in addition to the material and mode of construction of his boiler, consists in increasing the circulation, causing thin films of water to circulate rapidly over the heating surface, the steam, as soon as made, passing to the steam space: in this way the most power is got from the fuel, and the less is the danger from explosion. No boiler containing only dry steam and dense water can explode, if proper safety-valves be used. His boiler is made on the principle that every atom of steam shall be carried directly into the steam-chamber, without forcing its way through superincumbent water; the heat is also prevented from reaching the main body of water by an intervening shield.

The result is a rapid production of steam, steady increase of pressure, in a boiler containing steam free from water and water free from steam. Should a rupture take place, the result is a simple relief of pressure, without any explosive or disastrous results. This arrangement is favorable to economy of fuel and prevents injury to the boiler, as all the heat is at once absorbed by the thin stratum of water. To prevent loss of heat from the subsidence of sediments from the water, he introduces into cylindrical and flue boilers a curved, trough-like apparatus, which gives direction to the circulating currents and arrests the sediments.

The Hicks Boiler. — In this boiler, Mr. James M. Hicks claims to overcome the objections to the ordinary form of tubular boilers, namely, that for want of a proper circulation the sediment collects upon the most important heating surfaces, and the water is not returned to the bottom in a continuous and steady current. The boiler is cylindrical, upright, in the common form, with the usual outer shell, supported on hollow legs, forming the sides of the fire-box; from the lower tube-sheet rise the tubes, connected above with the upper tube-sheet, and opening directly into the smoke-pipe. Within the shell, and separated by a narrow space, is a circular iron drum surrounding all the tubes, and extending from near the lower tube-sheet to just below the proper water-line, and kept in place by stays; this divides the water among the tubes from the water near the shell of the boiler. Over this, extending from just above the water-line to within half an inch of the upper tube-sheet, is an iron cone, fitting at its lower edge the inside shell of the boiler, to which it is fastened: this forms a steam-chamber, into which the steam can pass only by going over the top of the cone.

The water directly over the fire is of course first heated, and rises inside over the top of the drum, delivering its steam, its place being supplied by the descending colder water on the outside of the drum, thus establishing a current up the middle and down the sides, rapid in proportion to the intensity of the heat. This circulation secures an even temperature in the water, and carries upward all the bubbles of steam which tend to adhere to the steam-making surfaces. The steam rises pure into the cone and is there further dried, without being superheated, and is collected in the steam space outside of the cone pure, whence it is conveyed by the steam-pipe to the engine. By this circulation all the heat is utilized, with great economy of fuel, and all dirt and sediments are deposited in the legs of the fire-box where the water is the most quiet, and whence it may be blown off by a tube below the surface of the grate; this effectually prevents incrustation, as ample experience with salt and very dirty water proves. It also prevents foaming, and generates steam rapidly. He has applied this principle of construction to horizontal and locomotive boilers.

GAS STEAM-GENERATOR.

The trial of Mr. Jackson's system of generating steam by gas, in working a hoisting apparatus in a London warehouse, gave the following results. The engine had a 6-inch cylinder and 10-inch stroke, and was equal to 3 horse-power, the boiler being equal to only 2 horse-power. The rate of working was 150 strokes per minute, and the trial started with 60 pounds steam, when 1,250 pounds were lifted 50 feet high in 30 seconds. Eight lifts were then made with the same weight, occupying with the lowerings 6 minutes. During the lifting the steam fell to 40 pounds, but in 2 minutes rose again to 50 pounds; four lifts and lowerings were then made in 4 minutes, the steam after each lift falling 3 pounds, but recovering itself in 30 seconds; these 30 seconds were occupied by the lowering, during which steam is not used. The amount of gas consumed was 50 feet in 15 minutes.

In another of these boilers, 4 gallons of water were evaporated in 30 minutes, with 75 feet of gas consumed; the same quantity was evaporated in 26 minutes, with 50 feet of gas consumed; 16 gallons in 86 minutes, with 200 feet of gas consumed; and 8 gallons in 43 minutes, with 100 feet of gas consumed. The pressure gauge ranged from 55 to 65 pounds, and the temperature of the heat passing out of the chimney was 300 degrees.—*Mech. Mag.*, 1867.

BOILER INCRUSTATIONS.

Friedrich, a German chemist, has published a method of preventing boiler incrustations, by putting pyroligneous acid into the water of the boiler until it faintly reddens litmus paper. This converts the carbonate of lime into the acetate, a much more soluble salt. More acid must be added as often as the boiler is fed, as the excess will always be distilled off with the steam. This, however, is capable of application only when the carbonate is the only lime salt present in the water; and to prevent the formation of crust in this case, common pyroligneous acid is probably as cheap as any boiler composition.

A NEW AMALGAMATOR.

Recent trials with a new amalgamator and desulphurizer have been made upon some of the most refractory ores, with results that promise a great revolution in gold and silver mining.

The powdered quartz, mercury, and sufficient water are placed in a wrought-iron cylinder, which is then closed air-tight and made to revolve slowly over a fire on a movable truck until the steam gauge indicates 70 or 120 pounds steam, according to the nature of the quartz. If the quartz does not contain much refractory ore, 70 pounds of steam are sufficient; if it contain much, 120 pounds of steam are necessary to thoroughly desulphurize and liberate the gold and silver. As soon as the required amount of steam is attained, the fire is withdrawn and the cylinder is kept revolving until cool. It is then opened and emptied, and is ready to repeat the operation. The machine will treat from 1,500 to 2,000 pounds of quartz at a time, inside of three hours, at very little expense.

It is claimed for the above process, that the steam not only desulphurizes but drives the heated mercury through the quartz in every direction, and the revolving of the cylinder constantly intermingles the quartz and mercury, so that every particle of the gold and silver must come in contact with the heated mercury, and consequently be taken up, thereby accomplishing a most perfect system of amalgamating and desulphurizing.

MANUFACTURE OF IRON AND STEEL BY MEANS OF MAGNETISM.

In a literary contemporary, Mr. W. Robinson gives a detailed account of his patented process for manufacturing iron and steel by means of magnetism.

Now, suppose there be no mistake about these results, what is the mode in which the magnet acts upon the crude iron? The mode in which the same or a similar result is arrived at may help us to an explanation. The two principal methods of turning crude iron into malleable iron and Bessemer steel are by the oxidation of the carbon and other matters out of the crude iron. In the puddling process successive portions of the melted iron are brought to the surface by stirring, and into contact with the air, till the greater portion of the carbon passes off in the form of carbonic acid gas, etc.; and the same thing is obtained much more readily and perfectly by the Bessemer process, by forcing the air through the melted metal. Now, we believe that it is an established fact that crude iron cannot become malleable till the carbon is driven off; therefore, if magnetism produces malleable iron from cast iron, it is by driving off the carbon in some way; but if it be driven out, it must be in the gaseous form. To render carbon gaseous, oxygen is necessary, and it so happens that among the gases, oxygen is a paramagnetic; therefore, in the magnetic sphere, there will be a concentration of oxygen. But this will not account for the oxidization of the carbon unless it can be shown that the carbon is brought in contact with the oxygen. On the surface it will be brought in contact with a condensed atmosphere of oxygen, but without stirring how is the carbon, which is mixed, or in combination with the metal below, to be reached? There seems to be but one way of accounting for it, namely, this: The particles of iron being magnetic, but the particles of carbon not being so, the particles of iron are necessarily colligated together when under the action of the magnet; and, the carbon squeezed out, the carbon will necessarily rise to the surface and there burn, which it apparently does, from what Mr. Robinson says, producing a great heat and intense ebullition of metal, and even melting the lining of the furnace and the bricks. Whatever the mode of operation may be, the results being, as stated, — and we see no reason to doubt them, — this method of converting crude iron into malleable iron is by far the simplest and most economical yet discovered. — *Mechanics' Magazine.*

PROCESSES FOR MAKING STEEL.

Production of Cast Steel and Iron directly from the Ore. — M. C. W. Siemens has patented in England a process for producing cast steel and iron directly from the ore by exposing the ore, in a finely divided state, to the surface action of intense heat, while currents of rich hydrocarbons percolate through the mass of ore in a transverse direction toward the heated surface. By the passage of the gases the ore is reduced and carbonized, and, the melting surface of the mass being enveloped in an atmosphere of reducing gas or flame, the reoxidation of the reduced metal is prevented.

Another Steel Process.— Mr. John Calvert, an English engineer, patents a mode of converting iron to steel, the chief peculiarity of which is the minute subdivision of the material by saws or other mechanical means while hot; allowing the particles to fall upon the hearth of a furnace in the presence of an excess of air and other gases, such as may be appropriate for the purification of the particular iron under treatment. It is also to be magnetized by electricity or by friction from agitation; this being supposed requisite for producing the proper molecular structure and strength.

Cast Steel Process. — As the Bessemer method consists in the simple oxidization of the carbon contained in iron, by penetrating it throughout with a blast of oxygen mixed with nitrogen (air), it is evident that mixing with the iron any substance capable of evolving oxygen would effect the same result. Mr. Bessemer patented this idea; but the substances, such as the nitrates of soda and potash, most available for yielding oxygen to iron, are very destructive to the vessel employed in the process. To meet this difficulty, Mr. John Heaton, now of the Langley Mill Steel and Iron Works, Nottingham, patented, about a year ago, the plan of placing the salts in pockets within the fire-clay lining of a revolving converter, so that all parts of the whirling mass might be brought in contact with the reagent. It appears that about 5 per cent. by weight is a sufficient proportion of the nitrate to be added to the iron for its conversion into steel. Samples of the product are spoken of as showing a fine, silky fibre at the fracture.

Iron Manufacture. — In converting cast iron into Bessemer steel, the triple compound of iron, carbon, and manganese is with great difficulty forced into the mass of metal previously treated by the pneumatic process; for the converted metal has a specific gravity greater than the compound. Mr. James Henderson, of Brooklyn, N. Y., has obviated this difficulty, by charging the blast furnace with a mixture of iron and manganese ores, or indeed any of the manganiferous iron ores, such as the red oxide of zinc, and Franklinite, so that there is formed on the hearth of the furnace a molten mass of metal, alloyed with metallic manganese in such quantities that it may be run directly into a Bessemer converter and subjected to the usual process of decarbonization, with this advantage over the ordinary method, that the indispensable manganese is thoroughly incorporated, and exerts its beneficial influence from the very beginning, instead of being introduced near the end of the pneumatic process. By this mode, it is claimed that Bessemer steel can be furnished much cheaper than by the older method, and finished bars, rails, plates, etc., can be produced by the same heat that melts the ores into crude or cast iron. The plan, now in successful operation in Austria, is soon to be largely introduced into this country.

Testing Bessemer Steel for Carbon. — This is done in the following simple manner by the English manufacturers. A standard piece of steel is kept on hand, in which the proportion of carbon has been accurately determined by chemical analysis. A few filings from this are dissolved in nitric acid of a certain gravity and kept in a phial. The shade of brown given to nitric acid by a certain proportion of carbon is very exact and uniform, and hence, a specimen of exact weight being taken from each charge and dissolved in half the standard weight of acid, and the solution then diluted with water until it reaches the exact color of the standard solution, the comparative specific gravity of the two solutions will determine the proportion of carbon in the specimen, to a hundredth of one per cent. There is not the slightest appreciable variation of ingredients, throughout different parts of the same charge.

SILICIUM IN IRON.

Dr. List, a German, has lately made a series of analyses respecting the reaction of the silicium in pig-iron during puddling and other refining processes. These analyses, like most of the other similar ones made during the last few years, prove that, under normal conditions, silicium is one of the most easily removable constituents of pig-iron. That this removal of the silicium is effected by oxidation, is shown by the fact that several varieties of pig-iron were found by List not to have lost any silicium when melted down in a cupola furnace. Calvert and Johnson found that pig-iron containing 2.72 per cent. silicium, contained only 0.197 per cent. when melted down, after an hour in a puddling furnace. Similarly, List found that the 1.92 per cent. of silicium, contained in a gray Nassau pig-iron, had diminished to 0.29 by the time the latter had begun to melt. In two other cases, where the process lasted a little longer, the silicium had diminished 88.83 and 96.6 per cent. Altogether it appears that pig-iron may contain up to 3 per cent. of silicium without disturbing the puddling process. From pig-iron containing more than 3 per cent. it would be difficult, if not impossible, to obtain good puddled iron. Dr. List states, in conclusion, that it is impossible to prove analytically the assertion of M. Lohage, that pig-iron for puddling must contain at least 9 per cent. of silicium.

SOLDERING IRON AND STEEL.

M. Bernard Lietar, of Rue de Houblon, Brussels, has just patented an improved composition to be employed in welding or soldering iron or steel. This composition consists of 1,000 parts of filings of iron or steel, according to whether the composition is intended to weld or solder iron or steel; 500 parts of borate of soda (borax); 50 parts of balsam of copaiba, or a resinous oil;

and 75 parts of ammoniacal salt (hydrochlorate, carbonate, or other). A mixture is made of the whole, which is then calcined and reduced to powder. To make use of the powder thus obtained, M. Lietar proceeds as follows: — Suppose two pieces of iron, or two pieces of steel, or even a piece of iron and a piece of steel, should be required to be soldered or welded one to the other. The composition is placed between the two pieces at the place to be united; the whole is put in the fire until the pieces have attained a temperature which permits the powder to become fused, which happens when the pieces have attained a cherry-red temperature. The pieces are then withdrawn and welded in the usual way. If the dimensions of the pieces, or any other obstacles, hinder their being put in the fire together, they may be welded as follows: Heat first one of the pieces to a cherry-red temperature at the place where the soldering or welding is to be made; then place the composition and apply the second piece, heated this time to white heat; then weld the whole together. This method is particularly applicable to the repair of large pieces. — *Mechanics' Magazine.*

WHAT MAKES IRON FIBROUS.

When Mr. Bessemer began to manufacture wrought iron from cast, by blowing air into the molten metal, it was objected to the product that it had no fibre, as common puddled iron had, and that iron without fibre must necessarily be weak. In this inference — which was wholly theoretical — we did not concur, and the question then arose, what does fibrous iron really mean? When the particles of wrought iron are brought to a high temperature, without the presence of any intervening material, they cohere in every direction, and the iron is not fibrous. But when slag is intermingled, as in common puddled iron is the case, there are intervening layers of cinder, which, when the iron is passed through the rolls, are not wholly expelled, but are only greatly attenuated; and as these planes are then very numerous, and pass in every longitudinal direction, they prevent, to some extent, the lateral adhesion of the particles, which, however, adhere end to end, and a fibrous iron is thus produced. It is now well known that homogeneous iron is much stronger than fibrous iron. But at the beginning of the manufacture, fibre was accounted as necessary in iron as in ropes or thread, — a theory resulting merely from the accident of the production of fibre by the modes of manufacture then exclusively employed. In the case of iron produced by the common process, any bubble or vacuity in the metal becomes filled with slag, which hinders the sides from being effectually welded under the hammer. But in the Bessemer iron, as the slag is absent, the sides of the bubble cohere when the ingot is subjected to pressure while still hot. It is better to hammer the ingots while still hot, after having been poured, than to allow them to cool and to heat them afterward; for in the one case the heart of the ingot is the hottest part, and in the other the coldest. — *Engineering.*

STEEL UNDER THE MICROSCOPE.

An experienced steel-maker can estimate very closely the precise quality, chemical composition, tensile and compressive strength, and even the mode of treatment which a steel has undergone, by looking at its fracture. We have already drawn attention in this journal to the interesting researches made by M. Schott, the manager of Count Stöllberg's foundery at Ilsenburg, upon the appearance of liquid and solidifying cast iron under the microscope, and we can quote the experience of this metallurgist as to the advantages to be obtained from microscopic observation of various kinds of steel. M. Schott, at his visit to the Paris Exhibition, made some most remarkable "guesses," as some steel-makers would call his conclusions, with regard to the qualities and method of manufacture of many hundreds of steel samples exhibited there, and of which he, in many cases, had no other knowledge than that which he could gather through the aid of a small pocket microscope, made of two pieces of rock-crystal, formed into a very powerful single lens. A pocket microscope, of this kind, ought to be the companion of every man interested in steel manufacture. Lenses of the usual kind, even if piled up in sets of three or four, are entirely insufficient. The lens must be of a very small focus, and properly achromatic. M. Schott contends that each crystal of iron is an octahedron, or rather a double pyramid raised upon a flat, square base. The heights of the pyramids in proportion to their bases are not the same in different kinds of steel, and the pyramids become flatter and flatter as the proportion of carbon decreases. Consequently, in cast iron and in the crudest kinds of hard steel, the crystals approach more to the cubical form from which the octahedron proper is derived, and the opposite extreme, or the shaft wrought iron, has its pyramids flattened down to parallel surfaces or leaves, which, in the arrangement, produce what we call the fibre of the iron. Between these limits, all variations of heights of pyramids can be observed in the different kinds of steel in which these crystals are arranged, more or less regularly and uniformly, according to the quality and mode of manufacture. The highest quality of steel has all its crystals in parallel positions, each crystal filling the interspaces formed by the angular sides of its neighbors. The crystals stand with their axes in the direction of the pressure or percussive force exerted upon them in working, and consequently the fracture shows the side or sharp corners of all the parallel crystals. In reality good steel under the microscope shows large groups of fine crystals like the points of needles, all arranged in the same direction, and parallel to each other. If held against the light in a particular direction, each point reflects the light completely, and a series of parallel brilliant streaks is shown all over the surface. Now, the exact parallelism of the pointed ends, or of the streaks of light, is one of the most decisive tests for a good quality of steel, and this is not visible quite so frequently as might be generally imagined. On the contrary, a great majority of steel fractures show crystals arranged in parallel groups or bundles, as before described, but clustered together in several distinct crystalline layers, which are not parallel to each other. The consequence is that the needle-points, visible under the microscope, appear to cross each other at certain places, or at least they point in such directions that, if elongated, these lines would cross each other at a short distance in front of the fractured surface. Wherever the crossing actually takes place, a ridge or line is generally visible to the naked eye, and the color of the two parts of the fractured surface which contain the different groups is different, since the light which falls upon one group, at the proper angle for reflection, will be in such a position with regard to the other group as to throw the points of the crystals into the shade. The one part of the surface, therefore, will appear bright or silvery white, while the other will look dark or gray in color. As usual, inferior specimens are more instructive than the best qualities, because there the peculiarities and faults come out most strikingly. We have seen a piece of a Bessemer steel block from a spoiled charge, in which the crystalline structure of the spiegeleisen was seen in some spaces, particularly at the edges of the air-bubbles, perfectly distinguished from the coarse-grained crystals of the mass of steel all round. This mass, moreover, contained groups of very different character within itself. In a specimen of steel or iron, made by another process, we could discover clearly defined crystals of pyrites, indicating the existence of sulphur in an unexpectedly tangible manner. Repeated melting, heating, or hammering of steel has, in general, the effect of reducing the sizes of crystals, and also of laying them more parallel. Still there seems to be a difference between the treatment which gives parallelism and that which causes the reduction of sizes in the crystals. The former seems to be principally due to the action of the heat, and repeated melting is the great panacea in this respect. The small-sized crystals, or what is called fine-grain, can be obtained by mere mechanical operations. In fact, hammering at a dull red heat, or even quite cold, is known to produce the effect of making the grain of steel extremely fine. This is a property, however, which is lost by reheating, and at a sufficiently elevated temperature steel seems to crystallize in large grains, which remain, if it is allowed to cool slowly and undisturbed by mechanical action. — *Engineering.*

EXPANSION AND CONTRACTION OF STEEL.

Expansion and contraction belonging to this subject is the enlargement or increase, or decrease in the bulk of the steel, as the case may be, in consequence of a change in the particles by the process of hardening. It is pretty generally known to those who are employed in the process of hardening steel, and to those in the habit of fitting up various kinds of work requiring great nicety, that the hardening of steel often increases its dimensions; so that such pieces of work, fitted with nicety in their soft state, will not fit when hardened, and the workman has therefore to resort to the process of grinding or lapping to make the work fit.

The amount of the expansion (or the amount of the contraction) of steel cannot be exactly stated, as it varies according to the size of the steel operated upon, and the depth to which the steel hardens; also in the different kinds, according to the amount of carbon combined, and even in the same steel operated upon at different degrees of heat. Steel which is the most liable to injury by excess of heat is the most liable to these expansions, and steel which is less liable to injury by heat is most liable to contractions. As, for example, the more carbon the steel contains, the greater will be its expansion; and the nearer the steel approaches to the state of iron, the less will be this increase of bulk.

Although the steel expands in hardening, it is not universal for pieces of all sizes to increase in dimensions; for sometimes it is smaller in dimensions after hardening.

Steel, like all other substances composed of particles, varies in its dimensions with a change in temperature. It follows that when the steel is at a red heat the natural positions of its particles are in a measure displaced, and it is expanded to a greater bulk; and when immersed in water and suddenly cooled such a change of its particles takes place as to make it hard and brittle. It also contracts to a smaller bulk by the loss of heat; but this cannot so rapidly occur at the central part, because it is protected by the surface steel. Consequently, large pieces of steel do not harden all through, or, in other words, do not harden properly to their centres, but toward the centre the parts are gradually less hard, and will sometimes admit of being readily filed; and as it is only the outer parts of the steel which harden properly, consequently it is only those parts of the steel which harden that increase in bulk. When the steel is immersed in the water, the water begins first of all to act upon the outer crust of the steel, and then cooling it gradually toward the centre. The outer crust being the first to part with its heat, it is of course the first to contract and become smaller. The outer crust in contracting is held in a state of great tension, by having to compress the central steel, — the central steel at the time being expanded by the heat. While the surface steel is in this state of tension, and the central steel in this state of compression, the particles of the surface steel, by the strain, are displaced to a greater distance from each other, and the particles of the central steel, by the compression, are compressed into a denser state. The particles of the central steel being compressed into a denser state, it causes the central steel, after it has become quite cool, to occupy less space than what it did previous to hardening. The particles of the surface steel become hard while in this state of tension; consequently the hardened part of the steel becomes fixed, and cannot return to its original bulk; consequently, the hardened part of the steel occupies more space than what it did previous to hardening.

If the displacement of the particles of the outer steel predominates over the compression of the particles of the central steel, the piece of steel under operation will then be larger in dimensions.

If the compression of the particles of the central steel predominates over the displacement of the particles of the outer steel, the piece of steel under operation will then be smaller in dimensions. In other words, if the expansion of the outer steel amounts to more than the compression of the central steel, the piece of steel will increase in bulk; if the compression of the central steel amounts to more than the expansion of the outer steel, the piece of steel will then decrease in bulk. The expansion of the steel is greatest when it is heated to a high degree of heat before immersion. This effect is owing to the particles being displaced at a still greater distance from each other, and which may, in some measure, account for the brittleness of steel when overheated. This expansion is, in some measure, reduced by tempering; and this effect is caused by the hardness being reduced, and allowing the particles to partly rearrange themselves in their natural positions.

The expansion of steel is prevented in some measure by annealing the steel about three times previous to its being finished, turned, or planed; for instance, after the first skin is cut from the steel it should be annealed again, after which another cut must be taken from it and again annealed, and so the third time. This may appear to some like frittering away time; but in many instances the time will be more than saved in lapping or grinding to their proper sizes after the articles are hardened, especially when it becomes necessary to lap or grind them by hand labor; for hardened steel works with great difficulty. Therefore in some instances it becomes a matter of importance in hardening to keep the article as near as possible to its original size. Articles made of steel, which have been well forged, will always keep truer and keep their original sizes better in hardening, and be less liable to break in hardening, than articles which are made of the steel in the state it leaves the manufacturer.—*Ede on Steel.*

IMPROVED STEEL-HEADED RAIL.

It is generally conceded by railway engineers that Bessemer steel rails will wear about 16 times as long as common iron rails. If such be the fact it is a matter of the utmost importance that railway companies renew their roads with steel rails or steel-headed rails as soon as those already in their tracks are worn out. Some of the first engineers in the country have expressed themselves in favor of steel-headed rails, provided the steel head could be welded perfectly to the iron, as in this country the weather is so intensely cold in winter that rails made entirely of steel are very liable to break. It is well known to all that until quite recently steel-headed rails have proved a failure, for the reason that it is such a difficult matter to heat a rail pile composed of iron and steel according to the usual mode of piling; as the iron requires about double the heat to bring it to a welding state that steel does: consequently either the iron is not heated sufficiently to weld, or the steel is overheated, which destroys its properties altogether. In either case the rail is unfit for use. As a general thing, the iron is not heated hot enough to weld to the steel, and the result is, that in a few weeks the steel cap separates from the iron; and the rail is rendered worthless.

S. L. Potter, Superintendent of the Wyandotte Rolling Mills, claims to have discovered a plan by which a pile can be made of iron and steel, and disposed in such a manner that the iron will receive twice as much heat in the furnace as the steel; consequently they are both brought up to a welding heat at the same time, without injuring the properties of either, and a perfect weld is secured.

A billet of Bessemer or other steel, about 5 inches by 4 inches, — having been previously rolled or hammered from ingots 7 or 8 inches square, — is introduced into the side of an ordinary rail pile, and charged into the furnace with the steel toward the flue, thus protecting the steel with the iron from the extreme heat. As it passes over the bridge from the fire-chamber, the heat passes through the iron to the steel; and it has been proved by actual experiment that the two metals are brought up to a welding heat at the same time. The pile is then rolled on edge, working the steel in the head. In the first passages through the roughing rolls a portion of the iron on either side of the steel is worked down in the lower part of the head, allowing the steel to form the head.

More than 50 different pieces of rails made after this plan have been subjected to 100 blows from a 2,000-pound steam hammer, literally crushing them, without impairing the weld in the least degree. Some of these rails are now in the track of the Michigan Southern and Northern Indiana Railroad, Michigan Central Railroad, and Detroit and Milwaukee Railroad, and have thus far given entire satisfaction. This plan is peculiarly adapted to re-rolling, as the old rails can be rolled into flat bars, then formed into a pile of the iron and steel. The old rails can, at a very moderate cost, be converted into a steel-headed rail, one-third being steel and two-thirds iron, that will be as durable and much less liable to break in cold weather than an entire steel rail. If it be preferred, a T-shaped piece of steel can be used instead of a square piece, and the same result obtained.

As they cost, at the present price of steel, only about 40 per cent. more than iron rails, and much less than rails made wholly of Bessemer steel, they seem well adapted to supersede the ordinary rails. — *Scientific American.*

AMERICAN CHILLED WHEELS.

The English still distrust the chilled cast-iron railway wheel as brittle and dangerous, and cleave to their expensive and comparatively short-lived wrought wheels. Mr. W. W. Evans, who has been for 30 years engaged in railway construction in the United States and North America, is now in England, engaged in the mission of introducing the American chilled wheels. Of course this is no American interest; the object being simply to induce the English to adopt for their own benefit (and for that of the manufacturer) the American way of making wheels. Mr. Evans presents to the British public, in "Engineering," a dense array of facts and statistics on this subject, mostly well known to intelligent Americans, but some of which are worth repeating even here. The chilled wheel is used almost exclusively in the western hemisphere, — in the United States, Canadas, and South America. They are also in high favor in Russia and Austria. Their peculiarly striking superiority for mountainous countries, where curves are sharp and grades are steep, renders Mr. Evans sanguine of introducing them on the mountain roads of India. Specimen sets are offered to all the English railways, free of charge until approved, and thorough public tests, by breaking up wheels with sledge hammers, are employed to remove the British prejudice against the article. 320 swinging blows with 28-pound sledges were struck on a chilled wheel, at one of these trials, before the stout smiths could break out a piece; as many more were struck before the wheel was broken up; the hub was not broken. It was then placed under a steam hammer of great power, and destroyed.

The life of the chilled wheel on the Erie Railway is quoted as about 140,000 miles, and there were wheels of this kind in the International Exhibition of 1862 that had run on Canadian railways 160,000 miles. The life of the English wrought wheel, as compared with the cast, is practically but little over 30,000 miles, because, after that amount of work, its face is left so uneven that it must be turned true in a lathe, at a cost about equal to that of recasting the iron wheel. The wrought wheel will stand two turnings, and sometimes three, making its total existence, with all the expense of turning, from 60,000 to 90,000 miles at the utmost.

The great English objection, the danger of breaking from frost and rough road, is turned against the wrought wheel by the facts of English railway accidents, and by the testimony of the manager of the Moscow Railway, who says that they have tried every class of wheels, and found none to withstand the roughness of their road and the severity of their climate, but the chilled cast wheel, an article made by themselves of Swedish iron and very inferior to ours. They had tried 20 of the German steel wheels, last winter, and broke one-fourth of them. — *Scientific American.*

IMPROVEMENTS IN THE MANUFACTURE OF IRON AND STEEL.

A new process is proposed for making wrought iron, which, it is claimed, will save 75 per cent. of fuel, and nearly all waste of metal. The ore, crushed and cleaned, is placed in the furnace, inclosed in sheet-iron canisters, and kept exactly at a reducing heat until deoxidization is completed, when the heat is raised to the welding point, and the canisters are treated in the same manner as puddle balls. The operation occupies 4 to 6 hours.

Steel Rails. — A method has been adopted of uniting iron and steel in the construction of rails, so as to obtain the advantages of steel on the faces, while making the stem mainly of the cheaper metal. It has been found impracticable to weld the two satisfactorily, and this difficulty is now obviated by connecting the two steel faces by a thin steel plate, like the letter H; thus making a complete rail of steel, except that the stem is slight, — a sort of skeleton stem, — reinforced with a sufficient thickness of iron rolled on each side to give the necessary strength and stiffness.

Dephosphorization of Iron. — Mr. Warren De la Rue (Eng.) has patented an invention, which consists in the introduction of lead, metallic or oxide, into the converting vessels so as to be thorougly diffused in the fluid metal, combining with the phosphorus in the iron, and the compound driven off by oxidation. Molten lead is introduced as soon as the blast has been turned into the converting vessel. Compounds are entered with the blast, in the shape of powder.

Improved Steel Masts. — This is the latest application of the Bessemer product; substituting much lighter and slenderer tubes of steel for the wrought-iron article which had already been applied to some extent in the British navy in place of "sticks." The new mast is strengthened by transverse longitudinal plates.

Steel Castings. — Among the novelties in steel from Prussia, displayed in the Exposition, is a locomotive cylinder and valve-casing cast solid in steel, — difficult enough in iron (says "Engineering"), but in steel very remarkable indeed, — as one of the first steps in a new art destined to produce the most important consequences. The cylinder is bored out, to show the quality of the metal, and the bored surface is as sound as the interior of a cast-iron cylinder generally is.

Hot and Cold Blast. — An inquiry instituted by the British Association has determined the ratio of strength in hot-blast iron as 1,024.8, and of power to sustain impact as 1,226.3, to 1,000 in cold-blast iron.

Rolling a fifteen-inch Armor Plate. — Sir John Brown has succeeded in rolling a plate of this thickness, intended for iron-clad forts. If the result of testing prove satisfactory, such plates will doubtless be substituted for the built-up system now adopted for iron-clad forts. By a peculiar process of manufacture, the special metal ingredients being kept a secret, these plates are said to combine the toughness of copper with the hardness of iron.

BRONZED CAST IRON.

The productions of the Tucker Manufacturing Company, in Boston, Mass., consisting of ornamental works in bronzed cast iron, have recently attracted much attention both in America and Europe. The material employed is made from several varieties of American iron compounded together, with a comparatively small admixture of the Scotch Coultness iron. A combination of several important qualities is thus obtained, and a material is produced possessing smoothness in working, softness, and strength. The castings, executed in green sand, undergo the customary process of pickling in dilute sulphuric acid, after which they are finished on their salient points either with the lathe or the emery wheel, as may appear the most expedient for the polishing. The beautiful, granulated, velvet-like surface of the field, upon which the polished portions appear to rest, is produced by the acid only, without the application of any tool.

The bronzing, the final stage of the manufacture, is thus accomplished: The iron, covered with a film of vegetable oil, is exposed to a high temperature, previously determined by experiment, and thus the desired color is obtained through the union of the carbonized oil with the oxidized metal. This is a *permanent* bronzing, since it is actually incorporated with the substance of the metal, and consequently not liable to injury from the action of the atmosphere, the touch of the hand, changes of temperature, excessive dampness, and similar casualties. — *Mech. Mag., July*, 1867.

BIRKHOLS' METAL.

The following is the copy of the patent, describing the process for making this valuable composition, resembling brass, securing great strength and solidity: —

"Be it known that I, Alexander Birkhols, of the city and county of Hartford, and State of Connecticut, have invented or discovered certain new and useful improvements in the composition of cast metal, by means of which greater strength is acquired; and I do hereby declare that the same is described in the following specifications.

"So as to enable a person skilled to make the same, I will therefore proceed to describe its component parts, the essential ingredient of which is cast iron. To make 100 pounds of this composition, I first take 2 pounds of cast iron, 2 ounces of charcoal, put into a crucible and heat to a white heat; I then add thereto 60 pounds of copper. Heat till both are melted together, then add 4 ounces of borax and 38 pounds of zinc.

"The mode of proceeding during the melting is much the same as with all other metals melted in crucibles. When melted it may be poured into moulds or bars suitable for the forge or rolling mill. Its strength is estimated to be 8,000 pounds greater to the square inch than the best wrought iron, rendering it far more valuable for various purposes.

"The proportion of parts may be varied, which will only change proportionably the desired effect, namely, greater amount of strength and solidity; but I believe that the proportions about as described will be best for all practicable purposes. I have described its component parts and the mode of proceeding to produce my improved composition, so as to enable a person skilled to make the same.

"What I claim, therefore, and desire to secure by letters patent, is the introduction of cast iron into a composition composed of copper and zinc in about the proportion, substantially in the manner as described."

COLORING OF ZINC PLATES.

A variety of beautiful colors, corresponding to those of the rainbow, can be imparted to zinc surfaces, by a simple chemical application continued a length of time proper for the desired color. It is necessary that the metal be pure, and especially free from lead. It is therefore to be rubbed with siliceous sand moistened with hydrochloric acid, then dipped in water and rubbed vigorously with blotting paper. The zinc is then immersed in a solution of 3 parts by weight of dry tartrate of copper in 4 parts caustic soda, with 48 parts distilled water, the whole at a temperature of about 50° Fah. The colors will appear successively, in the prismatic order, according to the period of immersion. In two minutes, the violet will appear; in three, dark blue; in four and a half, a golden yellow; in eight and a half, a red purple. Intermediate terms give intermediate tints. When colored, the zinc is well washed with water, and for greater permanence of color may be varnished.

NEW AGENT FOR AMALGAMATING GOLD.

The value of sodium amalgam has been thoroughly tested in the Pacific States of America, and better results have been obtained with it there than in any other mining district, yet it is now found that it can be entirely dispensed with by the substitution of a well-known and much cheaper chemical compound, — cyanide of potassium. It has always been considered that sodium amalgam owed its value to its power to attack and decompose the oxides of many of the metals, and it is now found that cyanide of potassium possesses the same property. It has been successfully used both on copper plates and in the pans. The plates are first cleaned with sand and nitric acid, and well washed in cold water; the surface is then swabbed over with the cyanide solution, and the mercury applied immediately, and rubbed on well. The plates will thus get a highly sensitive coating of mercury, which will seize upon the gold as it passes over them. In the pans the cyanide solution is applied with each charge of mercury, the proportion being varied to suit the ore operated upon. — *Mining Journal.*

TRANSPARENCY OF METALS.

Metals have generally been considered as opaque bodies, not permitting the passage of light through their substance. It is, however, very easy to show, by the use of an extremely thin film, as of gold or silver deposited upon glass, that light passes quite freely through it, and this property has latterly been turned to very good advantage. One of the earliest applications was as a substitute for the ordinary soot-blackened or colored glass, used in observing the sun during an eclipse, or at other times; and the silvering of the objective glass of the great telescope of the Paris Observatory has permitted an investigation of the sun's disk such as could not otherwise be prosecuted. Viewed through a lens, or even a plane glass thus silvered, the sun appears of a soft, bluish color, very sharply defined against a black background formed of the sky. All the peculiarities of the solar image, the different spots and foci in their variations of intensity, and the less luminous marginal regions, are shown with the greatest clearness, and even the filmiest clouds and vapors which seem to sweep over the disk can be readily perceived. The examination can be kept up any length of time without strain to the eyes. The physiological influence is very different from that of colored glasses, the use of which is sometimes very objectionable. Since all the different rays of light pass through the metal (although greatly tempered) except the outermost red rays, which are excluded, together with the dark heat rays, the silver must be deposited in the usual galvanoplastic or chemical manner, so as to form a very delicate film. Gold and platinum may also be used, but silver possesses several advantages.

This property, on the part of metals, of greatly subduing the rays of light, without extinguishing them to any extent, and of excluding almost entirely the rays of heat, is now applied to other practical purposes. Weak eyes can use spectacles thus prepared to the greatest advantage, where colored glasses are not to be thought of. For persons whose business keeps them before a glowing fire, such glasses are invaluable, since the sight is not strained by the light, nor the eyeball injured by the heat, which is measurably excluded. Screens of glass, to be placed before fires, have also been made on the same principle.

MIRRORS WITHOUT MERCURY.

It is well known that of the manufacturing arts, that of preparing glass for mirrors is one of the most injurious to the health of the artisan. Hitherto science has failed to suggest any method of defending those engaged in this dangerous employment from the poisonous exhalations of mercury, which is used in large quantities in this manufacture; but now French ingenuity has given to the world a substitute, which bids fair to supersede the use of mercury entirely, and make of a dreaded and fatal art one wholly innocent, as well as agreeable and cleanly. The report of M. Salvetat to the Society of Encouragement in Paris describes and approves this invention, for which it predicts a great success.

This invention is what may be called a method for the metallization of glass of every kind, even the coarsest and most ordinary, which, by a rapid, simple, and inexpensive process, becomes an excellent reflecting medium, while, strange to say, it still retains its transparency, so that the same glass may answer at the same time the double purpose of window and mirror.

The ordinary method of preparing looking-glasses is with an amalgam of tin and mercury, four parts of tin to one of mercury.

In the invention reported by M. Salvetat, neither mercury nor tin is used at all. The tinfoil is replaced by platina, not applied in leaf form, of course, but chemically, in a metallic and brilliant powder. The operation is perfectly simple. The glass, having been carefully cleaned and polished, is covered, by means of a brush, with a mixture of chloride of platina, essence of lavender, and a dissolvent composed of litharge and borate of lead. When dry, the glass is placed in mufflers, when the essence, being volatilized, leaves a deposit of platina dust firmly united to the glass. While two or three weeks are necessary for the manufacture of ordinary mirrors, the new process only requires a few hours.

In a hygienic point of view, the new process is absolutely invaluable, and is a true gift to humanity. So far from being exposed to the least injurious emanation from a poisonous substance, the most exquisite neatness and purity prevail in the factory. Neither dust nor moisture may be admitted, for every grain of dust would attract the liquid and leave the glass exposed, while dampness would contract the platiniferous deposit.

If the metallized glass compares favorably in durability and cheapness with the ordinary mirror, it cannot fail soon to supersede it entirely. Even after the lapse of years, it is well known that the mercury will crumble away from our mirrors, and that little cracks will appear in it. A glass which has been for a long time in one position, if reversed, will often suffer injuries, the mercury having a tendency to fall downward. The background of foil is also so extremely fragile and delicate, that it must be preserved from accident by the double protection of a stout flannel and a frame. It is also greatly affected by the variations of climate, and it is even said that the damages sustained by manufacturers who export mirrors to tropical countries amount to 50 per cent. of the value of their exportations. The platina, on the contrary, defies all climates and every atmospheric change; while, as to economy, it is certain that the new method is far less expensive than the old.

It has, besides, other advantages. To make a good mirror in the ordinary manner, the glass must be absolutely free from flaws, bubbles, and streaks, and of the most perfect transparency; while by the new operation the most defective glass, even the common bottle glass, in spite of its deep tint, becomes, after manipulation, an irreproachable mirror. Another condition with the mirrors of the past has been the parallelism of the two sides; a necessity which disappears under the new process, which demands only that the surface which receives the platiniferous deposit shall be prepared in the customary manner, when a perfect mirror is obtained in spite of the inequalities of its surface. Glass thus prepared may be also used for windows, being on the one side reflecting and from the other transparent, admirable for apartments whose occupants desire light and a view outside, but do not wish to be seen by passers-by. The platina can also be disposed on the glass in various designs; the most elegant lace curtain may be stamped indelibly on the panes of a window, while graceful arabesques on glass will ornament our public buildings. M. Salvetat believes that this invention will make a revolution in the decorative art.

NEW USES FOR MICA.

Puscher, of Nuremberg, lately suggested the use of mica for various decorative purposes. For one such application, the thin plates are first purified by treatment with strong sulphuric acid, and then silvered by the ordinary process adopted with looking-glass. The mica thus acquires a beautiful silver lustre, and it may easily be cut into any shape to be used for inlaying work. The flexibility of the mica will, of course, allow of its being applied to round surfaces. When a sheet of mica is heated to full redness for a time, in a clay muffle, it loses most of its flexibility, and is changed considerably in appearance. Under reflected light it has a dead silver-white look; but viewed by transmitted light it is seen covered with gray spots. This latter appearance is lost when two or three pieces are superposed, and the transparency is lost. The mica after heating is also a beautiful material for inlaying work. It should be cut into the shapes required before it is heated. Another very pretty effect is obtained by scattering small fragments of mica on freshly poured sheets of gelatine, and varnishing it with a dark-colored solution of gelatine. Finely ground mica on colored gelatine also shows very pretty effects; and a very finely ground material mixed with a solution of gum-arabic may be used, Puscher says, for silver ink. — *Mech. Magazine.*

IMITATIONS OF GOLD.

A beautiful alloy resembling gold, manufactured in Waterbury, Conn., a French discovery, consists of pure copper 100 parts; tin, 17 parts; magnesia, 6 parts; sal ammoniac, 3.6 parts; quick-lime, 1.6 parts; tartar of commerce, 9 parts. The copper is first melted; then the magnesia, sal ammoniac, lime, and tartar in powder are added little by little, briskly stirring for about half an hour, so as to mix thoroughly; after which the tin is thrown in, stirring until entirely fused; the crucible is then covered, and the fusion maintained for about 35 minutes, when the dross is skimmed off, and the alloy is ready for use. It can be cast, rolled, drawn, stamped, chased, beaten into a powder or leaves, and none but excellent judges can distinguish it from gold, except by its inferior weight. Another beautiful alloy, rivalling the color of gold, is obtained with 90 per cent. copper and 10 per cent. aluminium, which must be perfectly pure, of the best quality, and in exact proportion. It is little affected by the atmosphere, and is strong, malleable, and homogeneous in structure.

MERCERIZING COTTON.

To Mr. Mercer must be attributed the discovery of the peculiar action of caustic soda and sulphuric acid upon cotton. This singular process, now called "mercerizing," has the effect of untwisting the normally twisted flattened tubes of cotton filaments, and converting them into cylindrical tubes. When colors are applied to the cotton so treated, they pass more readily through the minute pores of the tubes, and are precipitated in denser layers in the interior of the latter, whereby darker and more permanent shades are produced. Calico so treated becomes greatly increased in strength, and though hitherto no large quantities of cloth thus prepared have been printed, owing to the expense of preparation, advantage has been taken of the process to prepare the cotton fabric used in the production of the endless web known to calico printers as the India-rubber blanket, which, when made with prepared calico, is rendered much more durable. The advantages are that the fabric contracts about one-fifteenth linearly in each direction, and the threads appear rounder, firmer, and closer together; the cloth does not reflect so much white light, but has a translucent appearance. Its strength is also improved. Cotton thus treated shows a superior affinity for some colors, especially indigo-blue. It takes as deep a shade of blue in one dip as common cloth takes in six, and, generally speaking, colors look better on this than on untreated cloth. The objection to the process was mainly the expense of the soda; but now that this agent has been reduced in price this objection will not be so formidable.

NEW TEXTILE FIBRES.

Blume, Decaisne, and other French naturalists have drawn attention to the Ramié (*Bœhmeria tenacissima*) of Java, as a textile. The Ramié belongs, like the hemp and the nettle, to the *urticaceæ*, and was transplanted from the island of Java to the Paris Jardin des Plantes, by Blume, in 1844, where it was reared in the hot-house until its introduction into the more congenial climate of Mexico by M. Roezl, former head of the Horticultural Institute of Belgium, within 11 years past. It is considered that only the middle and southern portions of our Gulf States will afford it a suitable climate, and that in that latitude it will make three or four crops a year, each equal in quantity to the most prolific hemp.

The perseverance of Mr. Roezl in domesticating the staple in the western world deserves the high reward his friends anticipate for it. Having first gone to Java and spent a year in familiarizing himself with the character and growth of the plant, he emigrated to Mexico with a store of its roots. On his way to the capital, he was robbed of his treasure by Mexican banditti, and was obliged to write to Europe for a new supply, which was at length procured through the good offices of the British navy; but this perished on the voyage to England. Again it was attempted, and again the plants were killed. A third attempt succeeded; but the plants had to be placed under hot-house cultivation in England, to give them strength for another great voyage. In 1859, after 6 years of waiting and endeavor, his plants arrived half dead, and with the skill of an accomplished and scientific horticulturist he nursed them into life, and within 2 years found himself the owner of a thriving plantation.

The most approved machinery for cleaning flax and hemp proving unsuited to the requirements of so fine a fibre, he produced two implements of his own invention, by which the stalks were converted, within 24 hours after cutting, into long skeins of pure, white, and silk-like fibre, ready for spinning. In February last, Mr. Roezl visited Cuba with specimens of the results of his 11 years' labor, which, after careful examination, were pronounced of the first importance by the agriculturists of the island, who predict that it will supplant tobacco and coffee as a staple for Cuba. Mr. Roezl takes 5 crops per annum from his plantation; the matured plant, which is perennial, attaining, when well rooted, the height of 20 feet. The statement that its fibre is stronger than hemp, as fine and white and twice as durable as linen, and more productive than cotton, is so far confirmed, that in 1865 Mr. Roezl exported and sold in England over 5,000 pounds of the staple at double the price of the best quality of cotton.

Another New Fibre. — By a late patent, a species of nettle, which grows luxuriantly and spontaneously throughout the Mississippi valley, is employed in the manufacture of cord, rope, cloth, bagging, and paper. The stalks, which grow from 4 to 8 feet high, are gathered in the winter, and are ready for the brake without any rotting process. The fibre is said to be exceedingly fine, strong, and susceptible of a high finish by dressing.

Textile from Hop Vines. — Another discovery in the field of textile material is that of a Belgian, who has shown that a second, most valuable, and heretofore useless product can be furnished by the hop vine. After the hop blossoms have been gathered, the stems are steeped like hemp. When this operation has been completed, the stalks are dried, beaten with a wooden beetle, and then the threads come off easily. After carding and working in the ordinary way, a very strong cloth is obtained. The thickest stalks also yield the material for several kinds of rope

THE PRESERVATION OF MEAT.

A new process for the preservation of meat, by means of a solution of bisulphite of calcium, has been lately patented in England by Messrs. Medlock and Bailey. The antiseptic properties of sulphite of calcium have long been recognized. In this patent, however, the more soluble bisulphite is employed. This possesses several advantages over other sulphites, which will strike chemists at once. It is easily obtained free from sulphate, and if any sulphate should be afterwards formed by oxidation, no unpleasant taste would be noticed by the consumer. These points have probably operated against the extended use of sulphite of sodium. The low equivalent of calcium is also somewhat in its favor. The ordinary preservative solution is made as follows: dissolve about a pint of common salt in 4 gallons of clear cold water, to which add half a gallon of the bisulphite, and mix well. If the meat, etc., to be treated, is required to be preserved for a very long period, a little solution of gelatine or white of egg may be added with advantage. All kinds of meat may be kept perfectly sweet by simply soaking the joints in the above preservative solution for 10 minutes, and then hanging them up, wetting them again with the solution once a day.

It is stated that beef, mutton, lobsters, etc., treated by this process, kept good for 12 days with the temperature varying between 80° and 110° F., the original odor and flavor remaining unimpaired at the end of the time. In 26 hours portions of the same animal matter, unprepared, were absolutely putrid.

Another method of preserving fresh meat has been devised and patented by Prof. Redwood, of London, and consists in giving the meat to be preserved a coat of paraffine. At a temperature of 130° this substance becomes fluid, and will, in this condition, bear a considerable amount of heat without boiling, and thus enable the experimenter to raise the temperature, if required, several hundred degrees above 212°, the boiling-point of water, without in any respect altering its condition. It was found by Mr. Redwood that animal substances, when immersed in a bath of paraffine heated to about 250° F., rapidly lost the air and water which all such substances contain, leaving the juice of the meat in a concentrated state. According to the thickness of the mass of meat, the time of its immersion is increased or diminished. By this process the germs of destruction are found to be quite destroyed, very much on the same principle that the various articles of food are prepared in hermetically sealed vessels, or calf's-foot jelly bottled and kept in a perfect state of preservation. When the meat has thus been allowed to remain a sufficient length of time in the highly heated paraffine, it is removed, and immediately dipped into a bath containing the same material, at a lower temperature; and after two or three dippings the process is complete, and the substances thus preserved are ready either for home or foreign consumption. Various samples have been prepared, and, after three months' keeping, have been cooked and found perfectly sweet, and free from any taint whatever. So successful has the process been, so far as it has been tried, in connection with experiments commenced last summer, that a company has been formed in London, where experiments are still going on with a great variety of different substances, such as bacon, beef, mutton, butter, eggs, sausages, cheese, hams, etc. The company hope that, ere long, choice beef and mutton will be sent home to Great Britain in a perfectly fresh state, and be sold at such prices as must of necessity prove a boon to the public generally, but more especially to the poorer portion of the inhabitants in this country. The following are the directions by which the preserved meat may be cooked: "Remove the greater part of the paraffine by breaking it with a hammer or other suitable instrument, and peeling it off; then put the meat into a vessel of boiling water, when the remainder of the paraffine will melt and rise to the surface, leaving the meat entirely free from it. When it has cooled, the hardened paraffine may be taken from the surface of the water, and the meat dried with a cloth. It is now ready to be prepared for food by any of the usual methods, but it should be cooked for only half the time required for unpreserved fresh meat. The paraffine that has been removed from the meat may be kept for subsequent use, being quite unchanged, nor injured in any way.

Transportation of Fresh Meat. — The experiment of transporting fresh meats from the West by railroad has proved a success. A car containing 16 steers and 22 sheep, killed and dressed at Newark, Ohio, has reached New York city in 4 days, delivering the meat fresh and sound as when first shipped. The car in which the meat was transported resembles a common freight car on the outside. The sides are double, with a space of 3 inches between the outer and inner sides. This space is filled with strips of cork packed tightly together. At each end, near the top of the car, is a chamber filled with ice. A large fan or wind-wheel works in a circular opening at the top of the car, forcing a current of air down the ice. The cold air then rises up at the bottom, and circulates all through among the carcasses. As the ice melts, the water and the impure air escape through the bottom of the car.

PROCESS FOR PRESERVING WOOD.

This process was invented by Mr. J. L. Samuels, who has applied for a patent. The wood to be operated upon is first placed in an air-tight cylinder, and thoroughly steamed, in order to vaporize the sap in the wood; the air is then withdrawn from the cylinder, by means of an air-pump, until a perfect vacuum, or nearly so, is created, which opens and frees the pores in the wood, when a solution of sulphate of iron is forced into the cylinder, under a pressure of 175 pounds to the inch, which forces the solution through the pores. This pressure is kept up for half an hour, giving the solution time to percolate or permeate every portion of the wood; then a solution of carbonate of lime is forced into the cylinder, which has the effect to precipitate the iron, forming a sulphate of lime; thus coating or filling all the minute cells of the wood with a mixture of oxide of iron and sulphate of lime. The wood is then thoroughly cleansed and dried, when it is found to have attained an extraordinary degree of toughness, and capable of receiving a beautiful polish, besides being rendered completely impervious to rot of any kind, and impenetrable to insects.

The invention is one long needed, and one which many have often vainly endeavored to effect, and will be of immense value to this city for preserving piles, which are rendered useless in a few years from the ravages of the *teredo navalis*, when the wood is used as at present. The inventor claims that wood thus treated will not only be useful when placed in the water, but will be equally available for railroad ties and street pavements, while from the hardening and drying process the wood is prevented from swelling or shrinking, thus providing a suitable wood for shoe-pegs, and various other purposes where strength and durability are desired. The wood thus prepared is capable of resisting a crushing pressure, when compared with the unprepared wood, of 8 to 1, and the pressure required to break it transversely is as 13 to 1.

Preserving Cereals. — M. A. E. Blavier, of France, has patented a process for preserving cereals in large chambers filled with pure and dry carbonic acid. This gas being incombustible, economically produced, and heavier than atmospheric air, is admirably adapted for the purpose. For wheat in large masses, he estimates the cost of applying his process at 2½d. yearly for every 22 imperial gallons.

SOFTENING WATER.

The two principal sources of impurity in water which render it unfit for household purposes, are organic matters, and salts of certain metals producing hardness, as found respectively in river and spring, or pump water.

Dr. Clarke, of Aberdeen, patented a process for rendering certain hard waters soft by the addition of lime; the soluble carbonate of lime, being rendered insoluble, takes down also, in a kind of network, the principal part of the organic matter in a state of solution. By this process certain salts, rather beneficial, are not abstracted; for instance, sulphate of lime tends to harden water, but as a preservative against the effects of lead it is invaluable. If water of 16 degrees of hardness could be rendered of about 5 or 6 degrees, at a moderate cost, it would prove invaluable to manufacturers, beside the economy in fuel and saving in plant, wherever steam boilers are required; it would save great labor in culinary and laundry operations; it would also be a more wholesome aliment, promoting digestion, and preventing the diseases arising from the presence of lime. The latest apparatus for this purpose consists of a galvanized iron cylinder, about a foot in diameter, and 3 or 4 feet high, in which are chambers wherein prepared lime is placed. It may be placed in any convenient locality, and requires no attention except to put a small portion of the lime in it, about once in two or three weeks; the cost of working is said to be about one farthing for 2,000 gallons. The water enters the cylinder at one point, and quits it at another, after having passed through the deposit of lime, as soft as rain water, as clear as spring water, and much purer than either — *Mech. Mag.*, 1867.

RESPIRATION IN DANGEROUS GASES.

Many plans have been devised for enabling men to penetrate dangerous gases, in mines and similar places, for the purpose of working or of rescuing their comrades.

The plan of Mr. T. Y. Hall, of England, was of a permanent character. Safety pipes of proper material were to be laid down in the floor of the main galleries of a mine, in the direction taken by the air, from the top of the "downcast" shaft into the workings, and back through the "return" to the "upcast" shaft,— these to be provided with boxes or joints at intervals of about 40 or 50 yards. An air-tight dress or casing is put on, so secured, as in that of a diver, that the man wearing it breathes only the enclosed air. Flexible tubes from the dress can be connected with the boxes on the safety pipes, and these tubes removed at will by the miner; having advanced the 40 or 50 yards, the length of the flexible pipe, it is unscrewed and attached to the next joint, so that he breathes pure air though passing through an atmosphere that would soon be fatal if breathed.

Galibert's apparatus, approved by the French Academy, is more simple, and permits free locomotion. A reservoir of air is carried on the back, fixed by means of braces to a waist-belt; the bag is made of a strong linen envelope externally, lined with a finer one, each covered with numerous layers of India-rubber; the usual capacity is 140 litres (1.76 to the pint), which will allow a man to remain 35 minutes in the most deleterious gases without inconvenience. From the bag tubes extend over the shoulders, provided with properly secured nose and mouth pieces. The man takes air from the reservoir and respires into it again, breathing the same air many times over without inconvenience. When the respirations become frequent, he begins to prepare to retreat, though after the first warning he can remain 7 or 8 minutes without danger. It can be prepared and adjusted in half a minute, and requires no instruction to use it, and will probably save many lives of workmen overtaken by "choke damp," or carbonic acid.

The apparatus of Mr. Rouquayrol, engineer to the Aveyron collieries in France, consists of a reservoir made of thick iron plates, capable of resisting a pressure of 25 to 40 atmospheres; the air is injected by very ingenious pumps, in which the pistons are fixed and the cylinders move. When charged with air, it is placed on the back like a knapsack; a kind of mechanical bellows is placed on the top, allowing the air, although at a very great pressure, to enter the lungs at the ordinary pressure; a little exterior valve, of two leaves of India-rubber, held together by the pressure of the atmosphere, opens itself to let out the respired air. With this apparatus a man can breathe with the same ease under water, and successful experiments have been made with it at the bottom of rivers and of the sea, and in the sinkings of mines; it is far preferable to the awkward and heavy dress usually worn by divers. Air may also be supplied to a Davy safety-lamp by this apparatus, ensuring a continuous light in searching for disabled miners. — *Quart. Journ. of Science, April*, 1867.

IMPROVED TANNING PROCESSES.

Mr. G. L. Loversidge, of England, has recently patented an improved process for the preparation and dressing of hides and skins for market. It consists in the employment of valonia and oak bark, or other tanning materials, in conjunction with a solution either of caustic soda, carbonate of soda, ammonia, carbonate of ammonia, or with mixtures of any of these solutions. A considerable saving of time is thus effected, and a leather of superior quality obtained. — *Mech. Mag., Oct.*, 1867.

Novelty in Tanning. — A tannery has been located at Rockford, Ill., in which is employed the patented process by exhausting the air from the vat. The tanning is said to be accomplished in 12 hours, and that of sheep skin in 15 minutes. The weight of leather from a given weight of hides is 10 per cent. greater than by the ordinary process, and the cost of the works is but 10 per cent. that of the old.

CARRÉ'S ICE-PRODUCING MACHINE.

The principle of this machine consists of sulphuric acid, marking 59° to 66°, circulating in a thin stream, through which passes vapor of water drawn along by a vacuum created pneumatically. The evaporation of this produces the cold. The recipient of the acid is formed of an alloy of lead and antimony, in the proportion of 5 to 6 per cent.; it supports, without alteration of form, a pressure of 5 or 6 atmospheres, while the pressure in practice cannot exceed 1 atmosphere. The copper pump is preserved from the contact of the sulphurous acid, always disengaged by the acid recently introduced, by an arrangement which necessarily and constantly oils the inside surface. The valves are opened mechanically, and cannot get deranged. The apparatus keeps the vacuum for several months; the acid is extracted when it has become diluted to about 52°; the congelation commences generally 3 or 4 minutes after the commencement of making the vacuum; if cold water at 3° or 4° C. is required, 2 minutes suffice, and a little shaking up for some instants restores the air which it has lost. Other substances can be substituted for sulphuric acid (which is, however, the cheapest agent to employ), such as caustic potash or soda, or chloride of calcium, which cause a congelation sufficiently prompt and intense. In the application M. Carré mentioned the adaptation of the apparatus on board ships and in cellars where the temperature could be indefinitely kept at 5° or 6° C. in all latitudes, also for the refrigeration of apartments.

M. Thénard first called attention to the curious and important fact discovered by milk-women, and of which he cannot find an explanation. If milk, a few minutes after being drawn from the cow, be cooled with very cold rain-water, it keeps fresh for many days, and can be sent to a long distance. Carré's apparatus can advantageously replace the cold water, especially in agricultural distilleries, which employ a good deal of sulphuric acid and keep at the same time a great number of cows. — *Chemical News.*

ASPHALT PAVEMENT IN PARIS.

Visitors to Paris are generally surprised at the appearance of the pavement of a great number of streets in the central parts of the town, and still more at the peculiar mode of making and repairing this asphalt pavement if they chance to see those operations carried out. The asphalt pavement was introduced into Paris in 1854, by M. Momberg, chief engineer, and M. Vandrey, engineer of the municipal service of the town of Paris. The first street paved in this manner was the Rue Bergère. The asphalt used for this purpose is a natural composition of pure carbonate of lime and of bitumen or mineral tar. It is found in abundant quantities at Seyssel, in France, and at Val-de-Travers, in the canton Neuchâtel, in Switzerland. In the first-named locality the layers of bituminous limestone are from 4 to 7 yards deep, and of very uniform composition, containing about 66 per cent. of bitumen and 34 per cent. of carbonate of lime. The natural stone is crushed into powder by machinery, and afterwards heated to a temperature of about 140° C. It then remains in the state of a dry, fine powder, somewhat similar in its consistency to moulders' sand, and in this form it is employed in the streets. The roads to be paved are first covered with a layer of concrete made of gravel and cement, and this layer is carefully dried before the application of the asphalt cover. The asphalt powder is then reheated and spread over the surface of the concrete in an even layer of about 4 centimetres, or 1 3-5 inches in thickness throughout. After this the powder is rammed and compressed by means of heated cast-iron rams worked by hand. This being done, a heated roller is passed over the surface. The roller weighs about 400 weight, and is repeatedly traversed over each short length of pavement newly rammed in. Two larger rollers, one of 1,600 weight and one of about 2 tons' weight, are afterward employed for flattening down the surface of the whole. The pavement is finished and ready for use immediately after cooling, say 2 or 3 hours after the first roller has completed its work. The asphalt pavement has now had an extensive and complete trial, and its advantages are very numerous. There is neither dust nor mud produced by it, and its surface wears no more than 1 millimetre, or one-twenty-fifth of an inch in thickness per annum in streets having a lively traffic. At the beginning there is a compression caused by the weight of the vehicles rolling over the pavement, but the whole gets soon into a state of uniform density, and the street then remains in a perfect state for a long time, requiring very little repair. There is no noise whatever from the wheels of carriages in asphalt-paved streets, so that there is a certain danger caused by this to pedestrians from the want of warning of the approaching carriages. This, however, disappears by degrees, as the public become more and more acquainted with this kind of pavement. The tractive force required by the carriages passing over asphalted streets is very considerably reduced, and still more important is the reduction of the wear and tear of carriage-wheels, springs, and axles, — a reduction which is due to the absence of all concussion and vibration in the rolling of the carriage-wheels over the smooth and uniform surface of the street. — *Engineering*.

IMPROVED INSULATOR.

An Englishman named Hooper is reported to have perfected the application of caoutchouc for insulation of telegraphic wires, so as to supersede gutta percha by an altogether superior article. Tests for inductive resistance on a knot of the Ceylon cable core, manufactured by Mr. Hooper, showed that the time of falling from a tension of full charge to that of half charge was 300 minutes. The Atlantic cable falls in 60 or 70 minutes. The inductive resistance was to that of gutta percha as 1.36 to 1. Its permanency of insulation at high temperatures is the most remarkable quality of this coating. At 212° F. its insulation is more tenacious than that of gutta percha at 100°. It is manufactured at a temperature of 280°. It is also nearly impermeable to moisture even under pressure, — the change in weight by absorption in three years being found to be only 1 per cent. in thin sheets. The material is first formed into massive cylinders, then shaved from the periphery by keen cutting machines into very thin, long sheets, next slit into tapes, and these are served around the conductor to the thickness desired, when the mass is welded by heating. The secret of the improvement, however, is said to be in the perfect elimination of oxygen, — imperfectly effected by vulcanization, — which was the element that caused the gradual softening and permeability hitherto experienced in the article. It was a process of slow oxidation or decay, which has been entirely obviated. The removal of oxygen leaves the caoutchouc of its proper color, pure white. — *Scientific American.*

THE MAGNESIUM LIGHT.

Magnesium has recently been applied with the greatest success in pyrotechny. The powdered metal, when covered with paraffine, is preserved from the action of acids and alkalies, and can safely be employed in the manufacture of fireworks. If only from 2 to 5 per cent. of magnesium be mixed with the ordinary rocket-powder the light is greatly intensified; and the effect was seen to great advantage in recent pyrotechnical displays at the Crystal Palace. In rockets the dense white smoke produced by magnesium is an advantage rather than a loss; for the canopy then seen floating like a network of snow-white gauze over each burning star not only adds by its appearance to the beauty of the display, but reflects downward an additional amount of light. The use of the magnesium powder in rockets for signals at sea deserves the investigation of the authorities at Woolwich, as the light is so greatly intensified at so small a cost. The American government is now seriously considering the desirability of adopting the magnesium light as their signal light for the service, both in lamps and out of them. At the Wimbledon meetings the light was employed with good effect, the magnesium balloons being generally mistaken by the public for meteors. — *British Journal of Photography.*

PROSSER'S LIME LIGHT.

The lime light has recently been introduced, on trial, into lighthouses, where it promises to prove a formidable rival to Holmes' electric light. At the South Foreland Point, Mr. Prosser's lamp for the production of lime light was placed three years ago in the upper lighthouse. The lamp was fixed in the centre of the Fresnel apparatus, which had already been employed with the electric light, and which was adjusted to the use of a four-wicked oil lamp, the burner of which was 3¾ inches in diameter. We take from the report of Professor Faraday, made to the Trinity House, on the 11th of June, last year, an account of the light, in regard to its working and success in the Upper Lighthouse at the South Foreland:

"The lamp consists of a central octahedral prism of quicklime, built up of many small pieces of lime from chalk; it is about 3⅝ inches in diameter and 16 inches long. It is supported by a clock which, when in action, lifts it perpendicularly, at the rate of 1 inch per hour. Eight gas jets, conveying mixed oxygen and hydrogen, are placed at equidistances around this lime, in a horizontal plane. When the gases are lighted and directed against the lime, they produce 8 places of intense ignition; and as the lime core is about 11.4 inches in circumference, the centres of these 8 frames are about 1.4 inches apart.

"The lamp practice in the lantern is very easy; the jets are easily and safely lighted and adjusted. The action then goes on for hours together without change. The clock raises the lime; draughts do not affect the light; there is apparently no circumstance present which can cause derangement, and, as far as appears by theory or practice, the lamp may be left until sunrise untouched, provided gas be regularly supplied from below. The lamp is easier of management than a common oil lamp. It is easily replaced, in case of need, by the ordinary oil lamp; and that has been done in times varying from 7 minutes to 10 minutes or more.

"The light produced is very white and beautiful in character, far surpassing that of oil or gas flame in its intensity, but not equal to the electric spark; but then it is much larger in dimension. It is like the light of a planet, whereas the electric light is like that of a star. It streams out from the lantern over the surrounding space in great abundance.

"The good and constant condition of the lamp will depend upon the sufficient and steady supply of the gases required. At present these are oxygen and hydrogen.

"The oxygen is made by the ignition of the native peroxide of manganese, in iron retorts fixed in a furnace, heated to bright redness by coke.

"The oxygen, after being passed through a washer, is conducted to a gas-holder capable of holding 600 cubic feet of gas; it is outside the building, appears to be steady in its action, and fit for its peculiar service. The pipes conveying the gas are 1½ inches in diameter outside the tower, and 1 inch in the tower. No inconvenience has as yet been experienced, at Westminster Bridge or elsewhere, from the action of cold on such exposed pipes. There are cocks at the gas-holder, and also in the lantern, governing the progress of the gas. The pressure upon it, when the lamp is burning, is 6 inches of water.

"The hydrogen gas is at present made by heating to redness a mixture of equal weights of iron borings and crushed coke dust in iron tubes placed in a special furnace, and then passing over it a stream of steam. There are 3 tubes, which require only once charging for the day; and they, with the furnace, seem to do their duty very well. The gas is passed through a washer, as in the former case, and then on to a gasometer of the same size and arrangement as that for the oxygen. A sufficient supply for the night's consumption is produced in 3 hours.

"There is an apparatus for the generation of hydrogen by the action of diluted sulphuric acid on iron or zinc. It consists of 3 large earthenware bottles. It has been used, and may be used again if occasion require it. Two men were at work in the gas department.

"The whole quantity of gas burned in the 12 hours upon the 6 jets is about 560 cubic feet, which is nearly at the rate of 7 7-10 cubic feet per jet per hour. The proportion of the 2 gases is about 248 oxygen to 312 hydrogen, or 1 to 1.26; if the gases were pure it should be as 1 to 2. The introduction of the common air at the charging will account for much of this, — impurity of the manganese for much more." — *Social Science Review.*

THE SPAKOWSKI NIGHT SIGNAL.

In Commander Colomb and Captain Bolton's systems of flashing signals, the longer or shorter flashes correspond to the dots and dashes (- — ——) of the Morse telegraph code, now well known. A new signal light, Spakowski's, just introduced for trial into the navy, promises to give great extension to this system of signalling. It enables the light to be readily seen, even in hazy nights, and without night-glasses, at a distance of 7 miles. The instrument weighs 7 pounds, and is about 3 feet in length. The staff, of about 2 inches diameter, is a hollow cylinder, inside of which is fitted a piston that can be pressed down to two separate distances in the cylinder, but which, when not in use, is kept in the upper portion of the cylinder by a strong spiral spring in the lower part of the cylinder or staff. Immediately over the top of the piston, and at the upper part of the cylinder, is a projecting nozzle-pipe, through which the air finds entrance on the opening of a valve, by drawing the piston downward. The upper portion of the cylinder is now full of air, which will be driven out on the piston being released by the operator's hand, and left to the upward pressure of the spiral spring underneath. Let us look at the upper portion of the instrument first. Here a cotton wick is burning from a small spirit-of-wine lamp fixed in the head of the instrument. Opposite to the flame of the lamp is about an inch of horizontally fixed brass tubing, of about the thickness of whip-cord, terminating in a needle-point from another piece of the same tubing, the one being the continuation of the other, and pointing direct at the spirit flame. A reservoir in the head of the instrument contains a little over half a pint of petroleum, and this reservoir is connected with the two small pieces of tubing, and by means of them subsequently with the air from the cylinder below. Now the piston being released, it is driven upward by the spring underneath, and forces the air through the small tubes in the face of the flame, and with it the petroleum in the form of vapor. The result of this is a column of flame of full 2½ inches in diameter, which darts upward from the point of contact between the petroleum vapor and the flame of the lamp, and this column of light lasts just so long as the piston is moving upward again to its normal position in the cylinder. The length of time during which the column of light is shown, therefore, depends upon the length to which the piston is pressed downward in the cylinder. Thus a 2-inch movement of the piston may be said to give a short flash —, and a 6-inch movement to give a long flash ——. A mechanical catch in the cylinder warns the signal-man when he has reached the proper distance for a short or long flash. —*Engineering.*

THE ANILINE DYES.

A new red has been obtained by Coupier by a combination of two of the hydro-carbide bases of coal tar, which he has decided to be incapable of yielding a color in their separate condition. It is named *toluen red*, and is pronounced the richest red yet known. The so-called aniline dyes are among the most beautiful results of chemistry. The series already includes and rivals the colors of the rainbow, and Coupier's analyses promise indefinite varieties of beauty to come. Beginning with the admired varieties of red and purple, such as mauve, magenta, etc., additions like that above named have followed, including the splendid green called verdine, unchanged by candle light, a blue as clear as opal or the Italian sky, a good yellow, and a fair black. The intensity of these colors is shown in the fact that 1 grain of magenta in 1,000,000 of water gives a good red; 1 in 10,000,000 a rose-pink; 1 in 20,000,000 gives a blush to the water, and 1 in 50,000,000 a reddish glow.

Aniline is, however, but a modification of one variety of hydrocarbides constituting the very variable bases of benzine and coal tar, and of which some combination is supposed by the investigator above referred to to be necessary to the production of colors. M. Coupier has been engaged in the endeavor to realize industrially the isolation and management of these bases, in order to establish methods for uniform results, with the above instalment of theoretical and practical success. The rectified naphtha is resolved into benzole which makes aniline, toluen which makes toluidine, xylen and hence xyledine, and a number of other distinct hydrocarbides, the possible compounds of which with each other and with oxygen, etc., when fully ascertained, will probably yield a complete and uniform series of dyes, before which the old vegetable and mineral dye-stuffs will soon disappear. At the meeting of the British Association for 1867, Mr. R. Pullar said: "Orchill or cudbear will not, I think, be replaced by coal-tar or aniline colors for many purposes, and especially for rich crimson or claret shades on woollen goods. I think there is every likelihood of this material being used to a greater instead of a less extent, and the introduction of the coal-tar colors has rather increased than diminished its use. I do not think the lichen products will ever compete with the coal-tar colors for light shades. It is a well-known fact, that purples, violets, and other shades produced in former days by the orchill or cudbear, gave way very much sooner than those produced from coal tar. A violet dress or ribbon was formerly stained red so easily by exposure to the atmosphere or the slightest acid, that very few persons thought of having such colors; while, since the introduction of the coal-tar shades, however, which, some say, are not so fast as the old colors, there is now an enormous sale, because they can be worn with impunity, and the colors, in most cases, stand well for a long time."

MM. Girard and De Laire have produced three new and distinct coloring matters from the residue of the manufacture of rosaniline. In making rosaniline, one-fourth only of the aniline employed is converted into that dye; another fourth is recovered by distillation; in the black residuum in the other half, hitherto lost, these chemists have discovered the three bodies which they call *mauvaniline*, *violaniline*, and *chrysotoluidine*. They have also discovered a new and pure blue dye, of comparative cheapness.

TREATMENT OF REFUSE IN EUROPE.

Two manufactories for the utilization of dead horses have been established in Germany, one in Leipsic, Saxony, and another in Linden, Prussia. The blood is manufactured into blood albumen, dried blood, or blood manure; the hides are sold to tanners; the hair is separated into tail hair, carded hair for stuffing, and very short hair for manufacturing carpets; and the hoofs are used for manufacturing common buttons, manure, or blood alkali.

The skinned animal is quartered and put into large cylindrical boilers, which are hermetically closed and kept under a steam pressure of 2 atmospheres. The condensed water softens the meat off and is then run off through a cock. When this water begins to run quite clear the cock is shut, and the steam is allowed to operate for about 8 hours. It melts the grease out, converts the skinny and stringy parts to glue, and even softens thin bones. Each cylinder contains 3 or 4 carcasses lying on a sieve bottom, under which an impure deposit of glue is formed, with a layer of pure grease above the glue. The melted grease flows off through a cock. It is liquid when kept at a medium temperature, is especially good for oiling machinery and wool, and makes a soap which is well adapted for the cloth manufacture. The glue, which of course contains also extracts of meat, is so changed by the heat that it can be used only for manufacturing bonesize, an article used in cloth manufactories, which remains permanently liquid and will not spoil by keeping. The next process is to crush the meat and bones to a yellowish powder (worth 3.50 to 4.00 per cwt.), which, according to Mr. Wicke's analysis, contains .0568 per cent. of moisture, .5687 of organic substances, .0653 of nitrogen, and .3745 of ash. The .3745 per cent. of ash is divided into .2989 per cent. of phosphoric salts (.1391 per cent. of phosphoric acid), .0033 o potash, .0034 of soda, .0441 of lime, .0041 of magnesia, .0104 of sulphuric acid, and .0043 of chlorine.

Artificial manure is manufactured of fish offal and spoiled fish, in the following manner, on the Lofoden Islands (Norway and Sweden). They dry and grind the back-bone and head, cut the other remains into small pieces and pile them with layers of fresh-burnt lime, in pits stoned up and bottomed with clay, upon which is placed a layer of turf ashes 5 inches thick. The mass is mixed together after 6 or 8 months and packed in bags.

Among the many economies of municipal administration in Paris is the sale of the yearly "mud crop." In 1823 this yielded only 15,000. It now brings 120,000, and when left for some time in rotting tanks is sold for manure, at the increased valuation of 600,000. — *Scientific American.*

THE TALLOW-TREE.

The tallow-tree of China, which gives rise to a vast trade in the northern parts of that empire, has been introduced into India. It grows with great luxuriance in the Dhoons and in the Konistar of the north-western provinces and the Punjaub, and there are now tens of thousands of trees in the government plantations of Kowlagia, Hawar Baugh, and Ayar Tolle, from which tons of seeds are available for distribution. Dr. Jameson prepared from the seeds 150 pounds of tallow, and forwarded 50 pounds to the Punjaub Railway, in order to have its properties as a lubricator for railway machinery tested. For burning, the tallow is excellent; it gives a clear, bright, inodorous flame, and is without smoke. The tree fruits abundantly both in the Dhoons and plains, and grows with great rapidity, many trees raised from seeds introduced 8 years ago being now 6 feet in circumference at 3 from the ground. The timber is white and close-grained, and well fitted for printing-blocks. The leaves, too, are valuable as a dye.

USES OF THE PINE-TREE.

A Paris correspondent writes to the "Chemical News" thus: "We are glad to hear that M. H. Schmidt-Missler's products of the pine-tree, forest wool, and other substances, are at present in active industrial development in Paris. Let us enumerate them rapidly. *Vegetable Wadding.* — This preparation preserves all the properties of the pine. It evolves an aroma eminently wholesome. *Raw Vegetable Wool.* — One-half cheaper than the ordinary wool mattresses. Those stuffed with this wool do not attract humidity. Its odor and the ozone due to its resinous principles keep off or kill the insects. *Schmidt-Missler Flannel.* — By reason of the resin, the tannin, and the formic acid it contains, it aids the exercise of the important functions of respiration, absorption, and perspiration, in a greater degree than ordinary flannel. It is at the same time a preservative and corrective agent, which merits to become popular in Europe as it is in Germany, and can be woven into any of the forms for which flannel is used, such as mittens, waistcoats, drawers, socks, etc.

GLASS FROM NATIVE ORE.

In February, 1866, a patent was issued to Richard Washburn, of Monsey, N. Y., for the manufacture of glass from the native ore. This ore, or silicate of iron, in a crystallized and hence opaque condition, exists in abundance in many parts of the world, as in the columnar basaltic rock of the Palisades of the Hudson, of St. Helena, and of the famous "Giant's Causeway." But all efforts to utilize it for the manufacture of glass had proved singularly unsuccessful until the invention above referred to. Messrs. Chance, Son, & Co., the celebrated manufacturers of Birmingham, who export great quantities of plate glass to this country, are reported to have expended not less than a quarter of a million of dollars, some years ago, for this purpose. It is gratifying to be able to add this important source of wealth to the list of those opened to mankind by American inventive genius, and to record the fact that the Newburgh (N. Y.) Glass Manufacturing Company, organized to work the ore of that vicinity under this patent, are already successfully turning out quantities of glass ware with the two peculiarities of unequalled toughness and unapproachable cheapness. The artificial glass hitherto produced, requiring some 30 per cent. of soda or other oxides as a base, consuming much fuel, and losing much dross, evidently could never be cheapened sufficiently for many of the uses for which it is very desirable. The simplicity of this manufacture direct from the native article, the abundance and accessibility of the material, and the extraordinary tenacity of the product — common quart bottles of the Newburgh manufacture may be freely used in driving nails into solid timber without risk to their contents — must eventually extend existing applications of glass in a beneficent degree, and bring it into many uses from which it has hitherto been excluded. The native glass in this region, and, in fact, generally, being the silicate of iron, has a dark color, and it is yet to be seen how far it can be whitened, by modification of the base and admixture of other bases, so as to become available for the finer purposes. That common window-glass may be produced at a great reduction of cost seems not to admit of doubt, and this alone involves great improvement in the structure of houses, in common horticulture, and in many other respects. — *Scientific American.*

GLASS-CUTTING.

Cutting Glass under Water with Scissors. — In order to insure success, two points must be attended to: first and most important, the glass must be quite level while the scissors are applied; and second, to avoid risk, it is better to begin the cutting by taking off small pieces at the corners and along the edges, and so reduce the shape gradually to that required, for if any attempt is made to cut the glass all at once to the shape, as we should cut a piece of cardboard, it will most likely break just where it is not wanted. Some kinds of glass cut much better than others; the softer glasses cut best. The scissors need not be at all sharp, as their action does not depend much upon the state of the edge presented to the glass. When the operation goes on well, the glass breaks away from the scissors in small pieces in a straight line with the blades. This method has often proved very useful in cutting ovals, etc., which would be very expensive if ground cut; and though the edges are not so smooth as may be desired for some purposes, the method is worth knowing. — *London Photographic News.*

A New Way of Cutting Glass. — It frequently happens that chemists and others wish to utilize some bottle or piece of broken glass apparatus, by cutting it in a certain manner. As some persons experience great difficulties in doing this, we give for the benefit of such a very simple means by which glass can be easily cut in any direction.

Take of powdered gum tragacanth, one-eighth of an ounce, dissolve it in sufficient water to form a middling thick paste, then dissolve one-fourth of an ounce of finely powdered gum benzoin in the least possible quantity of strong alcohol; mix both solutions thoroughly, add to this a sufficient quantity of finely powdered beechwood charcoal to form a doughy mass a little thinner than pill compositions. Out of the above mass roll little sticks about 4 inches long and 3 lines thick, and let them dry spontaneously. If, after being thoroughly dried, one of these sticks is ignited, it burns to a fine point until it is entirely consumed.

The glass to be cut is first scratched deeply with a diamond or file, then one of the above sticks is ignited and held with a very slight pressure on the crack, in the direction the cut is to proceed, and it will be found that the cut will follow in any direction the "taper" may be drawn. The taper must be withdrawn every few seconds and brought to a more lively burn by brisk blowing, as it is cooled by the contact of the glass.

By these means all kinds of vessels can be formed from otherwise useless bottles. Thus, for instance, by cutting the tops off of bottles, jars are obtained which are excellent as precipitating vessels. — *Humphrey's Journal.*

Drilling Glass. — To the old mode of boring glass with a file wet with oil of turpentine, a correspondent of the "Chemical News" adds an amendment from a German source, confirmed by his experience, to the effect that dilute sulphuric acid is much more effective, with less wear of the tool, than oil of turpentine. It is stated that at Berlin, glass castings for pump barrels, etc., are drilled, planed, and bored like iron ones, and in the same lathes and machines, by the aid of sulphuric acid.

Glass Printing. — De Mothay has prepared an ink for printing on glass by means of rollers similar to those used in calico printing, after which the glass is subjected to heat and the picture is vitrified and fixed in the glass, without producing any distortion or imperfection. Many thousands of plain patterns and mosaics of stained glass, produced by this process at a very cheap rate, are already in use for the decoration of church and other windows. The colors are mixed with a solvent of a silicate or silico-borate of potash and lead, as usual in painting on glass, and this composition, rendered plastic by resin in turpentine, is applied thickly to the rollers and transferred into glass, after which it is vitrified in the usual manner.

COMPOSITION OF GLASS.

It is commonly believed that alumina promotes devitrification, but from the experiments of the late M. Pelouze it would seem that a glass containing a considerable proportion of alumina is more difficult to devitrify than one containing a very small proportion, as all common glass does. He found that a very satisfactory plate glass can be obtained by employing 350 parts of sand to 100 parts of sulphate of soda and 100 parts of chalk; the proportion of sand could not be usefully increased beyond this amount. This glass was found to have a very low refractive power. He concludes that magnesia must be carefully avoided in the manufacture of glass.

Lead-Thallium Glass. — This has greater density and refracting power than common lead-flint glass; 300 pure sand, 200 minium, and 335 carbonate of thallium (instead of the usual 100 carbonate of potassa), give a glass of density 4.325, index of refraction 1.71, with a very slight yellowish tint. — *L'Institut*, 1866.

UNINFLAMMABLE PAINT.

M. J. B. Harris, of Kentucky, has invented a paint which consists in the combination of the ordinary oil paints with calcined schist, shale, or mineral coal, which is reduced to a chalky and powdered condition and freed from all hard and gritty particles. For white and red lead the following proportions may be used: 3 parts by weight of the calcined schist, shale, or coal, to 1 part of the lead; and for ochres and umbers, 4 parts of the calcined material to 1 part of the ochre or umber. No turpentine is used as a dryer, but japan, litharge, or dryers of a thin material should be employed. This preparation will resist the action of flame, sparks, and live coals, so that floors painted with it will not be liable to take fire from the falling upon them of burning coals; roofs will also be protected from sparks from chimneys, or other light burning substances carried by the wind from burning buildings.

SUMMARY OF IMPROVEMENTS IN THE MECHANIC AND USEFUL ARTS.

Uninflammable Fabrics. — M. Kletzinsky proposes the following mixture for rendering muslins and other light fabrics uninflammable. He takes equal weights of commercial sulphate of zinc, sulphate of magnesia, and sal ammoniac, and pounds all together in a mortar; he then adds 3 times the weight of ammonia alum. The addition of the last produces a pasty mass, which must be carefully dried at a gentle heat and then powdered. To make fabrics uninflammable, 1 part of the above mixture is used with 2 parts of starch. It is cheaper than tungstate of soda.

Hydraulic Cement. — In Dingler's "Polytechnic Journal" the following is given for making a cement completely impermeable to water. 2 parts of cement (Roman or Portland), 1 part of ground coal, and 1½ parts of slaked lime. It is very solid, and its color is dark.

Preserving the Bottoms of Iron Ships. — Welch's preservative cement is the last of the many compositions tried in England for preserving the bottoms of iron ships. It is an elastic cement composed of certain stone grits and bituminous substances, and with this the ship's bottom is coated with a layer about one-thirty-second of an inch thick. When firmly set, a liquid cement is laid on with a brush, and on this latter is transferred a metallic facing of copper-dust, a liberal dusting of the copper facing with fine stone grit completing the process. Two vessels partly coated with this composition, just returned from a twelve months' voyage to China, were covered with barnacles except where the composition was applied, which was perfectly clean, and presented the appearance of bright copper.

Preserving Polished Steel from Rust. — It is said that nothing is equal to pure paraffine for preserving the polished surface of iron and steel from oxidation. The paraffine should be warmed, rubbed on, and then wiped off with a woollen rag. It will not change the color, whether bright or blue, and will protect the surface better than any varnish.

Cement for Coal-dust Fuel. — One of the best cements for the agglomeration of coal-dust fuel is said to be that used in several continental establishments, consisting of coal tar, gluten, and starch. The quantities of these substances are altered according to the qualities and properties of the coal dust; but they are very easily ascertained by a few experiments. About 2 per cent. of this mixture (say, containing 2½ parts of coal tar, 1 part of gluten, and one-half part of starch) would be suitable for coal dust of an average quality of bituminous coal.

Deodorization of Vulcanized Rubber. — The offensive sulphurous smell of India-rubber goods is a serious drawback upon their otherwise great convenience. Mr. Stephen Bourne, an Englishman, has patented a process for removing this odor by treating the fabrics in a heated chamber with charcoal, and, in preference, animal charcoal, as more rapid in its effect. The operation may be conducted simultaneously with the vulcanizing, the apparatus required being very simple. — *Scientific American.*

A Process for Deodorizing Petroleum Oil. — That very industrious technical chemist, Dr. R. Wagner, tells us that the disagreeable odor of petroleum oil can be taken away by treating the oil with a solution of plumbate of soda. This is only a solution of oxide of lead in caustic soda, and will certainly remove all such odor as sulphur compounds might communicate to the oil.

Paper and Alcohol from Wood.— A company at Geneva, Switzerland, has commenced the manufacture of paper and alcohol from wood, by a method which appears to be an improvement on the other processes employed for the same purpose. The fibre is first treated with sulphuric acid, with the usual result (formation of glucose, and, by fermentation, of alcohol); but the pulp also acquires a somewhat glutinous consistence, which must be of decided advantage in the subsequent stages of manufacture, unless it is due to a partial conversion into parchment paper.

Uninflammable Dresses. — It is much to be regretted that the process of rendering the material of ladies' muslin dresses uninflammable is not more generally understood and used. Either of three substances, — phosphate of ammonia, tungstate of soda, and sulphate of ammonia, can be mixed in the starch, and, at the cost of two cents a dress, deaths from burned garments can be rendered impossible. Articles of apparel subjected to those agents can, if they burn at all, only smoulder; and in no case can they blaze up in the sudden and terrible manner in which so many fatal accidents have occurred to the fair wearers of crinoline. — *American Artisan.*

Making the Desert Blossom. — The artesian wells in Algeria, long attempted without success, now number about 100, delivering 5 or 6 million litres of water per hour, and converting deserts into gardens wherever they have been bored. The work is going on, defrayed by tax upon the benefited population, and is destined to reclaim incalculable wastes. In a single district (Ouled Rir) stretching far south into the desert, and now containing 35 wells, 2,000 new gardens have been formed and 150,000 date-trees planted. Four military boring brigades, well provided with implements, and with growing skill and experience, are steadily pushing on the conquest of the desert, and with almost unerring success in every attempt.

Road Locomotive. — A road locomotive is now in constant use in the neighborhood of Zurich, and is remarkable for the ease with which it ascends considerable inclines, drawing after it carriages containing as many as 40 passengers. It is said to be easily guided, its speed regulated with great facility, and quickly stopped.

American Industry. — The value in gold of the annual products of the people of the United States for the year 1866 was in round numbers as follows: Those engaged in agriculture, 1,609,000,000; manufactures, including all processes between the raw material and consumption, 917,000,000; mining, 100,000,000; fishing, 13,000,000; hunting, 2,000,000; wood-cutting, etc., 25,000,000; domestic commerce, 1,500,000,000; foreign commerce, 190,000,000; net annual earnings or gross increase of money value derived from exchanging products with foreign countries, engaging in improving the face of the country and subduing it to the purposes of society, 2,400,000,000; total in gold value, 6,756,000,000; the same reduced to currency, 9,458,000,000.

America at the Paris Exposition. — The "Engineer" says: "Although America, impeded by the great distance which her wares have had to travel, has sent but a very small quota to Paris, she has made an admirable selection in what she has sent. We doubt if any nation, in proportion to the amount of its exhibit, shows more elaborately and really well-finished workmanship, and certainly none has the imprint of vigorous inventive genius more clearly marked on its productions. Almost every machine and engine exhibited in the main gallery by the United States has some special peculiarity stamped upon it, which, whether it be really an invention or improvement, or only a questionable modification, at least shows the extraordinary activity of North American thought."

As a commentary on the above, we may add a report from Commissioner Beckwith to the Department of State, showing that of the 524 United States exhibitors at Paris, 262, or exactly one-half, received honorable awards. These awards include 4 grand prizes, 17 gold medals, 52 silver medals, 103 bronze medals, and honorable mention of 79 exhibitors.

Hottina. — This is a powder compounded by M. Hottin, of Paris, for making linen fire-proof without impairing its whiteness, when mixed about equally with the starch, a like quantity of gum being also added. It is prepared by adding a little ammonia to a solution of phosphoric acid lime, and filtering with animal carbon, then evaporating until concentrated, when 5 per cent. of gelatinous silicic acid is added, and the whole evaporated to a crystal substance and pulverized.

Berlin Ware. — This ware, so celebrated among chemists for its power of withstanding the action of heat, acids, and alkalies, is made from the following paste: 45 parts kaolin, 37.5 parts alumina, 16.5 parts felspar. The glaze is composed of 42 parts sand, 33 parts kaolin, 13 parts unburned gypsum, and 12 parts of broken unglazed fired paste as above. — *Dingler's Polytech. Jour.*

Lucifer Matches without Phosphorus. — In the third edition of "Knapp's Chemical Technology," the following formula is given: 3 parts of sulphide of antimony, 16 parts chlorate of potash, 1 part bichromate of potash, 10 parts red lead, 8 parts nitromannite, 4 parts powdered glass, and 5 parts of gum. The nitromannite makes the match more easily ignited. This substance is easily prepared by treating mannite with nitric acid, or a mixture of nitric and sulphuric acid, in the same way as cotton for the manufacture of gun-cotton.

Bleaching Process. — According to the chemist Bolley, hypochlorite of magnesia bleaches much more quickly than the hypochlorite of lime; it has also another advantage of not first coloring the straw brown before it bleaches it. He explains the difference in the action by showing that magnesia is a much weaker base than lime, and consequently parts with its chlorine more readily.

Cement for attaching Glass and Brass. — A resin soap is first formed by boiling 3 parts of resin and 1 part of caustic soda in 5 parts of water, and then mixing this with half its weight of plaster of Paris. This cement is said to be impervious to petroleum, only superficially affected by water, to adhere very strongly, and to be a bad conductor of heat.

Malleable Glass. — A piece of St. Gobain glass, prepared a long time ago by M. Pelouze, had lost its transparency from devitrification, but had not changed in density. This piece, supported by one extremity, having been placed in a drawer, was found, after some days, to have become curved under its own weight, having in fact become malleable glass; the surface at the same time was covered with efflorescence. Pliny, in his history, speaks of a glass which could be bent and unbent; and a process for making malleable glass seems to have been known in the 16th century.

Improvements in Locomotive Boilers. — Should the attempts to roll locomotive boilers in one single tube, without seam or joint, prove successful, a great gain in strength will be effected, with the probable disappearance of "furrowing," which usually appears along a seam of rivets. Steel boilers, with welded joints and without rivets, are coming into use, which will enable engineers to use steam at higher pressures and to work it more expansively.

ON SHIPS OF WAR.

Mr. John Bourne, at a meeting of the London Institution of Civil Engineers, in January, 1867, read a paper on "Ships of War." In his opinion, the only vessels capable of carrying sufficient thickness of armor to resist modern ordnance, were those built on the monitor or turret system, the invention of Capt. John Ericsson, of New York. He maintained that, although broadside vessels might be useful and even necessary, yet that no broadside fleet would be safe unless accompanied by a flotilla of monitors. It was simply a question of preponderance of forces; and in any future maritime war the strongest armor and the heaviest guns must necessarily prevail. He proposed that any monitors now to be built should have side armor 18 inches thick, backed by 4 feet of oak, and a turret 24 inches thick, carrying 2 20-inch wrought-iron guns. He considered that ample experience showed that such vessels were seaworthy, afforded comfortable accommodation for the crew, were healthful, and popular with sailors. In the common iron-clad, as the armor had to be spread over a high side, it was necessarily thin and weak; whereas in the monitor, the sides being very low, the area to be protected was reduced to a minimum, so that with the same displacement the armor might be made of great thickness, such as would be impenetrable by the heaviest existing ordnance. The "Kalamazoo" class of monitors had side armor 14 inches thick, backed by several feet of oak, and these vessels possessed great facility of evolution, as they were fitted with balanced rudders and twin screws. In both the armor and the guns, the broadside system was one of diffusion, the turret or monitor system one of concentration; the former had been adopted in England and France, the latter in America. In the broadside system the only material innovation on the model of the old men-of-war was in the application of iron armor to the sides; in some cases the armor was not extended to the bow and the stern, but only the central part of the sides and a belt at the water-line were protected, and armor bulkheads were carried across the ship, before and behind the protected portions of the sides, so as to form the central part of the vessel into a rectangular fort. On this principle the "Bellerophon" and other recent vessels had been built, and its advantage was that it enabled thicker armor to be applied. In the monitor system the guns, of large calibre, are carried in one or two cylindrical iron towers, and the weight of the broadside is concentrated in one or two enormous shot, which have momentum enough to go through the armor of any of the broadside vessels of the British navy.

The most material point of dissimilarity between the turret ships of Capt. Coles and those of Capt. Ericsson is that the sides are not nearly so low in the former as in the monitors, and the armor of the sides and the turrets cannot consequently, with any given displacement, be made so thick; nor would it be possible with safety to reduce the height of the sides, owing to the turrets being carried on rollers on the lower deck, thus passing through openings in the upper deck, which it is difficult to keep tight without jamming the turrets. The openings to the engine-room are also merely covered with gratings, or are otherwise similarly unprotected. In the monitors, on the contrary, the turrets revolve upon a metal ring, on the upper deck, and all the openings to the interior of the vessel are through the top of the turret, or through shot-proof trunks or pipes, so that even if the deck be washed by the waves, water cannot enter the vessel so long as the deck remains water-tight. Capt. Coles's vessels having been but little tested in actual war, the objections to his system are yet to be proved. On the other hand, the monitors had been found, during a war of unprecedented magnitude, to be both shotworthy and seaworthy; they were confessedly unequalled in their power of penetrating other vessels and of resisting penetration themselves.

In the monitor "Dictator" there is a single turret, carrying 2 Rodman guns, each of 15 inches bore; the sides of the ship are only 16 inches above the water-line, and are defended by armor 6 feet deep and 4 feet thick, 10½ inches of this thickness being of iron, and the remainder of oak; the turret is of iron, 24 feet inside diameter, 9½ feet high, and 15 inches thick; the vessel tapers to a point at each end, the side armor being continued so as to form a ram both at the stem and the stern; and by this projection at the stern both the screw and the rudder are effectually protected; the weight of the shot is 425 pounds, and the charge of powder 60 pounds.

Comparing the destructive and resisting powers of the "Dictator" with an iron-clad like the "Bellerophon," the latter carrying on each broadside 5 guns of 10½ inches bore, beside 2 guns at the bow and 3 at the stern of 7 inches bore, he maintained that none of these guns could pierce the iron turret or low sides of the former, or the deck, composed as it is of oak planks 9 inches thick, covered with 2 inches of iron, and that all the parts of the vessel are equally strong to resist the forces that might be brought to bear against them; that while the guns of the "Bellerophon" would be powerless against the armor of the "Dictator," even if fired in converging salvos, the "Dictator's" guns would easily pierce the armor of her adversary.

Even if it were doubted whether it was possible to make heavy vessels, so low in the water as the monitors were, safe at sea, their employment would be none the less necessary for the protection of ports, harbors, and estuaries. Though, in the nautical mind, the ideas of seaworthiness and height of side are indissolubly associated, there is no necessary connection between these conditions. In the monitors the deck is as tight as the bottom, and the only openings to the interior are through towers which the waves cannot enter. Such vessels rise well to the sea, and with such towers as those of the "Dictator" can encounter with safety the heaviest waves; the voyages of the "Monadnock" round Cape Horn, and of the "Miantonomoh" across the Atlantic, show their seaworthiness. Their reputed want of liveliness is a material advantage in any vessel requiring to take aim with heavy guns, since it must make the aim more sure.

BEEBE INERTIA FUZE.

It has long been considered desirable to have a fuze for spherical shot so arranged that the shell should explode at the instant of impact, but hitherto without success. With elongated shells there is no difficulty, as they are almost sure to strike point foremost. With spherical shells, owing to their rotation during their entire flight, it is quite uncertain which part of the shell will strike first; consequently the fuze cannot be fixed at any given point that will insure its explosion. In a fuze recently invented by Major W. S. Beebe, U. S. A., this difficulty seems to have been overcome. His fuze is not dependent on its arrangement previous to firing, but the explosion of the charge in the gun having released it, on the impact of the shell the inertia of the fuze sets it end on, and thus secures ignition. The fuze being used with a solid screw plug increases the force of the explosion of the bursting charge in the shell, and is neither dependent on the flash of the gun for ignition, nor is it liable to extinction from any cause.

It is very simple, consists of only two parts, can be quickly adjusted, and is less expensive than most fuzes now in use. To avoid premature explosion, the great danger in fuzes of this class, it is designed to be carried separately, and is quickly applied when needed. From numerous experiments, it has been ascertained that this fuze ensures explosion of the shell upon impact with earth and ice; yet it can be used in ricochet firing over water. The success of the 15-inch Rodman gun, and the efficiency of spherical shell in smooth-bore guns, will be greatly increased by this invention, which secures impact explosion, — a great advantage hitherto exclusively belonging to rifle projectiles.

STORAGE OF GUNPOWDER.

The usual construction of powder magazines is with thick walls and a bomb-proof roof, even in forts never intended to resist a siege. The damage caused by the explosion of such a magazine would be great in proportion to the mass of its materials and the increased force of the explosion of powder when confined; the lighter, therefore, the magazines are constructed the better, the lighter materials being less destructive than heavy fragments. The higher magazines are built from the ground the better, the explosion in that case having less effect upon adjoining objects. Whatever be the strength or weight of the sides, the roof should be made as light as possible, that the upward force of an explosion should not be checked and deflected laterally. The terribly destructive effects of several recent explosions show the desirability of constructing powder magazines of light materials, of raising them several feet above the ground, and of placing them, when possible, in isolated situations as free as possible from surrounding buildings. —*Mech. Mag.*

GUN-COTTON.

One great objection to the use of gun-cotton in fire-arms is its liability to attract moisture. The Messrs. Prentice prevent this by enclosing the charge in an excessively thin film of India-rubber, blown in the shape of a bubble. The charge is placed in a sort of barrel, and before this is placed a small disc of very thin India-rubber sheeting, which is securely pressed against the muzzle of the barrel; air is then forced in behind, and the bubble of rubber is blown; as soon as this is done, the charge is pushed into the bubble, the neck of which is immediately secured by a pair of forceps and tied; the quantity left on the charge is very minute, and does not interfere in the least with the ignition of the charge.

The Messrs. Prentice also prepare a very condensed charge, 1 inch of which will be found equal to 6 ounces of powder; of $1\frac{1}{4}$ inches in diameter 5 inches in length are equivalent to one pound of powder, costing $4\frac{1}{2}$ pence. By its use in hard granite rock a large saving in boring is effected; the charges slip readily into the holes, leave no residue on the side, and require the fuze to be connected only with the uppermost piece. The smoke, though invisible, in the atmosphere of a close mine, may be very injurious to the workmen resuming work too soon after a blast has been fired.

Mr. W. A. Dixon retards the explosion of gun-cotton by modifying the form in which it is used, by manufacturing it into cloth, and by incorporating it with a non-explosive material. It is coiled with a spiral piece of paper, the centre of the charge alone being pure gun-cotton. The result is that the first portion burns freely so as to overcome the *vis inertiæ* of the shot or bullet, while the remainder of the charge is so adapted that it shall all have spent its whole force just as the empty case leaves the muzzle. Thus the sudden ignition of the whole charge, and the danger attending it, are wholly obviated.

Mr. Prentice afterward improved gun-cotton by interweaving other cotton of suitable fibrous material in an inert state with it, to retard and modify the rapidity of its explosion for special purposes. He has ascertained in practice that it is desirable to employ as little inert cotton or other fibrous material as possible, in order to obtain the desired degree of retardation in the burning of the pyroxyline, especially for fire-arms, in order not to foul the barrels. He has further ascertained that the points of contact and intersection of the converted with the unconverted fibre should be as numerous as possible; and that the more minutely the fibres are divided, and the more intimately they are interspersed amongst each other, the less proportion of the inert fibre is required to produce a given retardation in the burning; consequently there should be as intimate a mixture of the two classes of fibres as possible.

He employs yarn, the cotton or fibre of which has been converted by acid into pyroxyline, before and after being formed into yarn. When the manufacture is for large or small arms, he has found it best not to employ more than 30 per cent. of the inert cotton with 70 per cent. of pyroxyline, when such fibres are respectively made separately into yarns, and are woven or interlaced into fabrics, and when the interspersion of the fibres is still more intimate, — as is the case in pulping the fibres and making paper of mixtures thereof. For sporting purposes, about 15 per cent. of the unconverted fibre makes excellent paper, and about 30 grains by weight of this paper rolled into a cylinder make a proper charge when used with about one ounce of shot. — *Mech. Mag.*

Mr. Abel, of the Woolwich Arsenal, has received a patent for a new method of preparing gun-cotton for general purposes which renders it safe and convenient to use. The invention has for its object to assimilate the physical condition of gun-cotton as nearly as possible to that of gunpowder, by mechanically converting it into a solid conglomerate state, and imparting to it either a granular or other suitable form that will present the exact amount of surface and compactness required for obtaining a certain rapidity or intensity of combustion. He claims: —

"First, reducing gun-cotton to a pulp, and consolidating such pulp with or without the aid of pressure into the form of sheets, discs, granules, cylinders, or other solid forms, either with or without the admixture of binding materials.

"Second, combining with gun-cotton reduced to a pulp gun-cotton in a fibrous state, and consolidating such mixture into sheets, discs, granules, cylinders, or other solid forms, either with or without the admixture of binding materials.

"Third, combining soluble and insoluble gun-cotton, either when both are in a state of pulp, or when one is in a state of pulp and the other in a fibrous condition, and consolidating such mixtures into cylinders, sheets, discs, granules, or other solid forms, either with or without the admixture of binding materials.

"Fourth, subjecting mixtures of soluble and insoluble gun-cotton, either when both are in a fibrous condition, or when both are in a state of pulp, or when one only is in a state of pulp and the other in a fibrous condition, to the action of solvents of the soluble gun-cotton, either alone or with the employment of pressure, so as to effect the consolidation of the same.

"Fifth, the application to the surface of the consolidated gun-cotton of a solution of the soluble forms of gun-cotton, or of shellac, or other suitable gums or resins."

It would be difficult to over-estimate the value of this discovery. By its means the patentee has succeeded in moderating the violence of the combustion to almost any desired extent, and has thus removed the chief, if not the only, source of danger attendant on the use of this agent for warlike or sporting purposes.—*Chemical News.*

NEW EXPLOSIVE COMPOUNDS.

M. Henri Adrien Bonneville, of Paris, has secured provisional protection for a new explosive compound. This invention relates to the manufacture of a new and improved explosive compound mixture by means of sulphate of lime and uric acid. These two substances are allowed to ferment during 24 hours, or thereabouts, and are then put into a recipient on a furnace, and subjected to an equal heat by placing at the bottom of the recipient a layer of sulphate of lime, about 5 inches thick, over which is poured a layer of the uric acid about half an inch thick; this latter substance becoming absorbed, triturate whilst hot, and granulate. The sulphate of lime, in its natural state, contains strontian; but, should that used be without, some should be added.

A cheap gunpowder, in which charcoal is replaced by common glue, is thus prepared by M. Pool, of Delft. The glue or gelatine is first soaked in cold water and then heated in diluted nitric acid until it dissolves. It is next evaporated to dryness, redissolved in hot water, and then carbonate of baryta is added to neutralize the acid. The solution is again evaporated, 1 part of sulphur and 6 parts of nitrate of potash for every 2 parts of glue being incorporated as the evaporation proceeds. This gives a slow burning powder, which may be rendered more energetic by replacing nitrate by chlorate of potash.

Dr. Borlinetto, of Padua, proposes a gunpowder composed of 10 parts of nitrate of potash, 10 parts of picric acid, and 8½ parts of bichromate of potash. These must be separately reduced to a very fine powder, and then intimately mixed. It is excellent for sporting. A mixture of chlorate of potash 3 parts, and tannic or gallic acid 1 part, was used as an explosive compound in 1857 and 1862, by Mr. Horsley, of Cheltenham; in 1865, a mixture of chlorate of potash 82 parts, with powdered cutch 18 parts, by Mr. Ehrhardt; in 1866, a similar discovery was again made in Italy,—all characterized by the great violence of the explosion when together, but non-explosive when separated.

"HALOXYLIN"—NEW BLASTING POWDER.

For some time past a new blasting compound—the novelty of which, however, consists rather in the mode of manipulating the materials than in the materials themselves—has been extensively used in the mines and quarries of the Austrian empire, under the name of haloxylin, which appears to have given great satisfaction, both from the quantity of work done and the manner of doing it. It is one of those powders which has the property of merely burning away when in the open air, and yet exerting a great rending force when properly confined in the blast hole; while it is not liable to ignite spontaneously, and cannot be exploded by percussion or friction. The smoke resulting from the explosion is less in volume than usual, and, in addition to this, it is free from the usual suffocating character of powder smoke; in fact, there is nothing in the residue injurious to health, or even disagreeable, so that operations can be carried on without intermission. A pound of haloxylin will occupy nearly twice the space of 1 pound of gunpowder; and as it does fully two-thirds the amount of work, bulk for bulk, as any powder now in use, it follows that a material saving of cost is effected.

The invention of this powder is due to Messrs. Wilhelm and Ernst Fehleisen, of Styria. It consists of sawdust, charcoal, saltpetre, and usually ferrocyanide of potassium, although the latter ingredient is sometimes dispensed with. The proportions in which they are combined are generally 9 parts by weight of sawdust, 3 to 5 parts of charcoal, 45 parts of saltpetre, and 1 part of ferrocyanide of potassium. The sawdust, which, if not from a non-resinous wood, should have the resin extracted from it, is passed through a fine sieve, and then mixed with finely powdered charcoal (from light woods) and powdered saltpetre. The mass is moistened with about a quart of water to the hundred-weight, and then stamped or crushed. By this means the whole is rendered homogeneous. The mass is now moistened again with water under ordinary circumstances, and with a weak solution of ferrocyanide of potassium when a quick powder is required. The subsequent processes of caking, granulating, and drying are conducted in the same way as in the manufacture of ordinary powder, and the grains can, if desired, be polished as usual; but this is found to be unnecessary.

Owing to the great cost of carrying explosive materials, the importation of haloxylin from Germany is, commercially, out of the question: it is, therefore, proposed to manufacture it in this country. There are at present three factories in Styria, Hungary, and Moravia respectively, yet they are scarcely able to keep pace with the continually increasing demand; and it is to this circumstance alone that is to be attributed the fact that until now no efforts have been made to introduce it into England. The Hunyad board of the Kronstadt Mining and Smelting Company made careful comparative experiments in their Telek iron mines, and obtained with half the weight of haloxylin the same results as with the powder in ordinary use; but such a high duty as this probably resulted from some exceptional circumstances not having been taken into account; that 2 pounds of haloxylin, however, will do as much as 3 pounds of other blasting powder, appears to have been well ascertained. The Austrian State Railway Company certify, as the result of the experiments made at their mines in the Banat, that the trials in the coal mines of Doman took place in a cross course when very dense vapors prevailed; nevertheless, the place could be approached immediately after blasting, no smoke being left. As to the effect, 2 to 2¼ ounces of haloxyline are equal to 3 to 3¼ ounces of blasting powder. The result of the experiment with this substance showed that a firmer inclosing wall was required than with powder; the effect upon the rock was more cleaving than crushing, and on account of this property it promises considerable advantages over powder for the blasting of coal. In the ironstone mines of Morawicza the experiment was made in less firm rock, with large bores, and a charge of 25 to 30 pounds of haloxylin produced an effect exceeding by one-third that of gunpowder. Such evidence as this is sufficient to prove that the non-explosive has, at least, some advantage over ordinary blasting powder; and when the quantity of blasting powder annually used in Great Britain is taken into consideration, it will be readily understood that, assuming even the smaller estimate 30 per cent. of saving, the inducement for the miners of this country to adopt it will be ample to insure, under any circumstances, a fair remuneration to those undertaking the manufacture. — *London Mining Journal.*

DIAZOBENZOLE.

This salt, discovered by Mr. Peter Griess, and named by him nitrate of diazobenzole, is prepared by passing nitrous acid through a solution of aniline in four times its volume of alcohol. The gas is passed through this solution until the addition of ether to a small portion causes the copious precipitation of white acicular crystals. When this point is reached, the whole of the reddish-brown liquor is mixed with ether; the crystals are then allowed to subside, and separated as far as possible from the mother liquor. They are then taken up with cold dilute alcohol, and re-precipitated by the addition of ether, when they are obtained as long white needles. They must be treated with the greatest care, and dried in the air, or over sulphuric acid; heated even below 100° Cent. they explode with great violence, far surpassing that of fulminating silver; friction, pressure, and concussion also cause explosion, with extreme destructive action. According to the French patent the compound is produced in the following way: 1 equivalent of hydrochlorate of aniline is mixed with 2 equivalents of hydrochloric acid, and to this mixture is added very gradually 1 equivalent of nitrate of soda in strong solution. This mixture is left to itself so long as any nitrogen is disengaged. When the evolution of nitrogen has ceased, it only remains to extract the diazobenzole, and get it in a state fit for commerce and use. To this end a concentrated solution of 1 equivalent of bichromate of potash in 1 equivalent of hydrochloric acid is added, which causes a precipitate of chromate or chlorochromate of diazobenzole.

NEUMEYER'S POWDER.

M. Neumeyer, of Saxony, has invented a powder composed of the same constituents as ordinary gunpowder, though in different proportions, which in contact with the air will burn but not explode, but when confined in a cannon or a mine will explode with great force. It is much less dangerous than ordinary blasting powder, and produces greater effects with the same amount of material. It requires an intense heat for explosion, about 400° C. or 752° F. The advantages of this powder seem to be that its safety from explosion as long as it is in contact with the atmosphere renders it safe in making, storage, and transportation; it gives very little smoke, and very little residuum, and its strength is not diminished by wet or a damp air; being redried it contains the same destructive power as it possessed originally; and its commercial value is said to be much less than that of any other powder.

In English war powder there are 75 parts of nitre, 10 of sulphur, and 15 of charcoal; and for sporting powder 77 of nitre, 9 sulphur, and 14 of charcoal; Neumeyer's powder consists of 75 parts of nitre, 6.25 of sulphur, and 18.75 of charcoal. To prepare the charcoal, pieces of birch wood are ignited and placed in a receiver, which is hermetically closed. The charcoal thus obtained is then soaked in soda-lye, and dried upon canvas strainers. It is then reduced to a powder, and is incorporated in a moist state with the other ingredients in the above proportions; it is then converted into powder of any degree of fineness in the ordinary way.

The glazing is omitted, by which the tendency to absorb moisture is said to be decreased. Its immunity from explosion when not inclosed was proved at the Sydenham Crystal Palace grounds, where 2 kegs, containing 35 lbs. of this powder, were ignited in a small building; each keg had a hole 5 inches in diameter in the top, and the powder burned away without any explosion.

THE CHALMERS TARGET.

This celebrated target, which seems to have resisted all shot which the best English ordnance can send against it, consists of wrought-iron hammered armor plates, 3¾ inches thick, behind which is a backing of alternate layers of hard-wood timber and iron plates, all strongly bolted together; in the rear of this backing is another armor plate 1¼ inches thick; then a cushion of timber 3¾ inches thick between it and a three-quarter inch plate, representing the side of the ship. The whole of this compound frame is held together by 2¼-inch screw bolts, with shallow square threads. It seems to have resisted well the Palliser shot; it remains to be seen how it will resist the 15-inch ball of the American cast-iron smooth-bore cannon, the weight of the ball being 453 pounds, the charge 100 pounds American mammoth grain powder or 83½ pounds English powder, with a velocity of 1,500 feet per second. Some experiments as to the strength of targets were recently made at Vincennes, when the 9-inch 12-ton Armstrong gun failed to penetrate a 5½-inch plate of soft iron, backed on the Chalmers system. Half a dozen rounds were fired at 25 yards' distance, and at the close of the experiments it was found that 3 of the shot were lying in front of the target, and 3 sticking in the backing. The full service charge of 43 pounds of powder was employed, and the steel shot had the ogival head recommended by Major Palliser. Recently the 7-inch Armstrong, with a 15-pound charge, sent the Palliser shot through plates 7 inches thick at Shoeburyness. The plates were without backing, and were composed of 2 2-inch layers of wrought iron enclosing a 3-inch layer of steel.

CHILLED SHOT.

The English are now making shot and shell of Bessemer steel for rifled cannon of 9-inch bore. The shot are solid, cylindrical, flat-fronted projectiles, and are slightly tapered at the fore end. They are 14 inches long, and are fitted at the back with a disc of soft brass (containing a preponderance of copper), which is intended for filling the rifling of the gun by expansion. The brass disc has at its back a projecting rim of about three-sixteenths of an inch thickness, and an equal depth, which forms an expanding cap, the sides of this cap being driven out laterally and forced into the grooves of the gun by the explosion of the powder. The pressure of the gases in the chamber of the gun is also made use of to secure the disc to the shot. The base of the latter is provided with 12 radial grooves, the segments between these forming inclined planes. The brass is forced into these grooves by the explosion, and is firmly combined with the shot itself. The shells are of similar shape to the shot, but are bored out of solid Bessemer steel cylinders, and fitted with cast-iron hemispherical fronts. The workmanship of these projectiles is very fine; and each of them is carefully packed in a separate wooden case for transport. A considerable number of chills for casting Palliser shot are also in course of manufacture at the above works, to the orders of the British government. They are made of soft gray cast iron, and have a pair of trunnions cast on them, so that they have the appearance of small mortars. The trunnions are carefully turned, and then made use of for fixing the chill to the face-plate of the lathe in temporary bearings for boring. The pointed bottom of the bore, corresponding to the nose of the Palliser shot, is finished with a tool carefully ground to a template from a flat piece of steel, this tool being inserted in the front of the boring bar, and held fast in its position by a pair of screws. Great numbers of such chills are in request, as they are rapidly destroyed in the casting of chilled shot.

AMERICAN GUNS IN ENGLAND.

The American 15-inch smooth-bore cannon has been amply tested in actual warfare, and is doubtless the most effective weapon known in modern warfare.

The English government have been experimenting with a 15-inch Rodman, cast by Cyrus Alger, at South Boston, and its performances have awakened considerable interest. The gun weighs 19¼ tons; with it was sent a quantity of our mammoth cannon powder and a number of the spherical shells. The London "Standard" has a report of the trials as follows: "The programme of Thursday's trials was with the object of testing the range, accuracy, and general working of the piece, and the velocity of the missiles when propelled by 35 pounds, 50 pounds, and 60 pounds of the American powder, and corresponding charges of English large-grained rifle powder, such as is used in our 7½-inch and 9-inch rifled guns. Fifteen rounds altogether were fired, and sufficed to give a valuable character to the weapon. The practice on such occasions as the present is to train the gun upon some definite object, such as a target, in a nearly horizontal direction, — in this case two degrees of elevation taken with a spirit-level quadrant, — and then to fire with various charges of powder, noting the spots at which the shots first grazed, and the time, in seconds, from the discharge in which they do so. The rest of the flight of the missiles in their ricochets is only incidentally noted. The object is not to hit the target, but to find out the distances certain charges will project shots of the same weight, the amount of deflection those shots experience, and the velocities they attain in their flight.

"The first seven rounds were with the American mammoth powder, very coarse but strong, the individual grains being as large as horse-beans, and roughly angular like the coarser flint gravel met with just below our sea-beaches. The velocity in all the following cases was taken at 50 yards from the gun:

"Round No. 1: — Charge, 35 pounds; weight of shot 452 pounds 12 ounces; recoil of gun-carriage, 5 feet; time of flight to first graze, 2.7 seconds; distance of range to first graze, 696 yards; deflection of shot to the right, 1.6 yards.

"Frame of screen cut by shot, and velocity consequently not obtained.

"Round No. 2: — Charge, 35 pounds; shot, 451 pounds; recoil, 4 feet 11 inches; flight, 2.5 seconds; range, 740 yards; deflection, right, 0.6 yards; velocity, 917 feet per second.

"Round No. 3: — Charge, 35 pounds; shot, 455 pounds; recoil, 5 feet; flight, 2.7 seconds; range, 737 yards; deflection, right, 0.6 yards; velocity, 926 feet per second.

"Round No. 4: — Charge, 50 pounds; shot 453 pounds 4 ounces; recoil, 8 feet 5 inches; flight, 3 seconds; range, 963 yards; deflection, right, 2.8 yards; velocity, 1,110 feet per second.

"Round No. 5: — Charge, 50 pounds; shot, 454 pounds; recoil, 8 feet 7 inches; flight, 3 seconds; range, 1,003 yards; deflection, right, 2 yards; velocity, 1,120 feet per second.

"Round No. 6: — Charge, 50 pounds; shot, 453 pounds 8 ounces; recoil, 8 feet 9 inches; flight, 3 seconds; range, 987 yards; deflection, right, 3.2 yards; velocity, 1,133 feet per second.

"Round No. 7: — Charge, 60 pounds; shot, 453 pounds 4 ounces; recoil, 10 feet; flight, 3.3 seconds; range, 1,138 yards; deflection, right, 1.4 yards; velocity, 1,210 feet per second.

"The next six rounds were fired with the English service large-grained rifle powder, the grains of which are far smaller than the American, and in appearance much like very fine coal dust. The combustion is also much more sensitive, and the powder stronger: roughly, probably, in the proportion of 40 pounds to 50 pounds.

"Round No. 8: — Charge, 35 pounds; shot, 450 pounds 12 ounces; recoil, 6 feet 4 inches; flight, 3 seconds; range, 879 yards; deflection, 1.6 yards; velocity, 1,037 feet per second.

"Round No. 9:—Charge, 35 pounds; shot, 452 pounds 8 ounces; recoil, 6 feet 7 inches; flight, 2.8 seconds; range, 880 yards; in line, true; velocity, 1,044 feet per second.

"Round No. 10:—Charge 35 pounds; shot, 450 pounds; recoil, 6 feet 5 inches; flight, 2.9 seconds; range, 873 yards; deflection, 1 yard, left; velocity, 1,010 feet per second.

"Round No. 11:—Charge, 50 pounds; shot, 453 pounds; recoil, 9 feet 4 inches; flight, 3.1 seconds; range, 1,023 yards; in line, hit the target near the centre; velocity, 1,191 feet per second.

"Round No. 12:—Charge, 50 pounds; shot, 451 pounds 8 ounces; recoil, 9 feet 9 inches; flight, 3.2 seconds; range, 1,073 yards; deflection, 2.2 left; velocity, 1,211 feet per second.

"Round No. 13:—Charge, 50 pounds; shot, 451 pounds 8 ounces; recoil, 9 feet 10 inches; flight, 3.2 seconds; range, 1,140 yards; deflection, 2.4 yards left; velocity, 1,214 feet per second.

"The two concluding rounds were fired with American mammoth powder.

"Round No. 14:—Charge, 60 pounds; shot, 451 pounds 8 ounces; recoil, 9 feet 10 inches; flight, 3.1 seconds; range, 1,012 yards; in line, true; velocity, 1,194 feet per second.

"Round No. 15:—Charge, 60 pounds; shot, 452 pounds 8 ounces; recoil, 9 feet 9 inches; flight, 3.1 seconds; range, 1,032 yards; deflection, 2.6 left; velocity, 1,210 feet per second.

"The alteration from right to left deflection was possibly caused by a change in the direction of the wind.

"We cannot in this notice enter into detailed comparisons between the performances of our own heavy rifled guns and this American cannon; but we may briefly add that the battering charge of our 9-inch Woolwich muzzle-loader is 43 pounds L.G.R. powder, and the ordinary service charge, 35 pounds. The weight of the 9-inch rifle shot, 250 pounds.

"The American Rodman has thrown its shot very true and a very long distance."

AMERICAN VS. ENGLISH GUNS.

It is much to be wished that the real power of the heavy 15-inch and 20-inch guns were understood in this country, instead of our believing so generally in their "low velocities." In the large chambers of these guns the powder gas has additional room for expansion, and, as would be the case with steam cut off at a small portion of the length of a large steam cylinder, it thus does more work. In reality, while the dynamic value of our cannon powder, for each pound weight, is but about 170,000 foot pounds, that of no better powder, fired in the large-bore American guns, is 200,000 foot pounds. Thus, the 15-inch gun, fired with 60 pounds of powder and a 440 pound shot, has an initial velocity of 1,320 feet per second,—a rate which would certainly not be considered slow by our own ordnance engineers. Our system of small bores and long shot not only strains our guns excessively, but loses us much of the useful effect of our powder.

The initial pressure of the powder gas is less in the American gun than in the English, from the less load per square inch of area of bore which the ball imposes. The bursting or damaging action is therefore less, while the dynamic value is greater, — precisely the effects which we wish to produce, as our object is not to burst the gun, but to propel the shot.

It has already been explained in these pages how we may, by the aid of piston shot and other devices, best expend the energy of a projectile in producing penetration of armor or other intended effects. Heretofore the difficulty has been how to impart the requisite amount of energy to the shot, and two systems for doing this have been propounded, — the English high-pressure system, with which it is almost impossible to avoid the bursting of the gun, even when of wrought iron, and the American low-pressure system, in which the want of pressure is compensated by increased area of bore, and by which cast-iron guns may be used with comparative safety. Of course, there is nothing to prevent the American principle from being produced in wrought iron as well as in cast; and no one would contend that the wrought iron would not be better. But whereas we have adopted a system which has already brought us up to the limit of our best materials, the Americans have adopted a system which, while realizing greater dynamic power, has not yet brought them to the limit of their worst. It is almost an insult to our intelligence to ask us which system is to be preferred. — *Engineering.*

We will briefly observe that the big monitor smooth bore, the identical gun installed in our turrets over five years ago, at the commencement of the rebellion, has shown that it can put its shot through any iron-clad in the British navy.

Even if in future trials the Shoeburyness artillerists succeed in bursting the American gun, it will not materially help their case, as the important fact of the great power of large round shot against armor plates has been fairly established.

One of Captain Ericsson's communications to the government of his native country on naval improvements has been made public in Europe, and is highly instructive as to the merits of different systems of heavy-gun making. The trial of the 20-inch guns at Fort Hamilton, in March last, furnishes him with data for comparing the performance of these guns with the best English wrought-iron rifled cannon. By the trials at Shoeburyness, the initial velocity of the 511 pounds rifled shot from the 13½-inch Armstrong gun being 1,250 feet in a second, its actual force is computed equal to 12½ millions of foot pounds; since a body moving at a velocity of 1,250 feet per second has the force acquired by a body falling *in vacuo* 24,414 feet, or 24,414 times enough to raise its own weight 1 foot. On the other hand, the force of the 20-inch, 1,080 pounds shot, with the proved initial velocity of 1,400 feet, is computed by the same rule at 32½ millions of pounds. The area of the English elongated shot exposed to direct atmospheric resistance is 143 square inches, and that of the American spherical shot is 314 inches; considerably less difference against the American shot than the computed force shows in its favor, without charging to the English shot the friction of the atmosphere against its long sides. The worst of it is that this, by far their most powerful gun, has not yet been made reliable. — *Scientific American.*

STRENGTH OF MODERN CANNON.

Prof. Daniel Treadwell, at a recent meeting of the American Academy of Arts and Sciences, read a paper "On the comparative strength of cannon of modern construction," from which the following table is taken: —

	Old 32-*pounder.*	10-*inch Columbiad.*	15-*inch Rodman.*	300-*pounder Armstrong.*	600-*pounder Armstrong.*
1.	7,500	15,059	49,099	26,880	49,280
2.	32	128	315	300	600
3.	8	18	50	60	100
4.	1,600	1,044	1,118	1,500	1,400
5.	40,000	17,030	19,530	35,156	30,625
6.	1,280,000	2,179,840	6,151,950	10,546,800	18,375,000
7.	1.00	1.69	4.73	8.24	14.35
8.	39.0	66.0	186.4	319.6	556.8
9.	170.7	144.7	125.3	392.4	372.8
10.	160,000	121,102	123,039	175,780	183,750

1. Weight of gun, pounds.
2. Weight of shot, pounds.
3. Weight of powder, pounds.
4. Initial velocity of shot, feet.
5. Height to which the shot would ascend if fired upward *in vacuo.*
6. Force in pounds raised 1 foot.
7. Force compared with a 32-pound shot under a velocity or 1,600 feet a second.
8. Force in number of horses working 1 minute.
9. Number of pounds of shot raised 1 foot by each pound of metal in the gun.
10. Force of 1 pound of powder in foot pounds.

The increase of resistance occasioned by rifling is not taken into the account, although it makes an important item against the Armstrong guns.

LYMAN'S ACCELERATING CANNON.

In the "Scientific American" for August 3, 1867, is a description, by the inventor, of the above cannon, which seems to promise considerable changes in the form and operation of rifled guns. From this account it will be seen that its performances are much superior to the ordinary rifle, while the destructive strain upon the barrel is much less.

If the gun is 18 feet long and the bore is 6 inches diameter, it weighs 33,000 pounds.

Shot — 300 pounds. Powder — 100 to 120 pounds.
Initial or breech charge — 5 pounds, very slow mammoth.
First accelerator — 25 pounds mammoth.
Second accelerator — 25 or 30 pounds No. 7.
Third accelerator — 25 or 30 pounds cannon or mortar.
Fourth accelerator — 25 or 30 pounds mortar or musket.

The accelerator plugs may be made of soft cast steel fitting closely in and protecting the cast iron from the fire of the powder. Instead of these steel chambers, ordinary plugs, only half the diameter of the powder chambers, have heretofore been used, but though no cast-iron accelerating chamber has ever failed, it is believed that a protection of half an inch of soft steel, which will keep the fire out of any defect that may exist in the cast iron, will increase its durability.

When the gun is fired the shot is driven by the initial charge past the first accelerator, when the fire sets back down into and lights the mammoth powder in this accelerator. This raises the pressure perhaps nearly as high as it was raised by the small initial charge before the inertia of the shot was overcome. The action of each of the remaining accelerators is the same. It is found by experiment that every additional accelerator increases the force of the shot, and every addition to the charge in the last accelerator seems to increase the force of the shot as much as though it was added to the first accelerator or to the charge in the breech.

Though this breech-loading arrangement is somewhat similar to that of Mr. Whitworth's cannon, it is believed to be a much safer arrangement for the following reasons: —

1st. When the gun is fired there is no pressure in the barrel within 6 inches of the end of the tube, and that 6 inches acts as a band to strengthen the tube.

2d. As we use not over one-quarter as much powder in the breech, the pressure of the fire acts against not over one-quarter as much of the length of the bore of the gun before the shot starts.

3d. The sabot in this accelerator prevents the fire of the powder from pressing around the shot, and the back 9 inches of the shot is freed on its bearings, so that the strain from rotating the shot falls entirely on the bearings in front. The part of the gun that is strained by the pressure of the fire is thus separated a considerable distance from the part that is strained in rotating the shot. This separation of these two strains by 9 inches of metal on which there is no strain greatly lessens the danger of bursting the gun, and removes the objection to the wedge action of the Whitworth shot, or any other shot that centres in the gun, as well as the objections to the large class of shot that are rotated by the sabot, or by a ring of softer metal.

The following table gives the comparative ranges of cannon, as compiled from official sources: —

	Diameter of bore.	Elevation.		
		2°.	5°.	10°.
	Inches.	Yards.	Yards.	Yards.
Old 12-pounder, round ball,	..	909	1,663	....
Old 42-pounder, round ball,	..	1,010	1,995	....
Rodman's 400-pounder in use on monitors, with 40 lbs. good powder,	15	812	1,518	2,425
Parrott's 10-pounder,	2.9	930	2,000	3,200
Parrott's 20-pounder,	3.64	950	2,100	3,350
Parrott's 30-pounder,	4.2	1,000	2,200	3,500

Common rifle with —

	Diameter of bore. Inches.	*Elevation.* 2°. Yards.	5°. Yards.	10°. Yards.
James' shot, 30-pounder,	4.2	1,000	2,200	3,500
Sawyer's, 30-pounder,	4.2	1,000	2,200	3,500
Hotchkiss shot, 30-pounder,	4.2	1,000	2,200	3,500
Armstrong's rifle, 12-pounder,	...	1,200	2,260	....
Whitworth's, 12-pounder,	3.25	1,254	2,330	....
Accelerator, 12-pounder,	2.55	1,590	3,584	....

In an accelerator we must use a small quantity, and very slow powder, at the breech for the initial charge, because we use a long, heavy shot. Then, when the curve has run down considerably and the shot is well under way, it passes over the first accelerator, containing perhaps 10 times as much as the initial charge. The fire sets back, down into, and lights this, and raises the pressure or curve nearly as high as the perpendicular made by the initial charge.

It was said by the officer in charge of the navy yard in Washington that the most powerful gun they ever had there for penetration was the Whitworth muzzle-loader, 5½ inches diameter of bore, — a gun made by shrinking bands of steel upon a core of steel.

They had tested this gun upon the same plate upon which they tested the 2½-inch bore accelerator. The shot of this Whitworth gun was cast steel, about 12½ inches, or 2¼ diameters long; the propelling power was 14 pounds of powder (No. 7), which, with the cartridge bag, filled the gun about 20 inches deep. The target was a very perfect plate, 10 feet long, 3 feet wide, and 5 inches thick, backed by 18 inches of solid oak. The shot penetrated 3½ inches into this 5-inch plate. Next they fired a similar shot with 18 pounds of powder (No. 7), which filled the gun over 2 feet deep. As the Whitworth gun uses a cake of beeswax and tallow for a wad, there was very little windage, but perhaps nearly the whole of that long column of strong powder was converted into an elastic fluid, as heavy as water and hotter than melted iron, before the inertia of the shot was overcome. Or it may be, as believed by some, that only a foot or so of the column was burned, while another foot next to the shot was rammed into a cake as hard as dry pressed brick, and not burned until it left the gun. This would make a very obstinate sabot, particularly if the bore was rough.

The shot penetrated but 3½ inches, and that splendid Whitworth gun was ruined. It was cracked along its top several feet. There were no other shot marks on this plate except the two Whitworth, which were still sticking in it, and though it was a very perfect plate, it was supposed the solid oak backing only prevented their passing through.

The accelerator had but 4 inches depth, three-fourths of a pound, of mammoth powder in the breech, but it had enough of the strongest cannon powder in the chambers to have filled the bore 30 inches deep. The shot was 17½ inches or about 7 diameters long. The twist of bore, being 1 revolution in 3 feet, keeps this long shot point on. The gun stood at the same port-hole that had been occupied by the Whitworth, in the battery 204 yards from the target, which was standing in the water. The shot passed through the 5-inch iron plate, the 18 inches of solid oak, a brace behind it about a foot thick, in which it broke off a 1-inch bolt.

Now, instead of using but 18 pounds of good strong powder in a 5½-inch bore gun, as was used in that Whitworth gun, which filled it 25 inches deep and spoiled it, we would use 5 or 8 times 18 pounds in the accelerators, which would be enough to fill the bore from 9 to 14 feet deep, if it was in the bore of the gun. That and the shot would more than fill the gun. But the powder being all in the accelerators except the 3 pounds of very slow powder, it fills the bore but 4 inches deep, and though the pressure is not raised one-fourth as high in the accelerator, the power exerted is 5 or 8 times as great as it was in the Whitworth cannon.

The reason for the comparative increase of range for every increase of elevation is the fact that our shot are more than twice as long and heavy as Armstrong's or Parrott's in proportion to their diameter, and therefore meet with much less resistance from the air in proportion to their momentum, notwithstanding their higher velocity.

If this 6-inch shot, propelled by 120 pounds of powder, of which 90 pounds is quick and strong, averages 1,666 feet per second with 5° elevation (and it will more than that if properly modelled for overcoming the resistance of the air), it will range 5,000 yards; that is, more than twice as far as any other gun, and more than 3 times as far as the 15 or 20 inch bore gun of the monitors. At 5° elevation, or 5,000 yards, it will penetrate at least 16 inches of iron plate and 4 feet of oak; that is, it will pass through and from side to side of any iron-clad vessel that can be floated.

The limit of the elevation of the 15 and 20 inch guns on the monitors is 6°, and their greatest range is less than 2,000 yards.

It is evident that two or three active wooden merchant vessels, properly prepared and each armed with one or two of these accelerators, would destroy a whole fleet of monitors or slow iron-clads without allowing them to approach near enough to roll their 15 or 20 inch shot within half a mile of them, or endanger them in the least in any way.

NOTE. — A similar gun is described in the "London Mechanic's Magazine" for May 24, 1856; and also in Mr. Holley's work on "Ordnance and Armor."

Perhaps gunpowder with gun-cotton would answer better than powder alone, from the difference of rapidity of explosion, — the slowest to be ignited in the cartridge first. — EDITOR.

THE GATLING BATTERY.

This gun differs essentially in mechanical construction and operation from all other fire-arms. It may be justly termed a machine gun, as it is automatic in its operation, loading and firing by mechanical agency without cessation, simply by turning a crank. The gun bears the same relation to other fire-arms that the printing-press does to the pen, or that the railway carriage and the locomotive do to the stage-coach and the team of horses.

The main characteristic of the gun consists in its having a series of 6 barrels arranged around a common centre with a carrier and lock-cylinder rigidly secured to the main shaft and rotating simultaneously. The cartridges are fed into the cavities of the carrier from boxes, and are driven thence endwise into the rear ends of the barrels, then exploded and the empty shells withdrawn, all at one continuous operation without cessation. As the gun is made to revolve, all the locks and barrels are operated, loaded, and fired by means of a spiral cam and a cocking ring. The barrels, inner breech, and locks all revolve at the same time, while the gun is being loaded and fired, both operations being carried on simultaneously. Three cartridges at the same instant are being loaded, being at different stages of the process, while the spent cartridge shells are being removed.

Test trials of the gun were first made, by order of the government, at the Washington Arsenal; afterward, at the Bridesburg Arsenal near Philadelphia; then again at Washington, and lastly a series of experiments at Fortress Monroe,— at the last place being tested against the 24-pounder flank howitzer. In the first trial, in January, 1866, at the Washington Arsenal, one of the small guns was used, carrying a ball of .58 calibre weighing 577 grains. The gun in this trial was tested for accuracy at a target of 10 feet square, at ranges of 100, 300, and 500 yards, and none of the balls missed the target. At 100 yards, the average of the balls to the centre was 3.6 inches; at 300 yards, 11.3, and at 500 yards, 28.4 inches. For rapidity, 20 shots were fired in 8 seconds. The penetration was 11 inches.

Col. D. H. Buell, who conducted the experiments at the Bridesburg Arsenal, reported that "the gun worked smoothly in all its parts, and the cartridges were fed and the empty cases thrown out with ease and certainty. The cartridges worked well, and no more difficulty is to be experienced with them than with any other metallic cartridges of a similar construction, if, indeed, so much. I am of the opinion that about 60 shots can be fired per minute. The gun can undoubtedly be fired faster on occasions, but I think that the above average is a fair one for continuous firing. The most rapid firing I obtained was 11 shots in 7 seconds."

Subsequent to the foregoing trials, 3 of the larger guns, carrying balls of 1-inch calibre and weighing half a pound each, were tested hundreds of times in the presence of Generals Grant, Hancock, Dyer, Chief of Ordnance, Delafield, Chief of Engineers, Maynadier, Hagner, and Secretary Stanton, and other military and civil officers, all of whom expressed their entire satisfaction with their performances. These trials, with those afterward made at Fortress Monroe, in competition with the 24-pound howitzer, established the fact that the Gatling gun was able to put 6 missiles in a target where the howitzer could place 1. At the distance of 1,000 yards it could put as many half-pound solid shot in the target as the howitzer could of canister at a distance of only 200 yards. — *Scientific American.*

RIDGWAY'S VERTICAL REVOLVING BATTERY.

This invention consists in attaching two to four guns to a wheel, or other suitable frame, in such manner that the guns may revolve with the wheel in a vertical plane, while both together, guns and wheel, are also susceptible of revolution in a horizontal plane; these two revolutions may either be simultaneous, or independent the one of the other. Two guns are placed on opposite sides of the wheel, so as to counterbalance each other, and to admit of alternate firing. When one gun is "in battery," the other is low down in position for loading. Most of the apparatus, and the greater part of the guns (if more than two), are between decks, and, as the axis of the wheel is below the deck and near or below the surface of the water, great stability must be the result. The part which projects above the deck is protected on all sides by a shot-proof spherical iron shield or dome, of small elevation, the central part of which is the wheel itself.

The movements are secured by mechanism of the simplest kind; all parts being perfectly balanced, the power required is merely that necessary to overcome the friction of well-made and well-oiled surfaces, and the power of steam is conveniently applied to effect this. The cleaning and loading of the gun are done when it is in its lower position, low down in the hold below the water-line. No port-hole is required but the muzzle of the gun itself, and for this no port stopper is necessary, as the recoil of the gun instantly elevates the muzzle out of the reach of hostile shot. The blow of recoil is distributed over the large sustaining surface of the wheel, and the force of this recoil, as stated by Prof. Benjamin Pierce, as it acts on the axle of the wheel, is only one-fourth part of that which is given to the trunnions of the same gun upon an ordinary carriage. There is no limit to the elevation of the gun, from any suitable depression below the horizontal to the zenith; every gun, therefore, may be used as a mortar for vertical fire.

No smoke is admitted to the casemate, except that from the vent; only one officer and one man can be required in the upper portion of the dome, where the gun is trained, sighted, and fired. This arrangement admits of the smallest exposed area of turret, — much smaller than the Ericsson turret, — and thicker armature at this point, therefore, is attainable with a given weight. Jamming between the side lobes and the wheel may be prevented by various simple devices.

This battery is peculiarly adapted for a swift, narrow-beamed, sea-going vessel, as the chief weight is below the centre of gravity of the ship. The advantages of this battery, as given by various naval commanders and constructors, are: any desired elevation is readily obtained; any desired weight of ordnance can be as easily managed when the ship is tossing and rolling in a heavy sea as when in smooth water; all the loading can be performed below, saving the time and labor of hoisting powder, shot, and shells; the guns will require no trunnions, cascabel, or any similar projections, which detract greatly from the endurance of a gun; more guns may be mounted in less space, requiring fewer men to work them, and with greater protection than in monitor turrets; a great reduction of weight, which is in the lower part of the vessel; the total weight of a battery, with a wheel 20 feet in diameter and fitted to receive 2 guns of 13-inch bore and 13 feet long, greatest diameter 41½ feet, is 134 tons; ventilation is better secured than by any other plan; 2 or 3 batteries can be placed in a single vessel. This battery is also admirably adapted for land batteries for harbor and coast defence.

Ample experience has proved that the recoil and movement of the wheel do not interfere with the accuracy of the aim; the shot leaves the muzzle before the movement of recoil commences. It will soon be tested in Boston harbor with 2 guns of 13-inch bore, the use of which has been granted by the U. S. government.

WHITWORTH ORDNANCE.

Some time ago we described and illustrated Mr. Whitworth's plan for compressing steel immediately after its being run into moulds for the manufacture of cannon, hollow projectiles, and various other articles. Another patent has since been added to those previously taken out by Mr. Whitworth, and experiments are now being made at the Charlton Street Works for perfecting this improved treatment of steel in making ordnance. A hydraulic press, capable of exerting a pressure of 2,000 tons, has been laid out for this manufacture. The steel manufactured at the Charlton Street Works is all made in pots, and melted in coke furnaces; but the introduction of Siemens' gas-furnaces is now under consideration, and will in all probability be effected at an early date. The results of experiments hitherto made of casting steel under great pressure, or rather of compressing steel in its liquid state, have been most satisfactory. The entire absence of air-bubbles and spongy parts in the metal, and the strength of the steel so produced, give to these castings the same nature and character which steel acquires by the process of hammering or rolling. —*Engineering.*

PUNCHED STEEL GUNS.

The new mode of manufacturing seamless steel tubes for ordnance or other purposes, promises to be largely adopted. The punching is done with a fine-pointed punch in the first place; the hole being started at both ends of the block, and the punch driven in till the two holes nearly meet in the centre. Blunt punches of a larger diameter are then driven in to expand the hole, and the diaphragm separating the two holes is forced out. This operation at once reveals any defect in the metal by the severe strain put upon the grain, and so enables a defective block to be rejected before any further labor has been wasted upon it. The hollow cylinders thus formed are heated and a mandrel inserted in the hole, and they are then drawn out under a hammer into tubes, the presence of the mandrel making the thickness of the metal acted upon very small compared with a solid forging of the same size, thereby securing a more thorough working. The tubes are again heated, and a mandrel having a long stem of somewhat less diameter is introduced into the bore. The tube is then passed through grooved rolls, the mandrel being held stationary by a collar on its stem secured in a frame in front of the rolls, in such a position that the head of the mandrel shall come directly in the centre between the two rolls so as to sustain the pressure. The motion of the rolls draws the tube off the mandrel. Another slightly smaller mandrel is introduced and the operation repeated till the tube is brought down to the diameter required. It will be seen that it is quite possible also in this way to produce tubes with a solid end, which are well adapted for guns. For gun-barrels there is a set of rolls with recesses cut in the grooves to produce the enlarged section required for the breech. The rolls are made to stop for two seconds at each revolution, so as to allow the tube to be properly inserted, though it has been found quite possible to do this without this precaution. This process is very valuable for making hollow railway axles, which, aside from being light, must necessarily be sound from the nature of the process. It is intended also to apply it to the manufacture of boiler tubes. — *Scientific American.*

TRIAL OF A HEAVY GUN.

At the experimental firing of the 20-inch gun at Fort Hamilton, March 15th, the charges used were, first shot, 125 pounds; second shot, 150 pounds; third shot, 175 pounds; fourth shot, 200 pounds; mammoth powder. This gun was fired at a constant angle of 25°. Gen. Rodman's pressure plug was used in getting the pressures. An examination of the record will show that from some unknown cause the amount of pressure of the third discharge exceeds that of the fourth, although 25 pounds less powder was used. At the same time the range is 2,827 yards less. The same irregularity may be observed between the second and third shots. Future experiments may explain these variations. It would undoubtedly have been more rapidly loaded had the running gear been free from dirt and properly oiled. The dust from the parapet (recently made) will insinuate itself, and unless removed soon forms with the oil a mixture which, on the axle, seriously retards the working of the gun. The mean recoil was 5′ 10″, or less than half the length of the top carriage. Weight of shot, 1,080 pounds.

The following is the record of the firing: —

Calculated Ranges. — First shot, 6,110 yards, 3.47 miles; second shot, 6,802 yards, 3.86 miles; third shot, 6,770 yards, 3.85 miles; fourth shot, 7,952 yards, 4.52 miles. These ranges are obtained by computation.

By Plotting, the Ranges are — First shot, 6,144 yards — difference, 34 yards; second shot, 6,860 yards — difference, 58 yards; third shot, 6,828 yards — difference, 58 yards; fourth shot, 8,001 yards — difference, 49 yards.

Times of Flight. — First shot, 26 seconds; second shot, 26 seconds; third shot, 27 seconds; fourth shot, 27 seconds. Length of base line, 2,310 yards.

Pressures (Maximum). — First shot, 21,000 pounds per square inch; second shot, 21,000 pounds per square inch; third shot, 25,000 pounds per square inch; fourth shot, 21,000 pounds per square inch.

Time of loading, running into battery, elevating, and priming, 8½ minutes. — *Army and Navy Journal.*

LARGE GUNS.

Krupp's Cannon. — One of the most important establishments of Prussia is that of Mr. Krupp, which, from the character of its work, must be ranked among the first manufactories on the European continent.

This establishment was represented at the Paris Exhibition by 4 or 5 steel cannon, ranging in size from the smallest field piece to the heaviest calibre, the latter being perhaps the most powerful cannon in existence. This immense gun is a rifled breech-loader of 14 inches bore, constructed wholly of cast steel, and weighs 1,000 cwt., and the cannon (intended for the armament of a coast fortification) consists of an inner barrel having several cast-steel rings or reinforces welded around it while hot.

The inner barrel, the most important part of the whole, weighs 400 cwt. and is wrought from a pig of 850 cwt., under a hammer of 1,000 cwt. The loss of its original weight is caused by the falling off of the head or mould end, by forging, turning and boring. The cast-steel rings weigh all together 600 cwt. The breech stopper is Krupp's own invention. A charge of gunpowder of 100 pounds is required to project the shot, which weighs 1,100 pounds.

The cannon is mounted on a steel carriage 40 feet long by 9 feet wide, and weighing 500 cwt. The mechanism for manœuvring this enormous mass of metal is so arranged that the proper elevation, declination, etc., can be given by one or two men with the greatest facility, and with such rapidity that a passing vessel can be aimed at with accuracy.

Ruelle Great Gun, at Paris Exhibition. — It consists of a cast-iron body, strengthened by 2 steel coils; the weight is a little less than 37 tons, and the diameter of the chamber rather less than 17 inches. It is a smooth-bore breech-loader. Its solid spherical projectiles are of 600 pounds weight, and the shell of the same form weighs 420 pounds, and contains 18 pounds of powder; the charges for the two are respectively 100 and 66 pounds. It is mounted on a cast-iron carriage, weighing 29 tons. The shape is long and bottle-like, longer in proportion to its diameter than the Prussian big gun. It is intended for port service.

American Guns. — The 15-inch gun is to be regarded as the lowest grade of the heavy smooth-bore ordnance of the future. This, with a charge of 100 pounds of powder, is a more formidable weapon than any European gun; the 20-inch gun, with 175 pounds of powder, has proved entirely successful, and no foreign iron-clad could resist a single well directed shot from such a gun, with this charge, within a distance of 100 yards. This monster gun will be accurate, as it will have a high initial velocity, a flat trajectory, and will retain immense *vis viva* at a long range. It is not at all improbable that 25-inch guns, with 275 pounds of powder, will yet be constructed and mounted on our forts for harbor defence. The 20-inch gun, from Fort Pitt foundry, Pittsburgh, Pa., weighs 95,000 pounds; its greatest diameter is 94 inches; at the muzzle 38 and 70 inches; length 189 inches; bore 157 inches. This is for navy service, and is shorter than others of like calibre heretofore cast. The ball weighs 1,000 pounds; charge of powder 60 to 100 pounds.

BREECH-LOADING RIFLES.

At a board of officers assembled at Washington, D. C., the following report was made: that the .45 calibre ball gave the best results as to accuracy, penetration, and range; with regard to uniformity of bore, that all rifle muskets and single-loading carbines used in the military service should, if practicable, be fitted for the same cartridge; that the charge for muskets should be from 65 to 70 grains of powder, and from 480 to 500 grains of lead. With regard to conversion they recommended the plan submitted by Mr. H. Berdan; this gives the stable breech-pin, secures the piece against premature discharge, and involves only a slight change in the present pattern. The bore of the present barrel can be reduced to the desired calibre by reaming out the grooves and inserting a tube.

The following are the results of the trials of several American breech-loading rifles, as reported by the New York military commission appointed to examine them. The Roberts breech-loader fired 84 balls in 6 minutes, all striking inside the target, and penetrating 15 1-inch planks laid side by side. The Sharpe's rifle fired 100 balls in less than 7 minutes, and penetrated the 13th plank. The Milbank rim-fire gun fired 99 balls in 6½ minutes, and penetrated the 11th plank. The Lampson gun fired 12 balls in 1 minute. Ball's carbine fired 75 balls in 9½ minutes. The Prussian needle-gun, which was tested in the same way as the others, fired an average of 6 to 7 balls per minute, and penetrated the 11th plank. The Remington breech-loader fired 100 balls in 7 minutes, and penetrated the 11th plank.

TRIAL OF BREECH-LOADERS.

The trials of breech-loading small arms, during the winter of 1866-67, by the board of officers detailed by Governor Fenton of New York, excited great interest among military men and inventors. The latest improvements and inventions were exhibited to the board, the sessions of which were attended by the Russian, English, Spanish, and Danish officers sent to this country by their respective governments to examine breech-loaders.

Thirty days were occupied in the examination of 17 arms, of systems adapted to conversion of muzzle-loaders, 10 arms not so adapted, and 3 magazine or repeating guns. The tests were severe, but only such as would fairly represent the contingencies of actual service. A description of each arm is given, and a full record of its endurance under the several tests. The arms are divided into 5 distinct classes or systems, based upon the attachment and movement of the breech-block, as follows: —

First Class. — The breech-block hinged to front or rear of receiver, and moving in a plane parallel to the axis of the barrel, in which are included the Allin, Berdan, Hubbell, Joslyn's swing-breech, Lampson, Milbank and Montstorm, all adapted to conversion of muzzle loaders.

Second Class. — The breech-block hinged to the left-hand side of receiver, and moving in a plane at right angles to the axis of the barrel, including the Empire No. 1 and the Joslyn's cap, both adapted to conversions.

Third Class. — The breech-block moving on a pivot at its rear end, and the forward end dropping in the receiver, below the chamber, for insertion of cartridge, including the Roberts, adapted to conversions, and the Peabody, intended for original arms.

Fourth Class. — The breech-block pivoted at its lower front portion, near the front of receiver, and below the level of chamber; revolving in a vertical plane passing through axis of barrel, falling back to open the chamber and forward to close it, including the Miller, Poultney, Remington, and the Robertson and Simpson, all intended for original arms.

Fifth Class. — The breech-block sliding in the receiver, either horizontally or vertically, including the Gray and the Meigs, both adapted to conversions, and the Ballard, National, and Sharps, intended for original arms.

In addition to which classification is the Empire No. 2, having no movable breech-block, the motion being in the barrel.

The magazine guns examined were the Ball's, Gray's, and Spencer's. The board arrives at twelve general conclusions or points, based upon its experiments, which may be briefly stated thus: —

1. That arms in classes first and second may be objected to, as having too extensive movement of breech-block; and, furthermore, that it is an undecided question whether the hinge attachment is sufficiently stable.

2. That breech-blocks hinged as in classes first and second require an independent locking device.

3. That breech-blocks hinged as in class second, on the left-hand side, are awkward to manipulate.

4. That arms of the third class, having lever above the stock, are objectionable on account of constrained action in operating them.

5. That large sliding surfaces, as generally used in the fifth class, are objectionable on account of the friction, etc.

6. That any movement of the barrel, relative to the stock, is a source of weakness.

7. That extensive lever movement in any arm is objectionable.

8. That the retraction of the empty cartridge-case should be by a positive motion, independent of springs.

9. That openings through the bottom of the receiver or the chamber are objectionable.

10. That the firing-pin should be strong and preferably in one piece.

11. That in the conversion of guns owned by the State, the reduction of calibre by reinforcement of the barrel is not advisable.

12. That the experiments thus far made are not sufficient to determine the result of the reduction in size of working parts by continued wear in service.

Of the arms presented to and tested by the board, it reports: —

1. Of those adapted to conversion of muzzle-loaders, it deems the Allin, the Berdan and the Roberts, as superior in all respects to any and all the others. But each of these arms possessing distinctive features, more or less meritorious in themselves and in their combination, the board recommends a farther and more extended competitive trial of these several arms, under such rigid regulations and requirements as the board may establish, to which regulations and requirements the several competitors shall consent and subscribe before entering their arms.

Of the remaining arms adapted to conversions the board would place in order of merit as follows: 4th, Joslyn's cap; 5th, Meigs'; 6th, Gray's; 7th, Milbank's, and 8th, Lampson's.

2. Of original guns not adapted to conversion the board report in order of merit: 1st, Remington's improved; 2d, Peabody's; 3d, Poultney's; 4th, The National; 5th, Robertson and Simpson's; 6th, Sharp's; 7th, Ballard's, and 8th, Miller's.

3. In regard to magazine or repeating arms, the board is convinced that for the present their use should be confined to the cavalry service, as an examination of the record shows that single breech-loaders are capable of being fired at least as many times per minute as a repeating arm, and are more simple in construction and less liable to derangement. In the cavalry service the proper management of the horse in action may render a repeating arm desirable as relieving the soldier from the embarrassment of loading in critical periods. The limited force of cavalry in the State service renders an immediate decision on this point unimportant, and the board recommends a delay in the selection and purchase of repeating arms, as several new inventions are now being perfected, and will soon be presented for trial and competition.

The board report in favor of "central fire" cartridges, the case to be made of brass and somewhat conical in form. More complete lubrication than is usual is particularly recommended. The Berdan cartridge is favorably mentioned. — *Army and Navy Journal.*

CONVERSION OF MUZZLE-LOADERS INTO BREECH-LOADERS.

The United States Government has already adopted a plan for converting, which has not only the approval of the Secretary of war and eminent ordnance officers, but has been examined by commissions or individual officers of various European governments, who, without an exception, agree that the converted piece excels the Prussian needle-gun, the French Chassepot rifle, or any other with which they are acquainted.

It is known as the "Allin Patent," and a large number of workmen are now employed at the Springfield armory in converting our muzzle-loaders into this breech-loading piece. A correspondent of the "World" thus describes the transformation: —

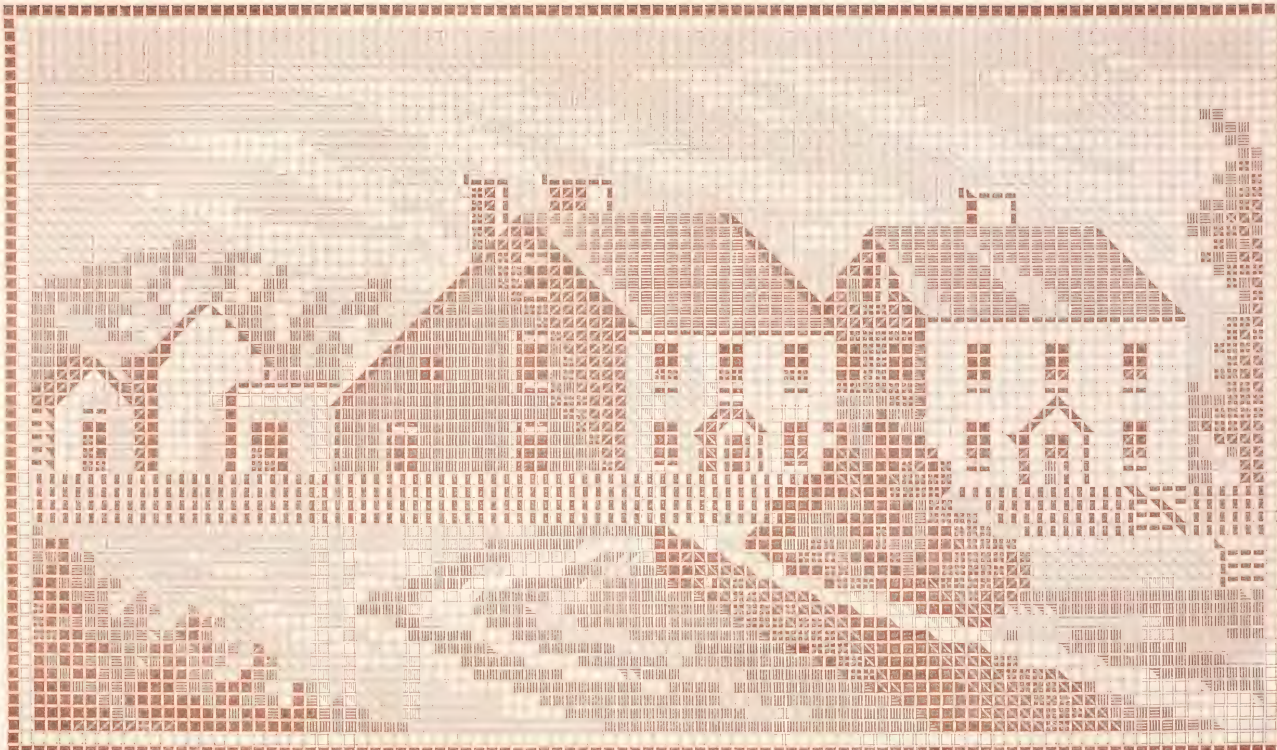
"The object is to reduce the calibre of the old muskets in order to admit of the use of a smaller cartridge, and thus secure greater range and force; that important point has been accomplished by reinforcing the barrel; that is, putting in a thin lining or sleeve, which delicate operation is effected with admirable precision and rapidity. The old rifling is first reamed out, leaving a perfectly smooth bore. The lining is then inserted and brazed so as to become practically a part of the original. This new interior is then rifled with a shorter twist than before, being reduced to one turn in 40 inches, while the calibre is reduced by the lining from 58-100 to 50-100 of an inch. — *Scientific American.*

HOW THE INITIAL VELOCITY OF SHOT IS MEASURED.

The discharged ball passes through two open frames, one near the gun, and one 40 feet distant, each strung with fine copper wires connected with a galvanic battery, and so arranged that the cutting of the wires in the first frame by the ball sets in motion an electric clock, and the cutting of those in the second stops it. The dial is so minutely graduated as to show just how many thousandths of a second are occupied by the ball in passing the 40 feet between the two frames.

THE SOCIETY OF ARTS' ALBERT MEDAL.

The Albert medal has this year been awarded to Mr. W. Fothergill Cooke, and Prof. Charles Wheatstone, F. R. S., in recognition of their joint labors in establishing the first electric telegraph. The first Albert medal was awarded, in 1864, to Sir Rowland Hill, K. C. B., "for his great services to arts, manufactures, and commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilized world." The second medal was awarded, in 1865, to his Imperial Majesty the Emperor of the French, "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of arts, manufactures, and commerce, the proofs of which are afforded by his judicious patronage of art, his enlightened commercial policy, and especially by the abolition of passports in favor of British subjects." The third medal was awarded, in 1866, to Professor Faraday, D. L. C., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so



THE HOME OF THE ADAMS'S, QUINCY, MASS.

Printed in Landscape Type, by Rockwell & Rollins, Boston.

largely promoted arts, manufacture, and commerce." In making the award this year, the council were placed in a somewhat peculiar position, inasmuch as by the terms upon which the medal was established they could only make one award, while the great object accomplished was due to the combined labors of two men. They felt, however, that so great a national work as the electric telegraph was especially worthy of reward by this society, and that the Albert medal could not be more worthily bestowed than in recognition of the services of those to whom the introduction of the telegraph was due. The award having been made, they have directed that the medal be struck in duplicate, and a copy, with a suitable inscription, be presented to each of the above-named gentlemen. — *Engineering.*

PICTORIAL PRINTING, OR STIGMATYPY.

Among the notable inventions of the year are two for the production of pictorial effects by the use of movable metal types, cast like ordinary printing types, and bearing upon their faces different devices, which, in combination, accomplish the most surprising effects. One of these is American, and the other German; but, as they appeared almost simultaneously, we notice first the American invention. Mr. A. P. Rollins, of Boston, conceived the idea of producing by the use of type substantially the effects ordinarily obtained by line engraving; and after considerable study determined upon the use of 14 different faces or characters.

The first effort in their use was made by Mr. Rollins himself, who composed a picture, 6 × 7½ inches, containing 10,230 pieces of type; producing a representation of an edifice, showing doors, steps, windows, columns, and the roof, in accurate perspective, with surroundings of trees, foliage, changing clouds, and other accessories, — all with surprising fidelity. Other pictures have since been made from the same types, with even greater success. The inventor does not claim that the idea is even yet fully developed; but his object in endeavoring faithfully to represent ordinary objects of architecture and landscape by the use of movable types, has been accomplished with remarkable success.

The German invention of a similar nature is due to one Fasol, a printer of Vienna, who, during the past year, has produced, with movable types, pictures of great beauty. The art, as practised by him, is called "Stigmatypy," from the fact that he uses only the full point, of different sizes, cast upon the same body. The effect is produced by the difference in shade, according to the proximity of the full points.

On the opposite page is presented a specimen of the pictorial printing, representing a correct view of the house of the Adams family, Quincy, Mass.

NATURAL PHILOSOPHY.

ULTIMATE CONSTITUTION OF MATTER.

This is a subject which at present pre-eminently occupies the attention of philosophers. The atoms of all solid, liquid, and gaseous substances on earth are known to be in a state of constant motion; but what these atoms are is a mystery, as they are much too small to be seen by the microscope. Some regard them as small rigid pieces of matter; others say that, however small we suppose these to be, we may suppose the existence of other atoms small enough to cut them; others consider them as not matter at all, but simply forces emanating from points; this is the prevailing opinion among philosophers at present. Helmholtz has proved mathematically that if a perfect fluid, destitute of viscosity or fluid friction, were thrown into a state of vortex motion or *wirbel-bewegung*, it would preserve that motion and form to all eternity, and if two such vortex rings were interlinked they could never be separated from each other. Professor William Thomson, in the "Proceedings of the Royal Society of Edinburgh," has recently advanced the idea that probably Helmholtz's vortex rings are the only true atoms, and he is now pursuing mathematical investigations on the subject; his ideas are there illustrated by some remarkable experiments with rings of smoke produced in air.

MOLECULAR MOVEMENT IN SOLIDS.

M. Tresca, by carefully oxidizing a section of a bar of apparently homogeneous rolled iron, has proved that it is really a bundle of minute fibres or filaments, each preserving its individuality throughout the entire length, whatever distortions the bar may have been submitted to. He thinks the rolling of iron something analogous to the combing and carding of wool. This filamentous structure, he says, will account for the different conducting powers of sheet and bar iron for heat and electricity; it also, he believes, satisfactorily explains the transformation of fibrous into crystalline iron in axles and other work exposed to continual jarring. Sheet iron, he says, is made up of superposed distinct sheets, the more or less perfect welding of which determines its properties.

In a general way he has shown that the molecules of solid substances possess the power of moving freely and independently, like the molecules of liquids, and that the movements are governed by the same laws. — *Mechanics' Magazine, June,* 1867.

AIR CARRIED BY FALLING BODIES.

M. Melsens, at a recent meeting of the French Academy, reported upon the fact that when a ball is allowed to fall into water from some height it carries with it into the water a volume of air twenty times the size of the ball; this air accompanies the ball in its descent, no matter to what depth, and is only set free when the ball strikes the bottom. Mariotte, who had made the same observation, had remarked that every drop of rain, as it falls, draws along with it a volume of air two or three times its own size, by which he accounts for the light wind felt near where a shower is falling. Melsens fired a pistol-ball into water, and found that the volume of air then carried into the water was a hundred times that of the projectile. When with an ordinary charge of powder he fired into a block of porcelain paste, the hole made in the paste was exactly the diameter of the ball; but when a very strong charge was used, the hole made was large enough to pass the arm through. It is well known that when a smooth pebble is thrown against a pane of glass, a clean circular cut is made without a crack; this, it has always been supposed, was due to the high velocity of the projectile, but Melsens' experiments contradict this. He found that when he fired a ball with a strong charge of powder, the glass was always broken into a great number of pieces; that a ball with a very low velocity cut a hole more or less clean; and that with a medium velocity a hole without any cracks might be produced.

TEMPERATURE OF MAXIMUM DENSITY OF WATER.

The determination of this question has occupied the attention of physicists for the last half century; their results differ from 1.76° C. to 4.44° C. The conclusions of Despretz, which give 4° C., are generally received, and are said to be confirmed by the most recent experiments of Professor Rosetti, of Padua; these show that at 4.07° C. pure distilled water has a density of 1.000134, which was the maximum obtained. The experiments made on the dilatation of saline solutions may lead to important results bearing on the interpretation of some natural phenomena.

OCEAN CURRENTS.

At a recent meeting of the American Institute, of New York, Professor Grimes made the following remarks on the subject of ocean currents. Since the discovery of the great Gulf Stream, similar currents have been traced both in the Pacific and Indian Oceans; and now physicists recognize five, one each in the North and South Atlantic and Pacific, and the fifth in the Indian Ocean. The six continents of the earth being arranged in pairs, from this and other points of similarity, it is evident that whatever force caused the one, repeated itself in forming the others. At the time when the entire earth was covered with water, six elliptical currents were formed. Five now exist; the sixth was formed in the North Indian, — an ocean no longer existing, owing to the elevation of the land; but the Caspian and Aral Seas, and the large lakes of Asia, furnish proof of its former existence. By a simple mechanical problem we can demonstrate why these ellipses were formed. If near the edge of a disc rapidly revolving on its centre a ball be placed, and caused by any means to pass alternately back and forth on the radius, its motion will not be in a straight line, but it will invariably traverse an ellipse. To make an application: when the waters of the Gulf of Mexico have become heated by the sun, the tendency will be to pass north until cooled, then to return to the equator, and such would be the only motion were the earth at rest; but the revolution of the earth is a constant force acting upon the current and gradually overcoming the northerly motion, and turning it to the east, by the coast of Ireland. Becoming cool, it seeks the warmer regions, and the easting is transferred into a general southerly direction; but, as it nears the coast of Africa, its velocity is lost, and, as the earth moves more rapidly than the current, the latter is left behind, or is giving an apparent westward motion, till the Gulf of Mexico is again reached, and the circle is completed. During the creation the land appeared on the margin of, and between, the circles; in proof of which theory he advances the pointing of the three southern continents to the south-east, — first noticed by Humboldt, — the accumulation of lands toward the north rather than the south, and the direction of the glacial markings during the drift period.

THE GULF STREAM.

Henry Mitchell's observations indicate the depth of the Gulf Stream to be scarcely more than one-third the maximum depth of the channel. He concludes that the Gulf Stream is not a profound movement, but an overflow of water from the gulf, having for its office the restoration of surface level, while the office of the counter-stream, or "polar current" beneath, is the restoration of equilibrium thus disturbed between waters of different specific weights or densities. This view of compensating currents is illustrated by observations in the Hudson River. In the dry season (July) the surface outflow of the river through the Narrows has been found to occupy three-fourths instead of half the 12 tidal hours; while in the under stratum the case is more than reversed, and the inflow predominates to such an extent that, as a general thing, it is constant along the bottom, although not in velocity; and the same conditions, with variable proportions, obtain for some distance up the river. On running a line of levels from New York to Albany, it was found that the bed of the Hudson River lies below the mean level of the sea for over 100 miles, while the surface of the fresh water, or river proper, in the dry season, is above this level, yet not so much above as to counterbalance the excess of specific gravity in the sea water, which consequently during the summer months flows in along the bed of the stream, while the fresh water overflows into the ocean. In other words, the Hudson, for 100 miles, is in the summer but an arm of the sea analogous to the Gulf of Mexico, deriving much of its elevation as a stream, from a like cause with that of the Gulf Stream, namely, its lightness, lifted above the sea level by the bottom pressure and inflow of the heavy sea water in the opposite direction.

The striking variations in the velocities of the Gulf Stream, which were particularly remarked by navigators during the late survey, the weather being exceedingly calm, are accounted for on the hypothesis that they follow the changes in mean sea level which depend upon the declinations of the sun and moon, — more especially the latter. Prof. Bache has shown that the mean level at Key West is one foot higher when the moon is on the equator than when she is at her greatest declination; while, on the contrary, in the North Atlantic the mean level is about 3 inches higher at her *maximum* declination; giving a variation of 15 inches in level to account for the variations in the velocity of the stream. — *Scientific American.*

MOUNTAIN ATTRACTION.

The pendulum experiments carried on in India in connection with the Trigonometrical Survey show that, contrary to theory, the nearer the observing stations are to the Himalayas the less is the force of gravity, the difference between theory and fact diminishing with the increase of distance from the hills. This seems to confirm the opinion of Prof. Airey that the strata of the earth below the mountains are less dense than the strata below plains and the bed of the sea.

FLUID RESISTANCE.

Until recently the main expenditure of power in screw vessels was supposed to be occasioned by the necessity of separating the water at the bow and closing it at the stern. In 1855 Mr. John Bourne promulgated the doctrine, that in ordinary well-formed vessels only a small part of the power expended is consumed for this purpose, the principal resistance being due to the friction of the water on the bottom of the ship.

LEAD FLOATING ON MOLTEN IRON.

Some experiments have been made in Germany which seem to show that molten lead when dropped upon liquid iron remains floating on the surface of the latter. As the specific gravity of lead (11.5) is more than one-half greater than that of cast iron (7), there arose some discussion on this subject, which has been recently closed in a very satisfactory manner by the researches of Prof. Karmarsch, of Hanover. An ironmaster in the vicinity of that town had sent to the professor some samples of such drops of lead lying imbedded in the surface of a cast-iron block, and which had been produced in the manner above described. Prof. Karmarsch found, upon close examination, that these drops of lead, instead of being solid globules, as was supposed at first sight, were all hollow, forming bubbles composed of a metallic skin, and apparently empty in the centre, so far as his observation has been carried. He explains the whole by supposing that the molten lead, at the temperature to which it is raised by the contact with liquid iron, forms an incipient vapor of lead, which is prevented from escaping by the skin of solidifying metal which forms on the top. The lead vapor, according to this explanation, keeps the lead resting upon the surface of the iron. It seems that in large quantities the result is different, since it is known that lead is occasionally tapped from the bottom of blast furnaces, which smelt certain classes of ores containing lead, and in these cases the lead is found below the liquid iron, according to its greater specific gravity. — *Engineering.*

SPEED OF MECHANICAL FORCE.

If a continuous solid iron rail was laid along a track for a distance of 150 miles, no amount of force applied at one end could move the other in less than one minute and a quarter, the time required for mechanical force to travel in iron that distance.

COLOR OF SUNLIGHT.

M. Brucke has observed that diffused solar light, instead of being perfectly white, is tinged with red. The light of burning magnesium, which appears to be so like sunlight, has a tinge of violet.

PHOTOMETRIC APPARATUS.

M. Paul Bérard, who directs, with M. Paul Audouin, the "Laboratory of Essay for the Illuminating Power of Gas," established in Paris, under the head direction of MM. Dumas and Regnault, has confirmed by many experiments results obtained, having a double view. 1. Two flames of equal density being given, one produced by a carcel lamp burning under fixed conditions, the other by a gas-burner, burning as much as possible under the same conditions, to determine the respective consumptions of oil and gas, in a given time, for each of the apparatus. 2. To study different burners, and the best conditions for the combustion of the gas.

The first problem was completely resolved by a series of photometric apparatus, very well constructed by M. Deleuil, and which comprise a carcel lamp burning at the normal rate of oil, a Foucault photometer with starched glass plates, and a telescope and movable plates, a standard burner and an argand one with 30 holes, and an automatic balance indicating by a scale, with the precision of 1 centigr., for a charge of 3 kilos. the quantity burned by a carcel lamp. M. Audouin said nothing of the photometric method; he did not even mention the name of M. Deleuil, but he enumerated very rapidly the conclusions of the experiments on burners. Let us mention them, as they are truly well defined. With *bat's-wing burners* the maximum of illuminating power corresponds to a slit seven-tenths of a millimetre wide. The same quantity of gas can give, when it burns in a good burner, four times the light given by a bad one. The increase of illuminating power corresponds to a very rapid diminution of pressure and consequently to the diminution of the velocity of flow; in other terms, with equal consumption of gas of a constant composition, the greatest illuminating power corresponds to the lowest pressures, the maximum corresponding to a pressure of 2 to 3 millimetres. The proportion between the diameter of the nipple and the expenditure, keeping the same width of slit, seven-tenths of a millimetre, has next to be determined. The gas flows with the same velocity or under the same given pressure, always with the same illuminating power, whatever be the bat's-wing in which it burns. For very different intensities the dimensions of the flame vary very little, its height being sensibly constant and terminated by a right line. *Other burners than bat's-wings.* — Bougie burner, a nipple with a hole in the centre. For the same height of flame, the illuminating power always coincides with weak pressures and a hole of seven-tenths of a millimetre; it increases almost indefinitely with the height. The great expenditures of gas are more advantageous than the weak ones. Manchester burner, a nipple pierced with two holes. When the diameters of the holes are very small, two bougie burners give a light equal to that of a Manchester burner, which they can form by their union. But the superiority of the Manchester burner over the two bougie burners becomes more and more considerable according as the holes increase in diameter. The maximum lighting power corresponds always to the minimum pressure, and to a diameter of seven-tenths of a millimetre. *Burners with a double current of air.* — The argand burner of 30 holes, seven-tenths of a millimetre, proved the most advantageous of all, and it is much to be regretted that it was not compared with the Monier burner, which is much more economical again. The lighting power increases indefinitely with the expenditure; the height of the chimney should not exceed 20 centimetres. The quantity of air burned by a burner is not proportional to the consumption of gas; all the burners do not require the same amount of air in order to give the maximum of lighting power. The introduction into common gas of 6 or 7 per cent. of air diminishes its lighting power by a half. 20 parts of air mixed with 30 parts of gas gives no light.

The standard carcel lamp consumes 42 grammes of oil per hour. According to the treaty between the town of Paris and the General Gas Company, 25 litres or 27½ litres of gas burned in a standard burner under the pressure of 2 or 3 millimetres, should furnish a flame equal in intensity to that of a carcel lamp burning during the same time 10 grammes of purified colza oil. — *Chemical News.*

The various ways of measuring the quantity or intensity of light have always been a matter of paramount interest to philosophers. The earliest contrivance, and certainly an excellent one, due to Count Rumford, consisted in intercepting the light received from a given source, by means of a certain number of plates of dulled glass; the smaller the number required to make the light disappear, the smaller, of course, was its intensity. This was called a photometer. Others have since been constructed on various principles, but they are not generally applicable to one of the commonest problems that occurs in trade, — namely, measuring the quality of burning oils by their illuminating power. This, "Galignani" informs us, has now been satisfactorily accomplished by M. Guérard Deslauriers, whose apparatus, which he calls a "lucimeter," consists of two constant-pressure lamps, and a photometer constructed on a new principle. Its shape is triangular; it is made of sheet iron painted black, and varnished, and is divided into two equal compartments. The latter are turned toward the lamps; the observer stands on the opposite side, which presents nothing but a flat vertical surface pierced with a hole bisected by the partition. Each of the two lamps is so placed as to transmit its light to one only of the two compartments, and exactly to the part where the hole is. The latter is covered with a piece of transparent paper on which, therefore, the rays of light from the two lamps are contiguously depicted. If their intensity is the same, the eye of the observer will perceive no difference; if there be any, on the contrary, one of the lamps must be brought nearer or removed further off, until the same intensity be obtained. The difference of distance will then mark the relative qualities of the two oils; which, combined with the quantity burnt in a certain time, is sufficient to determine their marketable value. — *Mechanics' Magazine.*

REAL IMAGE STEREOSCOPE.

In ordinary stereoscopes the observer places his two eyes opposite two lenses, and sees the virtual image of two pictures apparently at the same time. In the real image stereoscope of Mr. Maxwell the observer stands about two feet from the instrument, and looks at a frame containing a single large lens. He then sees just in front of the lens a real and inverted image of each of the two pictures, the union of which forms the appearance of a solid figure in the air between himself and the apparatus.

THE EIDOSCOPE.

This ingenious invention, recently introduced by Prof. Pepper at the Polytechnic Institution of London, produces the most novel and beautiful effects by means of a mechanical contrivance of extreme simplicity. Unlike the kaleidoscope, in which symmetrical effects are evolved by reflection from a number of irregularly-shaped objects, the eidoscope produces geometrical figures of exquisite beauty by a simple revolution of two perforated metal discs on their own axes. As the discs are slowly revolved, new and infinitely varied forms are created, with the most delicate gradations of tone. It is a remarkable feature that, while these changes are in progress, one perforation, and one only, on the upper plate, will be found perfectly coincident with another on the lower, while all the rest are irregular and form different combinations. When, however, for the magic lantern the discs are put into more rapid motion, the greatly accelerated velocity, instead of producing geometrical figures, causes flashing rays of light to appear and be projected on the screen, with the most extraordinary results. By employing variously colored discs of glass or other material with this instrument, the most gorgeous effects of color may be obtained.

VELOCITY OF LIGHT AND SOUND.

It has been calculated that the deepest note which the human ear perceives as a continuous sound is produced by 16 vibrations in a second; the acutest by 48,000. The extremes of color are red and violet, the former given by 458 billions of vibrations per second, and the latter by 727 billions. The relative velocities of light and sound, and the relative refinement of the media through which their effects are conveyed, are illustrated by this comparison.

WAVE LENGTHS OF SPECTRA.

M. Heinrichs, in the "American Journal of Science," gives the results of his studies on the relations between the wave lengths of absorption bands in the spectra of various elements. Among his conclusions are the following: the wave lengths corresponding to the bands in each elementary spectrum differ, by a fixed number or some simple multiple of the same; or, in other words, if we suppose lines to have been made at regular intervals, and then some of them obliterated, the actual condition now existing would be reproduçed. The dark lines are produced by a certain interference. They are the result of, at most, three systems of interference. The lines generally are closer, the greater the atomic weights of the elements. The distance of the lines is related to the atomic dimensions.

SPECTRUM ANALYSIS.

Father Secchi of Rome uses a cylindrical lens, of a focal length of three inches, placed in front of and near the eye-piece; beyond the lens is placed an Amici prism, in which the deviation is nothing; this is a powerful, cheap, and easily applicable arrangement. He so places this spectrometer that the lines in the spectrum are parallel to the celestial equator, or to the direction of the star's apparent motion; a known or comparison star is then brought on to one of the threads of the finder; returning then to the large telescope, he brings one of the points of the micrometer behind one of the principal lines of the star's spectrum; the star to be compared with the first is then brought under the same thread of the finder. If the micrometer point coincides with a line of the spectrum, this line and the line of the first star's spectrum are evidently identical. One of his most remarkable results, if correct, is theobservation that γ Cassiopeiæ and β Lyræ show bright lines — in the first there are several bright lines, but one dominant line in the blue-green, taking the place of a dark line — the line F of hydrogen. This observation seems to indicate that some stars owe their light in part to the luminosity of their gaseous envelopes, and notably to the presence of burning hydrogen.

M. Jansen, of Paris, has ascertained, after Secchi, that the intensity of certain lines seen in the solar spectrum varies with the amount of moisture present in the atmosphere; by transmitting the light of 16 gas-burners through a tube filled with steam, he reproduced all these lines. — *Quarterly Journal of Science*, 1867.

Stellar Spectra. — Father Secchi divides the spectra of the stars into three types. 1. The first and most dominant type is that exhibited by white stars, like Sirius; their characteristic is a black band in the green-blue, and a second band in the violet; half the visible stars belong to this type. The two remarkable exceptions, γ Cassiopeiæ and β Lyræ, are perfectly complimentary to the type, and have a luminous band instead of a dark ray in the green. Another modification is presented by the constellation Orion (α excepted), which has no large bands, and in which the violet lines are very difficult to see. 2. Stars having colored bands in the red and orange; the most remarkable and typical is α Herculis; the spectrum of which has the appearance of a series of columns illuminated from one side; the stereoscopic effect of the convexity of these bands is surprising. 3. Stars giving fine lines, as Arcturus, Capella, Pollux, and our own Sun; the spectra of these stars perfectly resemble that of the sun, with fine lines in the same places; in them may be seen the principal solar rays, B, D, *b*, E, F, G, and many secondary rays.

Iron in the Solar Atmosphere. — M. A. J. Angström has compared the solar spectrum with one formed by two iron electrodes, with a battery of 50 elements, and has found more than 460 rays corresponding to the lines of iron. He has proved the existence of manganese in the sun by the coincidence of nearly 30 lines. He has also discovered a new ray of hydrogen, nearly half way between G and H, which he calls *h*.

Spectrum of Iron Flame. — M. Secchi has recently communicated to the Italian Society of Modena some curious observations on the spectrum of a flame closely resembling that of certain yellow and red stars. The flame is that proceeding from a converter in which Bessemer steel is being made, and at the time when the iron is completely decarbonized. The spectrum presents a series of very fine and very numerous lines, similar to those of α Orionis and α Herculis, only reversed. This results from the great number of metals burning in the flame, and is the only flame comparable with that of the colored stars.

Spectrum of Light through Ice. — He had previously ascertained that the spectrum of the color of sea-water is deprived successively of its red, yellow, and green as the depth increased, at the greatest depths appearing violet-blue. To ascertain if the same fact held true in the case of glaciers, he made experiments in an artificial grotto, about 400 feet deep, in the glacier of Grindenwald. The ice wall was nearly 50 feet thick; the solar light that penetrated through was of a fine blue tint, giving to the human countenance an alarming cadaverous aspect. On looking toward the entrance at a certain distance, the cavern appeared to be lighted up with a red light, undoubtedly the effect of contrast. The thickness of the superposed mass was not enough to show a greater effect than the almost complete absence of the red, and a great diminution of the yellow. The ice was perfectly compact, limpid, and with few air-bubbles.

BREWSTER'S NEUTRAL POINT.

In the April number of the "Philosophical Magazine," Sir David Brewster says: "Dr. Rubenson has never been able to see, even under the fine sky of Italy, the neutral point which I discovered under the sun, and which, I believe, has never been seen by any other observer than Mr. Babinet."

The point in question can be easily seen in Philadelphia on any clear day, when the sun is more than 20° above the horizon, and I have reason to believe that it can be found with equal ease at many other places in the United States, although I have not been able to find any published observations except my own. — *American Journal of Science*, Vol. 43, pp. 111, 112.

As all the phenomena of skylight polarization are very interesting, and as some of its laws are still imperfectly understood, others may, perhaps, be induced to turn their attention in this direction, so as to determine whether the difficulty experienced by European observers is owing to a higher latitude, to a moister atmosphere, or to some other cause.

A simple Savart polariscope is sufficient for making the observations. In positing Brewster's neutral point, I have usually raised the lower sash of an attic window so that the bottom of the sash will screen the sun from the polariscope. I have thus been able, in every instance when the atmospheric conditions seemed favorable, to see very distinctly the neutral point, and the oppositely polarized bands above and below. — PLINY E. CHASE, *in American Journal of Science, July*, 1867.

NEW POLARIZING PHOTOMETER.

Mr. W. Crookes explained the construction and use of this instrument at the Dundee meeting of the British Association. Two discs, emitting natural — not polarized — light, are placed in front of it, and at a considerable distance behind is a doubly-refracting prism of Iceland spar, rendered achromatic by a piece of glass, which will separate the light emitted by the two discs into three; but, for the purposes of the instrument, the outer two must be disregarded. The difference of intensity between the original self-emitting discs is proportioned to the free polarized light found in the central disc of light. This is again split up, and the difference of intensity between the first discs is ascertained from the difference between these final ones. In comparing the light of two stars, he makes use of Arago's polarimeter, which, twisted in one direction, gradually cuts off one kind of light, and, when twisted in the opposite direction, cuts off the other kind of light, so that the intensity of the light is measured by the angle through which the instrument must be turned.

COLORS OF SOAP-BUBBLES.

Sir David Brewster, at the meeting of the British Association in 1867, stated, as the result of his experiments, that the colors of soap-bubbles are not produced by different thicknesses of the film itself, but by the secretion from it of a new substance flowing over the film, expanding under the influence of gravity and molecular forces into colored groups of various shapes, and returning spontaneously, when not returned forcibly, into the parent films. All the phenomena are emitted by ordinary soap-bubbles, though a mixture of glycerine made the films last much longer.

PERSISTENT ACTION OF LIGHT.

M. Niepce St. Victor, some years ago, made the discovery that the actinic properties of light could be stored up, and made, after a long interval, to produce their photographic effect. The accuracy of his results was called in question at the time, but his most recent experiments completely confirm them. In these he exposed to sunlight strips of ordinary paper covered with plates of colored glass, arranged as the colors of the solar spectrum; after the exposure, the strips were placed in perfect darkness upon other strips of paper sensitized with chloride of silver, which, it was found, were blackened by that part of the exposed strip which had been covered by the blue, indigo, and violet glass. Here would seem to be a clear proof of the persistent action of light.

The same physicist also announces the extraordinary fact that porous or rugose surfaces which have been exposed to light have a definite decomposing action on salts of silver, when placed in contact with them in the dark. It has been considered probable by many natural philosophers that phenomena like phosphorescence are due to the emission of light previously absorbed. Till M. St. Victor's discovery, this hypothesis was supported only by vague speculation. He has shown that pieces of pasteboard, which have been exposed to the light, give out actinic force in the dark, and may be employed in producing decomposition of silver salts.

According to the "Laboratory," in the optical room of the "Conservatoire des Arts et Métiers" at Paris, near a window, is a frame, containing half a dozen test tubes filled with powders, bearing a descriptive label by M. Becquerel. On closing the window shutter, for darkness is required to reveal the beauties of the apparatus, the powders exhibit in a most striking manner the phenomenon of phosphorescence, each shining with a different colored light. It is called by its French makers the "Phosphoroscope," though this name has been applied to a very different instrument; but as a scientific toy it is likely to become known in England as "A Trap to Catch Sunbeams." Most of the powders are sulphides, and the brightest emanation is probably from the tube containing sulphide of barium. The phosphorescence may be induced by exposure to daylight for a few seconds, or to the light of a piece of magnesium wire.

IMPROVEMENT IN OBJECTIVES.

At a recent meeting of the Massachusetts Institute of Technology, Mr. Charles Stodder exhibited the immersion lenses of Hartnack, and similar ones made by Mr. Tolles, of Boston. He exhibited one of Mr. Tolles' one-fifth objectives, of only half the power of Hartnack's, which resolved lines on Nobert's test, 112,000 to the inch,—a microscopic excellence hitherto unparalleled in the records of the science, and proving the extraordinary superiority of Mr. Tolles' lenses.

ON THE NATURE OF THE LATENT IMAGE IN PHOTOGRAPHY.

When light, considered simply in reference to its illuminating power, falls upon any substance, we are accustomed to consider the effects of that illumination as passing away at the same instant of time that the illumination terminates. But there are a vast number of well-recognized exceptions to this rule, which we know under the names of *phosphorescence* and *fluorescence.*

If certain bodies, known as "phosphorescent," be exposed to a bright light, such as the direct rays of the sun, and then be removed to the dark, they will emit a very distinct light. This light continues to be emitted for a time of variable duration. With some substances it continues for days; with others it terminates in a few hours. Becquerel has enormously extended the number of substances that act in this way, by showing that the period of time during which they phosphoresce may be exceedingly short, and so escape ordinary observation. He constructed an extremely ingenious instrument by which phosphorescence could be made evident even when it continued for but a very minute fraction of a second after the light which fell upon the substance was removed. These facts, then, embraced under the general term of phosphorescence, prove incontestably that bodies may, by light, be thrown into a state of vibratory motion, lasting for a longer or shorter, sometimes a very considerable, time after the exciting cause is removed, and that, so long as this vibratory movement continues, they will themselves emit light.

But light, such as it comes to us from the sun, is endowed with another property distinct from illumination, and which we conveniently term *actinism.* There is not the slightest reason to doubt that bodies may be endowed with the power of being impressed by these rays, and retaining them precisely as bodies may the illuminating rays. Herein lies the explanation of the physical or latent image. It is simply a phosphorescence of actinic rays. Once stated, the whole matter is so evident as to carry conviction with the simple statement.

Let me, then, explain the manner in which this phenomenon takes place with iodide of silver. Pure iodide of silver undergoes no decomposition by light when thoroughly isolated from all substances, organic and inorganic, which are capable of aiding in effecting reduction. But, if exposed to light, it continues for a certain time thereafter to retain the vibrations it received; and just for so long as these vibrations continue, will it be instantly decomposed if brought into contact with any substance which would have caused its decomposition had the two been subjected to the action of light together.

Iodide of silver, if exposed to light in the presence of pyrogallic acid and nitrate of silver, is reduced. If the iodide be exposed separately, it is thrown into a state precisely similar to that of a phosphorescent body, except that it continues to vibrate in unison with the actinic instead of the illuminating rays; and so long as this condition remains, if it be brought into contact with the above-mentioned substances, the effect is the same as if they had been exposed together to ordinary light.

For this property of light I propose the name of *actinescence*, a name which, though not in every respect suitable, has the great merit of indicating the parellelism of the phenomenon to that of *phosphorescence*.

The more we examine these phenomena, the more we shall perceive that actinescence must, so to speak, exist. For different phosphorescent bodies emit light of very different colors, showing that their respective capacities of prolonged impression are confined to rays of a certain refrangibility differing for each in each case. Now we know that the actinic influence accompanies rays of a certain refrangibility, especially the violet, the indigo, and the rays immediately beyond the visible. The permanence, therefore, of these actinic rays under suitable circumstances is no more difficult of conception than that of any other rays; and that this permanence exists for illuminating rays is a fact which has been known and recognized for centuries.

On what, then, does the faculty of receiving a latent developable impression depend?

On the possession by the body of two properties: First, that of being decomposed when brought into contact with certain agents in the presence of light. Second, that of being able to retain the influence of the chemical rays, so that on being brought into contact with these agents, after removal from the light, the same decomposition may be brought about.

The first of these properties is sensitiveness to light.

The second is actinescence.

The joint possession of the two renders a body capable of receiving a latent or physical image.

It is easy to conceive that a body may be actinescent without being sensitive to light. In fact, substances that phosphoresce with a blue light are probably actinescent also, but not being sensitive to light, they of course can form no latent image.

To this class undoubtedly belong those substances which possess the property hitherto deemed so mysterious, that of storing up chemical power after exposure to light. When this fact was first published by Niepce de St. Victor it was received almost with ridicule. But in the views here explained, this remarkable fact finds its natural place so completely that its existence would even have been anticipated, had it not already been observed.

On the other hand, substances that are merely sensitive to light when brought into contact with others, but which have no power of retaining light impressions until the decomposing agent is brought into contact with them, are likewise incapable of receiving latent images. But these capacities may exist conjointly, as we see in the case of a large number of silver compounds.

This new view will, I think, dispel all the mystery that has seemed to some to envelop the idea of a physical image, and brings all the most obscure facts of photo-chemistry into parallelism with well-understood and very simple phenomena. —*Philadelphia Photographer.*

HELIOGRAPHY, OR SUN-ENGRAVING.

Mr. Charles Nègre, of Avignon, described his beautiful process of chemical steel engraving before the Photographic Society of Paris, at the last meeting reported in our foreign exchanges of March 1st. The steel plate is first coated with a varnish of some soluble substance mixed with bichromate of potash, which has the property of becoming fixed, or insoluble in water, by the action of light. This coating is then exposed to the wrong side of the negative obtained directly in the camera, and the light transmitted through the light portions of the negative fixes the varnish, while the dark parts leave it soluble so far as covered by them. The soluble portion of the varnish being washed off, the residue perfectly represents the lights of the negative, which are the shades of the future picture. The plate is then placed in a gold bath and submitted to the action of electricity, which beautifully gilds the exposed parts of the surface with a layer of gold inseparable from the steel, and distributed of course to the minutest points unprotected by the fixed varnish. All that remains is to clean off the fixed varnish and subject the surface to the action of diluted acid, which has no effect upon the gilded parts, but etches the exposed surface of steel with a delicate exactness which no manual skill could imitate. The plate is now ready to give impressions with ink, although it will of course receive any desired additions or alterations at the hands of the engraver. The process is of inestimable value both to the investigation and diffusion of science, and with the aid of the microscope will introduce to common view many of the most instructive and curious minutiæ of nature.—*Scientific American.*

LOXODROGRAPH.

An ingenious contrivance, called the loxodrograph, has been recently invented by a French naval engineer, M. Corradi, for ascertaining a ship's course during a voyage. On the dial of the compass, instead of the star which indicates the north, a circular opening is made, furnished with a small lens. The light shining upon the compass penetrates through the lens, and traces a black mark or line on a sheet of sensitive paper underneath, which is made to move at a certain speed by means of clock-work. The sensitized paper turns with the action of the ship, and as the needle remains perfectly steady, every deviation or alteration of the course is photographed on the paper.

PRODUCTION OF NATURAL COLORS BY PHOTOGRAPHY.

M. Niepce de St. Victor has recently communicated to the French Académie des Sciences the results of his latest researches, having for object to obtain and fix the colors of nature by means of photography. His paper is full of very important, new, and interesting facts, proving that the fixation of natural colors on the photographic tablet as a practicable and available result, which for a long time has been considered as a dream, is not perhaps so far from being fully realized, — not as a mere scientific experiment, but as the completion of the splendid discovery of photography.

The process of M. Niepce de St. Victor may be shortly described as follows: The silver plate must first be chlorurized, and then dipped into a bath containing 50 centigrammes of an alcoholic solution of soda for every 100 grammes of water, to which a small quantity of chloride of sodium is then added. The temperature of the bath is raised to about 60° C., and the plate is only left in for a few seconds, the liquid being stirred all the time. The plate being taken out, it is rinsed in water and then warmed until it acquires a bluish-violet hue, which is probably produced by the reduction of a small quantity of chloride of silver. The plate is now coated with a varnish composed of dextrine and chloride of lead. In this way all the colors of the original, including white or black of more or less intensity, are reproduced, according as the plate has been prepared, and as the blacks of the copy are either dull or brilliant. The reduction of the chloride should not be too great, because otherwise nothing but pure black or pure white could be obtained; and in order to avoid this inconvenience a little chloride of sodium is added to the soda bath. A few drops of ammonia will produce the same effect. By this process a colored drawing, representing a French guardsman, was reproduced by M. Niepce, with the exception of one of the black gaiters, which he had cut out and replaced with white paper. The black hat and the other gaiter produced a strong impression on the plate, while the white gaiter was perfectly reproduced in white. Much more intense blacks may be obtained by previously reducing the stratum of chloride of silver by the action of light; but then all the other colors lose their brilliancy in proportion.

This production of black and white is a considerable step in heliochromy. It is a most curious and interesting fact, for it would prove that black is not entirely the absence of light, but is a color of itself, producing its own effects, as well as the other colors. This was illustrated by the experiment made at the suggestion of M. Chevreul, whose researches on the contrast and effect of colors are so instructive and interesting. Accordingly, M. Niepce tried to represent on his plate the black produced by the absence of light in a hollow tube. But the hole produced no effect, or rather it was negative, which is not the case when the black of natural objects, represented in a colored picture, reflects its own tint, or, if we may say so, its own rays, — endowed, it would appear, like all the others, with chemical action, for the apparent reason that the hole could not reflect any rays, and its blackness is the result only of the absence of all rays. The same thing may be said of the white, but less extraordinarily; for the white being the result of all the rays of light united, it may be more easily understood that the chemical action of the white would be the compound result of the various rays of which it is composed, and that result is the same as that which gives us the sensation of white. Certainly the reproduction of black and white by M. Niepce de St. Victor is a most extraordinary fact unfolded by his beautiful discovery, and perhaps more surprising than the reproduction of all the colors themselves. — *British Journal of Photography.*

CHEMICAL FORCE OF THE SOLAR LIGHT.

This, or actinism, upon which organic nature depends so largely for life and health, varies very much under different conditions; so much so that within the tropics it is said to be very difficult to obtain good photograms. The apparatus for determining it relatively has lately been improved by Bunsen and Roscoe, in a manner analogous to that for measuring ozone. After many experiments they have succeeded in preparing paper of a standard sensitiveness, in which the tint produced in a given number of seconds varies in exact proportion to the intensity of chemical force in the light employed. It was found in France that the actinic intensity varied from 1 to 20 between December and June.

VITRIFIED PHOTOGRAPHS.

De Mothay and Maréchal have produced a new method for fixing vitrified photographic images in porcelain, enamel, glass, etc. The article is first varnished with a solution of 4 parts of caoutchouc in 100 of benzole, with the addition of one part normal collodion. After drying, a second coating of iodized collodion is poured over the first, and unites intimately with it. It is then immersed in a bath of nitrate of silver, and the image is produced either by camera or superposition, developed by any of the usual agents, and fixed by two successive baths, one containing a solution of an iodocyanide, and the other an alkaline cyanide. It is next steeped for some instants in a solution of protoxide of iron, pyrogallic acid, or any other substance that will reduce the salts of silver. The image is intensified by the action of pyrogallic, gallic, or formic acid, or sulphate of protoxide of iron mixed with an acid solution of nitrate of silver; requiring 4 to 6 applications for images to be seen by reflection, and 12 to 15 for those to be seen by transparency. During this operation the image is washed three or four times in alternate baths containing iodocyanides and alkaline cyanides, and then, immediately afterward, in sulphate of protoxide of iron, pyrogallic acid, or other reducer of salts of silver. The consecutive baths are to dissolve the non-adherent silver precipitated over the whole plate in each reinforcing bath, while intensifying the fixed image. The washings in the reducing bath, rendering the metallic surface neutral, increase powerfully the subsequent action of the reinforcing bath. The image is now immersed for several hours in a bath of chloride or nitrate of platinum, or in alternate baths of chloride of gold and nitrate of platinum, or again in a bath of chloride of gold, according to the color desired. During this steeping, the silver of the image is partly replaced by platinum or gold, or a mixture of both. The platinum bath gives eventually by vitrification a greenish black, the alternation of platinum and gold yields black, and the gold alone results in gilt images. Next the image is washed in a solution of alkaline cyanide, or a concentrated solution of ammonia; then covered with a thick varnish of caoutchouc or gutta percha, and heated in a muffle, when the organic matters are consumed and the metal left. Finally, the image is covered with a silicic or boracic glaze, and brought to an orange-red heat, by which it is vitrified, and unchangeably fixed. — *Scientific American.*

PERMANENT PHOTOGRAPHS.

At the last meeting of the members of the Inventors' Institute (London), Mr. Pouncy, of Dorchester, read a paper on sun-painting in oil colors. The paper was illustrated with many fine specimens of the applicability of his process to pictorial and decorative art. The photographic prints exhibited were on paper, canvas, panels, copper, etc., and showed a fine gradation of tone, quite as perfect as the finest silver photographs, while it must be admitted they possess over the latter the immense advantage of absolute permanence. The sensitive medium used is bitumen of Judea, dissolved in turpentine, benzole, or other hydro-carbon, with which is ground up oil color of any desired tint. The pasty mass is then brushed over a thin sheet of translucent paper, and dried in the dark. When dry, the sheet is exposed under a photographic negative to daylight, or a strongly actinic artificial light, which hardens or renders insoluble those parts of the sensitized pigment to which the transparent parts of the negative have permitted access of light. After some minutes' exposure to light, the embryo picture is washed in turpentine, benzole, or any other solvent of bitumen. This dissolves those portions which have not been affected by the actinic rays, leaving the remainder of the pigment firmly attached to the paper, in quantity proportional to the amount of light which permeated the different parts of the negative. The picture is now complete, and may be transferred, as in the lithographic process, to card-board, wood, stone, etc.; or, if ceramic colors are used, it may be transferred to potters' "biscuit," and burned in as usual. Mr. Pouncy may be congratulated on having at last, after years of patient toil, so far perfected his process that it will now, in all probability, receive many commercial and artistic applications. — *Mechanics' Magazine.*

NEW DRY PROCESS.

At a late meeting of the London Photographic Society, Mr. William England described a dry process which he has found to fulfil better than any other the conditions required in a dry-plate process of photography. We may here premise that the pictures which were exhibited as having been obtained by means of the process in question were excellent, and in no way inferior to any that could have been produced by means of wet collodion from the same subjects. The plates are exceedingly sensitive, judging from the ordinary dry-plate standard; the certainty seems such as to satisfy even exacting experimenters, while the keeping properties may be deduced from the fact of one of the pictures exhibited having been printed from a negative kept seven weeks previous to development.

A plate is coated with ordinary collodion and excited in a forty-grain bath. It is then washed until all "greasiness" disappears, by being transferred first to a bath of distilled water, followed by a similar application of common water. Some plain albumen, to which a few drops of ammonia have been added, is now poured over the surface and made to travel over every part of the film, for which purpose it should be several times tilted backward and forward. The film is now washed, so as apparently to remove the albumen, some of which, however, will always remain, no matter how prolonged may be the washing to which it is subjected. The plate now receives a final sensitizing, by having poured over its surface a thirty-grain solution of nitrate of silver, to which a few drops of acetic acid have been added. The plate is now subjected to a final and thorough washing, and is then dried. The exposure required is about three times that given to a wet collodion plate. A plain solution of pyrogallic acid, of the strength of two or three grains to the ounce, serves to develop all the details, which are afterward strengthened in the usual manner by citric acid and silver. Mr. England prefers to fix with weak cyanide of potassium, although hyposulphite of soda may be employed for the same purpose.—*British Journal of Photography.*

NEW METHOD OF KEEPING WET PLATES SENSITIVE.

The value of a bromide in securing immunity from stains, comets, and other markings, has long been known; but its mode of operation in doing this has not been well understood. Its action in permitting long keeping, however, is easily explained. The process of double decomposition, in which the bromide salts employed in the collodion are changed into bromide of silver, is much slower, as is well known, than is the conversion of iodides; and when a simply bromized collodion is employed, the immersion in the nitrate bath needs to be very much prolonged, in order to convert the whole of the bromide in the collodion into bromide of silver. In effecting his purpose Mr. Blanchard pursues the opposite course. Employing a very highly bromized collodion, he gives the plate the shortest possible immersion in the nitrate bath, keeping it in motion from the first, to get rid rapidly of the greasy, streaky appearance of the plate. The solution running evenly over the film, without streaks or oily-looking lines, which is generally regarded as the indication of sufficient immersion, is, in reality, no test of the conversion of the salts in the collodion film into salts of silver; it merely indicates that the alcohol and ether in the film have become thoroughly mixed with the aqueous solution, and that the mutual repulsion has ceased. Under ordinary circumstances, however, by the time this is thoroughly effected, the mutual decomposition of the iodides originally in the collodion and the nitrate of silver, and the formation of iodide of silver and a nitrate of potash, or other base, is also complete. With bromides, this operation is not so rapidly completed; if, therefore, a collodion film containing a large portion of bromide be immersed and kept in motion so as rapidly to get rid of greasiness, and then removed after a very brief immersion, the film will contain a large portion of the bromide, — say, of cadmium or ammonium, — which remains undecomposed, and is not converted into bromide of silver. In this fact lies the safety of the plate for long exposures. The free nitrate of silver — which would otherwise be crystallizing on the surface of the film, or, by the concentration of the solution caused by evaporation, acquiring a readier tendency to abnormal reduction — now performs a different office; being in contact with the unconverted bromide of cadmium or ammonium, it is decomposed by it, and aids in the formation of bromide of silver in the film. Instead of being made stronger by evaporation of water, the free nitrate is made weaker by the loss of the silver which combines with the bromine, whilst the nitric acid, combining with the base which leaves the bromine, produces an innocuous, or possibly in some cases a hygroscopic, and therefore beneficial salt. It will thus be readily seen how the use of a large portion of bromide and a very short immersion of the plate in the nitrate bath tend to prevent the stains of crystallization or of reduction consequent on long exposure in warm weather. The mode in which the effect in question is secured in the case described may possibly suggest an explanation of the general action of bromides as aids to clean negatives. It is probable in most cases where a freely bromized collodion is employed, and the plate kept in the nitrate bath the usual two or three minutes, that some portion of unconverted bromide remains in the film, and that the formation of bromide of silver goes on after the plate leaves the bath, the bromide of silver being formed at the expense of the free nitrate on the film, which is thus much weakened. As the use of a weak solution of nitrate silver, at times secured by redipping the plate in a weak bath, is known to be conducive to cleanliness, the weakening of the free nitrate by the formation of bromide of silver may also be a source of the cleanliness well known as an accompaniment of the use of bromides.

The amount of bromide in collodion for very long exposures may vary from two grains to two and a half. Any soluble bromide may, we presume, be used without impropriety. — *Photographic News.*

IMPROVEMENTS IN PHOTOGRAPHY.

Chloro-Iodized Collodion. — A friend of ours is working entirely, both in the gallery and the field, with chloro-iodized collodion; the results are excellent; we are inclined to believe they are better than can be obtained with a bromo-iodized collodion. Our own experience with a similar collodion is equally satisfactory; we get more detail and better work in general with the chloro-iodized than with the bromo-iodized collodion.

The following is the formula: Alcohol, 4 ounces; ether, 4 ounces; pyroxyline, 48 grains (more or less); iodide of ammonium, 40 grains; chloride of ammonium or magnesium, 8 grains.

Chloride of magnesium is more easily soluble in alcohol and ether, and therefore preferable. Our friend has 24 grains of chloride of ammonium in this quantity of collodion; but we are certain so much will not dissolve. — *Humphrey's Journal.*

Prints in Bitumen. — Mr. Swan has shown us a curiosity in carbon printing, — prints produced in the following novel manner: Paper was saturated with a solution of asphalt, of such consistence that when dry no gloss appears on the paper. After exposure under a negative, an image was developed by means of turpentine, applied so that the soluble asphalt shall find its way out of the paper from the side opposite to that exposed to light, so leaving the insoluble asphalt to form a print with half tone. The same principle is, of course, applicable with chromo-gelatine printing; the material saturated with the chromo-gelatine being of an open texture (woven materials, for an example), and the coloring matter being of course soluble with the gelatine. Prints by Mr. Swan's processes are regularly published in Paris. — *Photographic News.*

Leptographic Paper. — This is the name given to a species of new photographic paper which is prepared by a company in Paris, and sold, ready sensitized, at a comparatively low price. It consists of the ordinary paper upon which a sensitizing collodion or film has been poured and dried. Exactly what the film is composed of does not yet appear. It was at first supposed to be nothing more than paper covered with collodio-chloride, as in Simpson's process; but the leptographic film seems to be different from that, as it is more insoluble, keeps better, is harder, etc.

The leptographic paper possesses some very peculiar and valuable qualities: The paper being prepared beforehand and properly protected from the light, is ready for use at any moment; it may be left, indeed, in the printing-frame, if the weather is unfavorable, and then exposed again two or three days afterward, in order to finish the impression already commenced, and all this without any inconvenience or detriment to the whites, — a convenience which is very agreeable, and which occurs with no other paper. It has been demonstrated by experience that this paper is as sensitive at the expiration of half a year as on the day of its preparation.

Photographic Effect of Snow and Ice. — Mr. Notman says: "To produce the effect of fallen snow, I have tried many ways, such as carded wool, white furs, — that from the arctic fox, for instance, — but latterly salt, which I find by far the best, as you can throw it on and about stones, rocks, etc.; and it so easily takes any desired form, — such as a drift. When thrown upon the figure, it adheres to the cloth; in fact, as a representative of snow, it leaves nothing to be desired.

"To represent falling snow: after the negative is dried and varnished, I take some Chinese white and mix it with water to the consistency that experience alone can dictate as best suited; put it into a phial, introduce one of those perfume-blowers, and blow into the air a shower of the liquid Chinese white, and, as it falls, catch as much of it as is desirable on the varnished side of the negative: by judiciously holding the negative, you can so direct it as to give the effect of a slant to the falling snow.

"To represent ice, I use sheet zinc, over which I have polished plate glass. At first I was in hope that zinc of itself would be sufficient, but a short trial convinced me that the zinc required protection from the action of the salt, which I use to represent the snow on the banks at the side." — *Photographic News.*

Ornamenting Glass, Porcelain, etc. — A method of ornamenting glass, porcelain ware, etc., with photographic pictures, has been invented by W. Grüne, of Berlin, which also contains a new method of preparing negatives so that positive films may be readily printed and removed from the negative. The negative, after being fixed and toned with chloride of platinum, is dried and varnished with a glassy flux which is annealed upon the negative by heat in a common muffle. The photographic film being now protected, the negative may be dipped in water, acids, and other solutions with impunity. To produce positive prints, one side of the negative plate is covered with collodion, sensitized, exposed to light, fixed and toned in the usual manner. The positive film may be then detached by loosening one corner with a soft brush and floating it off in a vessel containing water and a little glycerine. Any number of films may be thus printed and floated. The film may now be floated upon the surface of the glass or porcelain which is introduced into the water-vessel, a soft brush being used to spread the film nicely. The film is now covered with the glass flux, and then annealed in a muffle as before described.

By toning the film prior to annealing with different metallic salts, a variety of colors may be produced on the picture. For example, if gold color is wanted, the films are treated with chloride of gold; steel color, chloride of platinum; black, chloride of iridium; brown, chloride of palladium. If the different salts are applied to different parts of the film, the various colors will be seen combined in the picture after it is annealed, and beautiful effects may be produced. The pictures may be polished and burnished subsequent to the annealing process in the usual manner.

Submarine Photography. — M. Bazin has obtained clear submarine photograms at a depth of 300 feet, in his diving studio, by means of the electric light thrown through water-tight lens windows upon the objects to be photographed. The value of this invention in submarine surveying is obvious.

Photomicography. — For a very interesting paper on this subject, see "Popular Science Review" for January, 1867.

Photographic Light. — Mr. Sayers proposes the following: nitrate of potash in powder, and well dried, 24 grammes; flour of sulphur, 7 grammes; red sulphuret of arsenic, 7 grammes. These three ingredients being well ground together, the mixture, on being ignited, will yield a most powerful photogenic light; 200 grammes of the compound will make the light last half a minute. The cost of the mixture is not more than 16 to 20 cents per kilogramme, which would last two minutes and a half, while light from magnesium wire costs about 1s. per minute.

THERMOGRAPH AND BAROGRAPH.

In the thermograph used by the meteorological committee of the British Association, as described at the meeting at Dundee in September, 1867, an air-speck, formed by a break in the mercurial column of a thermometer, allows the light of a gas lamp to pass through it, producing an image which is obtained on a revolving cylinder covered with photographic paper. As the cylinder revolves once in 48 hours, and as the thermometric column rises and falls, these motions delineate a curve, by means of which the temperature of the thermometer is denoted from moment to moment. There would be but one curve if there were only one thermometer; in practice there are two, the dry and wet bulb, — one registering the temperature, the other the amount of evaporation. In this instrument the simultaneous records of the two thermometers are obtained, one under the other, on the same sheet of paper, — the under curve denoting the readings of the wet bulb thermometer, and the upper those of the dry bulb.

By an arrangement of Mr. Beckley, the light is cut off from the sensitive paper for four minutes every two hours. A small break is thus produced every two hours on each curve, by means of which the time of any phenomenon may be easily ascertained. By drawing lines through the simultaneous breaks of the wet and dry bulb curves, a series of lines is obtained perpendicular to the direction of motion of the cylinder, which serves the purposes of a zero-line.

The arrangement for cutting off the light every two hours is also introduced in the barograph used by the committee. In this instrument the curve denotes an uncorrected barometer; the zero-line is not a straight line, but is formed by the interception of the light from the cylinder by a stop, which, by means of a lever arrangement, rises and falls with temperature as much as the barometric column rises and falls from the same cause; that is to say, in order to find the true height of the barometer, we measure between the zero-line and the line denoting the top of the uncorrected column, since, when the top of the column rises or falls through temperature, the zero-line rises or falls just as much.

A NEW BAROMETER.

A self-recording barometer, which has been termed Barometrograph, has been invented in France by M. Brequet. It is designed to furnish diagrams every 6 hours of the pressure of the atmosphere. It consists of 4 metallic boxes, the upper and lower of which are curved; these are vacuum-boxes, and are, in some measure, a modification of the aneroid barometer. The registration is made by a revolving cylinder, which is wound by clockwork, and is covered with a paper on which lamp-black has been deposited. On this paper a lever from the barometer makes its traces as the wheel revolves.

A NEW PSYCHROMETER.

M. Becquerel, Sen., has recently described to the Academy of Sciences of Paris a new psychrometer, so modified as to act by electricity, which he regards as valuable for climatological purposes. For the old instrument of two thermometers, the bulb of one of which is dry and the other constantly moist, he substitutes a thermo-electric circuit composed of iron and copper wire of a diameter dependent on their lengths; the longer they are the greater is their diameter. Within this circuit there is a galvanometer provided with a short wire, and intended to show when the temperature is the same at both the points where the metals have been soldered together. One of these points is placed in a medium, the temperature of which is lowered until the needle of the galvanometer returns to zero, in which case the temperature is the same at both points, this result being independent of the magnetism of the needle; the only requisite condition is that the zero of the scale remains unchanged in the course of the observation. The second point of junction is placed in the medium contained in the aqueous vapor, the elastic force of which is to be determined. It requires to be set right by comparing it with the common psychrometer. With it he has ascertained the elastic force of aqueous vapor at an altitude of three metres above the surface of the soil, at the top of a tree, and at the surface of a river.

SIEMENS' AND WHEATSTONE'S ELECTRO-MAGNETIC INDUCTION APPARATUS.

Last year Mr. Wilde's Magnetic Induction Machine caused considerable stir in the scientific world, on account of the primary exciting magnets being of so small a power and the ultimate current of electricity excited by the large secondary electro-magnet being of so large a volume and of so great intensity. It was soon perceived that in proportion to the difference between the power of the secondary magnet and the power of the primary exciting magnet the driving power varied; and that by this machine there was a veritable conversion of mechanical into electrical force, combined, of course, with magnetic force. Though this was not the most economical way of producing electricity, it afforded a valuable addition to our knowledge of electric induction.

The apparent paradox was this: that a small magnet, capable of supporting only 40 pounds, was capable of exciting a current of electricity that would cause a large electro-magnet to support 1,800 pounds. The power required to drive the machine was more than a hundred times that excited in the large electro-magnet; this, though material as far as economy of production is concerned, did not account for the fact that a small amount of magnetic force, in co-operation with mechanical force, was capable of exciting an indefinitely large amount of magnetic force. The true cause of this indefinite power of increased excitation of magnetism is the comparative slowness of magnetic excitation in iron as compared with the quick excitation of electricity in a copper conductor when passing through a sphere of magnetic force. In other words, the magnetic polarization of iron requires an appreciable time to arrive at a maximum; but the maximum of an induced current of electricity is acquired almost instantaneously. This being so, an indefinitely small induced current of electricity may excite an indefinitely large amount of magnetism in iron by repetition, the only limit being the number of currents that can be excited within the time of magnetic saturation of any given piece of iron. Now, iron requires not only a definite time for saturation, but also a definite time for demagnetization. Moreover, there always remains in most specimens of iron, for a considerable time after magnetization, a small amount of magnetism, which has been termed residual magnetism. In this new apparatus this residual magnetism is made use of and multiplied to almost an indefinite degree by the current of electricity excited by itself in co-operation with mechanical motion.

Prof. Wheatstone, for the purpose of showing that the least appreciable amount of magnetism might be multiplied by electric induction to the full saturation of any electro-magnet, took a piece of boiler plate one-half inch wide, and 15 inches long, bent it in the horseshoe form, and coiled it with 640 feet of No. 14 covered copper wire. Between the poles of this electro-magnet he caused a Siemens keeper to revolve, having first excited the magnet by means of a small electric current or by bringing it in contact with a permanent magnet. The current being stopped or the permanent magnet withdrawn, the keeper was then set in motion by the force of two men. The small current of electricity excited in the coil of the keeper by means of the residual magnetism in the electro-magnet being passed round the electro-magnet, its magnetism was thereby augmented, and consequently its inductive power; so that the magnetism of the magnet and the electric current of the keeper reacted on each other till they both acquired a maximum of power by the conversion of mechanical force into electricity and magnetism. When a length of platinum wire was inserted in the circuit, when the excitation was at its maximum, 4 inches of the wire were made red hot.

Prof. Wheatstone considers it easy to prove that the residual magnetism of the electro-magnet is the determining cause of this powerful effect. We think there is no doubt that if there was no residual magnetism there would be no excitation of electricity, unless the coils of the revolving keeper should happen to be at an angle to the magnetic meridian. But the true reason for the magnetic and electric accumulation is the difference in time required for the maximum excitation of these two forces in given conductors, combined with the known law of their mutual action and re-action. If magnetic induction were as instantaneous as electric induction is, there could be no augmentation of the residual magnetism, or, at most, the amount would be so small that it would be inappreciable, — seeing that action and re-action are always equal and opposite.

By this arrangement magneto-electric machines may be made, as it were, independent of the magnetic power of permanent exciting magnets; an electro-magnet and armature being used instead of a permanent magnet and armature, the electro-magnet having in addition a small permanent magnet as keeper; the machine being set in motion and this permanent magnetic keeper being removed, the residual magnetism combined with mechanical motion being sufficient to produce the greatest effects. Of course, in such a machine there is a great expenditure of mechanical force, and therefore, as an economical mode of exciting the electric force, this arrangement is not likely to be used; but in cases where enormous amounts of electric force are required, this law of magneto-electric induction shows how it may be produced without limit, except that of the available driving power. It is not yet decided whether by this means electricity can be produced economically from steam power or not. It is certain that Mr. Wilde's arrangement has not yet produced it economically, and this new arrangement will not produce it more cheaply, as it commences with a smaller amount of magnetism than Mr. Wilde's does, and, in fact, nearly all the magnetism and electricity has to be produced from the mechanical force applied. We have in this acquired an addition to our knowledge of electric and magnetic induction, that, by the dynamic difference of these forces and their mutual action on each other, an indefinite amount of augmentation of each can be produced. Thus, we have progressed one step farther in the most difficult problem in the science of magnetism and electricity, — the problem of induction. — *Mech. Mag.*, 1867.

WILDE'S ELECTRIC MACHINE.

At a conversazione of the Royal Society, March 2, 1867, Mr. H. Wilde, of Manchester, exhibited his wonderful electro-magnetic machine. There was something imposing in the sight of the apparatus itself, with coils 4 feet high and 10 inches thick, containing 1,400 weight of copper wire, and between them an armature made to rotate 1,500 times in a minute by a 15-horse power steam engine standing just outside one of the windows. Round and round flew the wheels, every rotation sending two fresh streams of electricity into the coils, until on a sudden the intense current was conducted to the lamp placed in a reflector at one end of the room, and an intensely brilliant electric light flashed in the eyes of all beholders, dazzling them as the noon-day sun, illuminating the nooks and corners of the spacious apartment with a clearness beyond that of sunshine, and deadening the vivid flame of the sun-burner in the centre of the ceiling until it appeared of a dull brown. When tried once at Wilde's factory, in Manchester, it threw the flames of the street-lamps into shadow at a quarter-mile distance. Dazzling though it was, the light fascinated all within its influence, and they who had provided themselves with colored glasses gazed on it with wonder and admiration. Some, placing a lens in the path of the ray, burned holes through sheets of paper; others held out their hands to intercept the heat, which could be distinctly felt at a distance of 50 yards. Then the lamp was turned off, and the light blazed for a while in the middle of the experiment stand, more dazzling than before; then a long loop of wire was screwed into the terminals, and held up on a hook by an attendant; in a few seconds it smoked, assumed a dull red color which brightened to a glowing white, under which the wire melted and fell in glittering fragments to the floor. Short lengths of thick iron rod were similarly fused; but the crowning experiment was the melting of a rod of platinum. To those who know what is meant by the fusing of this very refractory metal, this experiment will be the most convincing of all of the enormous power of this machine.

It was interesting to watch the steam engine during these experiments, for, in every instance, it slackened speed when the wires or rods were growing hot. The resistance is then great, and becomes greater as the metal increases in heat; and it was only by constant care on the part of the driver that a uniform rate of motion was maintained.

By and by arose the question, what practical use can be made of this surpassing light? To which the answer was: it can be used instead of oil for lighthouses. The Commissioners of Northern Lights have had a small machine made to be tried at one of the lighthouses under their charge; a French company have bought the right to use it in France, intending to apply it first at the lighthouse on Cape Grisnez, whence, as is declared, the light will be seen across the whole breadth of the Channel. The cost of the light, as computed by a competent authority, will not be more than 6d. or 8d. an hour, including coal, carbon-rods for the lamps, expense of maintenance, and interest on the price of the machine. This must be considered cheap for a light which makes the sun look pale.

Beside the production of light, the machine is susceptible of mechanical and chemical applications. An electro-plating firm in Birmingham are about to use it instead of a battery for the deposition of copper; the cost will be less than that of the zinc and acid of the galvanic battery at present employed in the process; and a firm in Whitechapel are setting up one of the machines for the production of ozone in large quantities, to be applied in the bleaching of sugar. With such a promising commencement, we may be sure that many other useful applications of Wilde's machine will be discovered. — *London Athenæum.*

THE ELECTRIC LIGHT.

Our ideas of the electric light are almost invariably associated with the recollections of trouble and difficulty often experienced in the management of a large galvanic battery, with its accompanying fittings, acids, and fumes, detrimental alike to the clothes, hands, and olfactory organs of the operator. How different it would be if, instead of the cumbrous paraphernalia, we had but to turn a wheel, and lo! our sun would send forth his brilliant beams! This is not now a matter of mere theoretical speculation, but is really *un fait accompli.*

In the new machine no magnetism, no electricity, is required to commence the action. Nothing but motion is needed to convert a mass of iron and covered wire into a magazine of intense electric power.

The new machine consists essentially of a bar of iron bent in horseshoe fashion; around this is coiled covered wire, as in an ordinary electro-magnet. Between the poles revolves a spindle carrying covered wire, insulated, but so arranged that either end will be alternately brought into contact with each terminal of the wire surrounding the iron bar. Again; the spindle is so placed that, during its revolution on its long axis, it is made to present each side in succession to either limb of the horseshoe. The spindle is driven by an endless band, which passes around the circumference of a tolerably large fly-wheel. This is the general construction. When the spindle is rapidly revolved the horseshoe becomes magnetized, a powerful electric current being induced in the wire helix at the same time; and, as the motion is continued, the forces go on acting and reacting until a very high degree of intensity is obtained. The electricity can be taken between two terminals placed in proper position. In this respect an important point of difference exists between Mr. Wilde's machine and Professor Wheatstone's, inasmuch as in the former any body which we wish to submit to the action of the electric current must form the terminals of the complete circuit, whereas in the new apparatus the substance to be operated upon forms a bridge or short cut for the electricity, in order to complete the circuit.

The power of this apparatus is so great that, even when of small size and easily turned by the hand, it is capable of burning a piece of iron wire 30 inches long and one-sixteenth or more in diameter. In this experiment, at the moment of separation of the fused and glowing iron, the metal scintillates in a very beautiful manner. The same result is also obtained by approaching one terminal, consisting of iron wire, to the second end; the iron immediately takes fire and burns with brilliant coruscations. When the current is made to pass between charcoal points a beautiful and steady light can be obtained. This is the point which chiefly interests us, and we have little doubt that before long we shall have a machine which will be practically available, and enable us to realize the idea conveyed in the term "turning on the sun" whenever we need additional light.

Finally, we have in the new machine a remarkable illustration of the co-relation of the forces — the muscular power of the human arm being ultimately converted into a brilliant light, as exhibited by the following chain: —

Muscular power — Motion
Magnetism — Motion
Magnetism — Electricity
Heat — Electricity
Heat — Light
Chemical action — Light

— *British Journal of Photography.*

THE COST OF ELECTRIC LIGHT.

The time appears to be near at hand when the electric light will be used for a variety of purposes. It is worth our while to inquire as to its cost. The expense and inconvenience attendant upon the production of electricity upon a large scale have hitherto been an obstacle in the way of using the electric light, except for lecture rooms and a few other purposes. But the recent improvements in the construction of magneto-electric machines and thermo-electric batteries have put it in our power to command the services of this beautiful illuminating agent on any desirable scale of magnitude.

In order to examine the question of cost intelligently, let us refer both electrical and illuminating effects to the common measure of power, namely, the foot-pound per minute. The experiments of Mr. Julius Thomson, of Copenhagen, have shown that the power to maintain the light to that of a standard candle for one minute is equal to the raising of a weight, not exceeding 13 pounds, one foot high in that time. I have arrived at a similar result from a reduction of recorded experiments made by Müller, Ritchie, myself, and others. I am satisfied that, where an electric light of not less than 800 to 1000 candles is produced, under proper management, the power required will not greatly exceed 15 foot-pounds per minute per candle. For smaller amounts of light the power required will be greater.

Now let us inquire what amount of electricity is the equivalent of, or is represented by, 15 foot-pounds per minute. If 100 feet of No. 18 pure copper wire be coiled into a helix and immersed in a pound of water, and if the ends of this wire be connected to the poles of one cell of the Grove battery (pint-cup size as used in telegraphing), the temperature of the water will begin to rise at the rate of 1° F. in 9½ minutes, or 0.105° per minute. Now, if the temperature of one pound of water be raised 1° F. per minute, this effect will be the thermal equivalent of 772 pounds raised one foot high in space per minute; the heating effect, then, of our Grove cell upon the water is the equivalent of $1.105 \times 772 = 81$ (call it 80) foot-pounds per minute.

It is well known that a galvanic battery will perform its maximum work when the external resistance which it encounters is equal to the internal resistance of the battery. I have found the internal resistance of the pint-cup Grove cell to be equal, on the average, to that of 100 feet of pure copper wire, No. 18 size. Hence the maximum external effect of the ordinary Grove cell may be set down as the equivalent of 80 foot-pounds per minute, equal to the production of $80 \div 15 = 5\frac{1}{3}$ candle lights. I would not be understood as saying that this amount of light can be produced by a single Grove cell, but that 1,000 cells, if properly arranged, would be capable of evolving somewhat more than 5,000 candle lights from a single lamp.

With sulphuric acid costing $2\frac{1}{2}$ cents, nitric acid 10 cents, zinc 8 cents, and mercury 50 cents per pound, the cost of running 1,000 Grove cells 1 hour, while doing their maximum work, would be 27.65. This would give for 5,000 candles a cost of about $5\frac{1}{2}$ mills per hour per candle.

The cost of gas light per candle per hour would be about 1 mill, if gas costs 3.25 per thousand cubic feet, and if 1 cubic foot per hour gives the light of 3 candles.

With the Smee battery, carefully managed, the cost of 5,000 candle lights would be about the same as with gas.

Let us now look at the cost of electricity as developed by the magneto-electric machine. The power expended on the machine is consumed in friction, in heating the wires, magnets, etc. On a well-built machine which I examined in 1861, 1,100 foot-pounds per minute were required to keep the machine in motion when the circuit was open, and the machine doing no work. But when the circuit was closed, 3,200 foot-pounds per minute were required to maintain the same velocity of rotation; nearly all this excess of power (namely, 2,100 foot-pounds) was measured as electricity, about two-thirds (say 1,300 foot-pounds) being expended internally, heating the coils and magnets, etc., and the balance, 800 foot-pounds, measured as external useful effect. Had the external resistance been larger, a greater proportion of the expended power would have appeared as useful effect. Suppose, however, that only 800 foot-pounds per minute could be utilized by this machine and used for illuminating purposes. This would be the equivalent of $800 \div 15 = 53.33$ candles, and the total power required (including friction, etc.) would be $3,200 \div 53.33 = 60$, about 60 foot-pounds per minute per candle.

In the vicinity of Boston, power is furnished, per horse-power, at the rate of 180 per year of 313 days of 10 hours each, or at the rate of $\frac{180}{313 \times 10} = \$0.0575$ ($5\frac{3}{4}$ cents) per hour. If only one-fourth of this power could be utilized as light, $\frac{33,000}{4 \times 15} = 550$ candles would be the equivalent of 1 horse-power, and would cost

$0.0575 \div 550 = 0.0001046$, about one-tenth of a mill per hour per candle, being about one-tenth the cost of gas light.

Let us for a moment take another view of the matter. The average hourly consumption of coal by a good steam engine may be set down at 4 pounds per hour per horse-power, $= (33,000 \times 60) \div 4 = 495,000$ foot-pounds from 1 pound of coal. Utilizing as electricity, and thence light, one-fourth part of this, we get $495,000 \div 4 = 123,750$ foot-pounds, or as light, $\frac{123,750}{15 \times 60} = 137.5$ hour candle lights from 1 pound of coal, through the agency of the steam engine and the magneto-electric machine.

With the thermo-electric battery I have been able to develop 130,000 foot-pounds of electricity from 1 pound of coal $=$

$$\frac{130,000}{15 \times 60} = 144.4 = \text{to about 144 candle lights.}$$

There is still another point of view worthy our attention. Common gas coal will yield about 10,000 cubic feet of gas per ton. This, at 3 hour candle lights per cubic foot, would give $(3 \times 10,000) \div 2,000 = 15$ hour candle lights per pound of coal. About 25 cubic feet of illuminating gas weigh 1 pound. Hence 1 pound of gas, after it is made from the coal, will yield a light equal to that of a candle for 75 hours. One pound of pure carbon, wholly burned to carbonic acid gas, yields 14,500 units of heat, equal to $772 \times 14,500 = 11,200,000$, or 11 1-5 millions of foot-pounds of work; hence, were the total energy of 1 pound of pure carbon converted into light, it would be equivalent to 1 candle light for the time of

$$\frac{11,200,000}{15 \times 365 \times 24 \times 60} = 1\ 5\text{-}12 = \text{1 year and 5 months.}$$

To recapitulate: the gas made from a pound of coal would yield a candle light for 15 hours; 1 pound of the gas would yield a light equal to 1 candle for 75 hours; but could all the energy in a pound of carbon be converted into light, it would be equivalent to the burning of a candle for 12.410 hours.

Thus it will appear that by our ordinary methods of gas-lighting we utilize much less than 1 per cent. of the energy stored in the coal. I think we may reasonably expect that electricity, as developed by the thermo-electric battery, the magneto-electric machine, or some still more efficient apparatus, will help us in some way to bridge the chasm between 15 and 12.000 hour candle lights from a pound of coal.—MOSES G. FARMER, *in Scientific American.*

IMPROVED MAGNETO-ELECTRIC MACHINE.

Mr. Tisley, of England, has made a great improvement in the magneto-electric machine, on the suggestion that if the armature had two wires instead of one, the current of one being sent through a wire surrounding the magnets, their power would be increased, and a considerable current obtained from the other wire for external work; or, there might be two armatures, one to increase the power of the magnets, and the other for blasting or other purposes. Two bars of soft iron, $7\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{2}$ inches, are each wound round the centre portions with about 30 yards of No. 10 copper wire, and shoes of soft iron so attached at each end that when the bars are placed one above the other, there will be a space left between the opposite shoes in which a Siemens armature can rotate. On each of the armatures is wound about 10 yards of No. 14 copper wire, cotton-covered. If the armature, in connection with the electro-magnet, is made to rotate, there will be a very feeble current generated in it; this passing round the electro-magnet will increase its power with every additional impulse. It will thus be seen that the only limit to the power of the machine is the rapidity with which the armature is made to rotate, which is entirely dependent on the amount of dynamic force employed. The great improvement in this machine is the introduction of the second armature, which, although it takes off currents generated in its wire by the increased magnetism, does not at all interfere with the primary current, and, when attached to a regulator, is found to give an electric light equal to 40 elements of Grove's or Bunsen's at the expenditure of one horse-power.

He exhibited a machine at the Paris Exposition about 24 inches in length, 12 inches in width, and 7 inches high. Though imperfectly constructed, its power would keep 50 inches of platinum wire, .01 in diameter, incandescent, and when a small voltameter was placed in circuit with the second armature, it would give off 250 cubic centimetres of gas per minute. — *Quart. Jour. of Science*, 1867.

PROF. WHEATSTONE'S CRYPTOGRAPH.

The importance of a secure cipher for commercial, military, and other telegrams of a confidential nature, grows with every step in the extension of telegraphic correspondence, and has brought forth a most ingeniously simple and effective invention for the purpose mentioned, which has been adopted by the British War Office. The parties to a confidential correspondence by telegraph are each furnished with a little instrument consisting of a dial having the letters of the alphabet printed in regular order in a circle near the circumference, with one blank space, making 27 intervals. In a circle within this runs a flanged groove having room for just 26 letters, and in which the letters, printed on separate bits of card of the exact size, are arranged in any arbitrary order understood between the parties. A secure and convenient way to fix this arbitrary order in the mind without risking it on paper, is to agree upon any word easily remembered, and when a despatch is to be sent or deciphered, write down the letters of this word, and under them write the remaining letters of the alphabet in their proper order from right to left, one letter under each letter of the word, then beginning another line under this in the same way, and so on until the entire alphabet is arranged in both lines and columns, which are to be read vertically, and the letters in the inner circle of the dial are to be arranged in that order. After the despatch is sent or deciphered, as the case may be, remove the letters, and the instrument is again uncommunicative.

But the mode of communication remains to be described. The centre of the dial is penetrated, exactly like a clock, by a shaft or arbor passing through a hollow arbor, the former bearing a long and the latter a short index hand. Each of these arbors has also fixed on it a spur-wheel, gearing on a loose pinion common to both, so that turning the one turns the other. But the spur-wheel of the short hand has 26 teeth and that of the long hand 27, answering respectively to the divisions of the inner and outer circles, so that at every revolution of the long hand, the short hand completes the circuit of the alphabet and one letter further, thus gaining one every time. Consequently, a message spelled out with the long hand, and written out in the letters simultaneously indicated by the short hand, would be in a constantly changing cipher, in which no letter would be represented twice by the same substitute, and no possible clue could be obtained without first obtaining the magic word upon which the inner circle of letters was arranged. The receiver of the message, having properly arranged the arbitrary alphabet in the instrument, has only to turn the short hand to the letters of the despatch as received, in succession, and write off those indicated by the long hand. The instrument is, of course, only to be turned forward, or from left to right. — *Scientific American.*

ELECTRIC-DISTANCE METER.

The collection of articles sent to the Paris Exhibition by the Austrian War Office contains an ingenious apparatus, invented by M. C. Cocziczka, captain in the corps of engineers, for measuring the distances and indicating the movements of distant objects. This apparatus requires two points of observation placed at a certain measured distance from each other, and connected by a telegraph wire. At each of these stations a telescope is used for observing the object in view, and below the telescope a small table is placed in one of the stations, representing the map of the space in front of the observer. At one fixed point upon the table, exactly below the axis of the telescope, there is a long thin needle balanced upon a point, and connected to the telescope, so as to follow all movements of the latter and to be always parallel to its line of sight.

Beside this, a second needle, which turns round a point which represents the second point of observation upon the small map, is placed upon the table, and this second needle is connected with the telescope of the other station by an electric arrangement. The movement of the distant telescope is made to cause this needle to turn to an equal angle with itself, in a somewhat similar manner to the magnetic needles of the electric telegraph. The distance between the centres of the two needles on the paper being made to scale, so as to represent the measured distance of the two places of observation, it follows that the position of the two needles will indicate the two lines of sight of the two telescopes both fixed upon the same distant object, and the point where the two needles cross each other (one of the needles being slightly below the other) will correspond to the exact position of the distant object. If the latter is in motion, and the two observers follow its movements so as to keep it constantly in sight, the two needles will constantly change their position, and their point of intersection will make the same movements upon the map, on a small scale, as the distant object makes in reality; the movements of the object and those of the point of intersection of the two needles being simultaneous. For purposes of warfare there are several applications of this instrument, which will readily suggest themselves; but similar instruments may be used with advantage for purposes of general surveys of land, and for similar operations where they are not unlikely to effect some considerable saving of time, if properly employed. — *Engineering.*

EARTH CIRCUIT IN TELEGRAPHY.

The failure of the earth circuit of a short telegraphic line in the Pewabic copper mine, Lake Superior, is interesting from a practical point of view. The wire used was a one-sixteenth inch copper wire, wound in the same manner as waterproof fuse, the wire taking the place of the powder. To the surprise of all, no signals could be transmitted through the line. The end of the wire underground was put into a hole drilled into the rock and tamped in; a bed of earth was then made, and lastly a pool of water tried, but all to no effect. Above ground the line worked well enough.

Though the earth, generally speaking, will conduct electricity, some substances, of which any specific portion of the earth may be composed, will not conduct it; for example, dry sand and dry freestone rock will not, and quartz rock will not any more than glass; dry earth will not, as is recognized by all telegraph constructors, who bury the earth-plates deep in damp earth. In this case an attempt was made to form an earth circuit in non-conducting material. The end of the wire in the mine was tamped into the solid rock, probably quartz, which would be about the same as tamping it into a glass bottle, filled with earth or water. The chances of electric communication would be still less, if the wire was not perfectly insulated in its whole length. The remedy would be to make a return circuit of insulated wire. — *Mechanics' Magazine*, 1867.

A NEW SAND BATTERY.

Father Secchi, of Rome, in a recent number of the "Laboratory," described a new, simple, and useful galvanic battery. He takes a piece of thin sheet copper, 8 inches square, and cuts on one side 6 notches 1½ inches deep, so that 6 points are left. The points are alternately bent in horizontally, and the sheet is rolled and soldered so as to form a hollow cylinder resting on 3 points. This is set in a glass cylinder of the same height, at the bottom of which are placed some broken crystals of sulphate of copper, through which the 3 vertical points are forced, the 3 bent horizontally resting on the sulphate. On well-fitting discs of bibulous paper, passed over the copper cylinder down to the sulphate, is placed a thin layer of sand. A zinc cylinder, 6 inches high, is then passed over the copper to rest upon the sand, and then the space between the copper and the zinc and the zinc and the glass is filled up with sand nearly to the top. The copper cylinder is then filled with powdered sulphate, and the battery is set in action by pouring water upon the sand. According to him, a battery of this size and description will keep in constant action for more than two years. It is specially applicable to electric clocks and bells.

TÖPLER'S ELECTRICAL MACHINE.

This consists essentially of a circular plate or disc of vulcanized rubber, gutta percha, or glass, mounted upon a vertical axis, and caused to rotate rapidly by means of a band and wheel. The disc is coated upon each side with two segments of tin foil, a free space being left between the segments, while the coatings are connected over the edge of the disc by strips of foil. A piece of hard rubber, forming a segment of a circle, is then excited by friction, and placed near and parallel to the lower coated surfaces of the revolving disc. This lower surface becomes electrical by induction, the opposite electricity being driven over the edge to the upper surface of the plate. As the plate revolves, one under segment of tin foil is removed from the inductive action of the excited surface, and the second becomes parallel to it, when the free electricity is decomposed as before. Two isolated conductors are placed above and parallel to the disc, and each carries at one end a light spring or strip of tin foil, which rests upon the upper surface of the disc. The two strips are so arranged that, as the disc revolves, one is just leaving a segment of tin foil as the other is brought into contact with it. In this manner the electricity driven to the upper surface is first carried off by one conductor, while the electricity retained upon the lower surface at first, as the plate revolves, passes to the upper surface, and is drawn off by the second conductor. The same process then takes place with the second coating, and so on alternately. It will be seen that so far the apparatus is exactly equivalent to an electrophorus, and that the action, though powerful at first, must diminish rapidly as the inductor loses electricity. To remedy this difficulty, a second but smaller glass disc is placed on the same axis, coated with tin foil in the same manner, and provided with a similar inductor and similar conductors. This second inductor is connected with one pole or conductor of the upper and larger plate. Of the two similar conductors belonging to the lower plate, one is connected with the earth, while the other is connected with the inductor of the upper plate. In this manner, as the discs rotate, the earth furnishes a constant supply of electricity, and the action of the machine is remarkably powerful.

Holtz's machine depends on similar principles; it is described in "Poggendorff's Annalen," cxxvii. 320. A simpler form is described by Bertsch in "Cosmos," No. 7, 1866. All these instruments are much more powerful than plate electrical machines of the same size, and they have the advantage of working with but a small application of force. —*American Journal of Science, March,* 1867, *from Pogg. Ann.* cxxv. 469.

NEW FORMS OF THE HOLTZ MACHINE.

M. Bertsch, in the "Comptes Rendus," Vol. 63, p. 771, describes a form of the Holtz machine, as modified by himself; though analogous in form, the generator is very different. It is composed of a single disc of isolating substance, instead of two, so that the action of a layer of interposed air in the production of the phenomena need not be considered. The disc, a thin sheet of isolating substance, is mounted on a shaft of the same, and can, by a handle, be rotated 10 or 15 times in a second. Two collectors with metallic points, not connected, are placed perpendicularly to the plane of the disc, at opposite extremities of its diameter, and serve as the origin of the manifestation of the double current which is created. Each collector is furnished with a movable arm, serving as an electrode, ending with a ball, and they separate from each other at right angles, or approach until they meet. A conductor with a large surface is connected with one of these poles, to increase the tension.

Behind the plate, and parallel to it, can be placed one or more sectors or thin plates of isolating material, not in contact with the last, but at a little distance from it; these can act either alone, or superposed one on another; they are of about 60 degrees each, of a triangular shape, and serve as inductors.

To start the machine, one of the sectors is rubbed lightly with the hand, which electrifies its surface, and placed in the position indicated; the wheel being put in motion, a series of sparks without intermission spring between the two electrodes. The apparatus remains charged, whether the motion of the wheel is interrupted or not, as does the ordinary electrophorus. In a dry atmosphere the flow of electricity will last for several hours without any sensible diminution: this seems to prove theoretically that it would continue indefinitely if the air was absolutely isolated. If a second sector be added behind the first, equally electrified by friction, the quantity of electricity is doubled, without increasing the tension, because the surface of the conductor remains the same; a third and fourth sector superposed on the first, so many new inductors, increase the quantity, which is limited only by the distance of the electrified surfaces, the diameter, the rapidity of the wheel, and the promptness with which it regains equilibrium by the electrodes. With a disc of 50 centimetres of hardened rubber and movement of 10 turns a second, and 2 sectors, can be obtained almost uninterrupted sparks of 10 to 15 centimetres long, having sufficient tension to pierce a piece of glass of one centimetre thickness; a tube more than a metre long, filled with rarefied air, can be continuously illuminated, and combustibles at a short distance set fire to. This plate can charge in 30 or 40 seconds a battery of 2 metres (21½ square feet) of interior surface, which will volatilize a sheet of gold leaf, and burn a metre of iron wire employed in the lightning arrester of telegraphs. In the simplicity of its construction, this machine seems to realize practically the idea of a continuous electrophorus, and of a convenient and permanent source of electricity.

Ritchie's Modification. — At the meeting of the Society of Arts of the Massachusetts Institute of Technology, March 21, 1867, Mr. E. S. Ritchie, of Boston, exhibited a new form of electrical machine of his own construction, a modification of the machine of Holtz, upon which, from its simplicity, it is believed to be a great improvement. It is described in the "Journal of the Franklin Institute" for May, 1867.

A strong plate of plate-glass is fixed in a vertical position upon a mahogany frame, and sustains the bearing of one end of the revolving shaft supported at its opposite end by a single pillar. The revolving thin plate is fixed in the usual manner on its shaft by a collar and binding nut of vulcanite, and is placed about one inch distant from the thick plate. Four holes are drilled through the thick plate at suitable distances from the centre, through which pass the stems of the rods with points or combs; balls of metal or vulcanite screw against the opposite side and hold the combs firmly in place; the balls are connected with the discharging pillars. Four pairs of little pillars or bolts project from the supporting plate in a circle surrounding the revolving plate, made of vulcanite; their outer ends are furnished with movable screw shoulders and nuts. Upon each pair is placed one of the glass sectors of the Holtz machine; or, on alternate pairs, the rubber sectors of the Bertsch arrangement. These pillars (the middle one removable), with sliding discharging rods, furnished with balls of different diameters and points, are connected by wires (covered by insulating material, if desirable) to the balls of the combs. Any desired combination can easily be made; either of the sectors or combs with its connections can at pleasure be removed, or their distance from the revolving plate adjusted. The relative positions of the parts are held with great firmness. The presence of the stationary plate, near the revolving one, adds to its insulation, and, in this way, to the efficiency of the machine; in other respects the advantages sought are simplicity and stability. The insulation of the supporting plate allows the discharges to be brought nearer the revolving plate, avoids disturbing influences from one to the other, and allows the machine to be much more compact in form.

The following are extracts from a letter from Mr. Ritchie to the editor of the "Journal," giving the results of some of his experiments: —

"I removed the two upper sectors of my machine, leaving 2 at 90 degrees apart, thus leaving nearly three-fourths of the plate between the sectors on one side; from this portion I removed every conductor as far as possible; still, the machine in action is surrounded by *such an atmosphere* of electricity, that there is danger of being deceived in the results sought. I took proof planes of 2 and 3 inches in diameter, with lac handles, to take the charge and bring to the gold leaf electrometer, stopping the plate suddenly and applying the proof planes, — sometimes to both sides, and sometimes to one side, simultaneously or alternately. They, *in general*, indicated opposite electricities and different intensity in opposite sides of the plate; yet, in a large number of trials, made as nearly as possible in the same place relatively to the sectors, the results were so contradictory that nothing could be determined, — sometimes the one side was positive, sometimes negative.

"I then applied the proof plane on one side and a disc of metal of larger diameter to the opposite side in connection with the earth, thus leaving the electricity on the side of the proof plane free, and by repeating many times the experiment in the same place, on both sides, I was surprised to find both sides of the revolving plate of the same kind in all cases; *negative* when the preceding sector had been excited *positive*. The two sides of the sectors, when removed, show also the same kind.

"The role of the papers upon the sectors is far from clear; they may be on either or both sides of the glass. Of a number, made as nearly alike as possible, a few may act well; the varnish of some may be scratched even through the paper in all directions, and with slight loss of effect. Others may resist all excitation, but, by doubling a piece of tin foil over the edge, may perform well. The paper may be left off entirely, and a piece of tin foil doubled over the edge, as large on each side as the paper is usually made, retaining a card-point *feeder*, without varnish, and yet this may do very well for at least one of the sectors, where only a pair is used.

"The power of the instrument for evolving ozone is very great, and I have reason to caution those using the machine in a confined atmosphere."

According to "Comptes Rendus," Feb. 11, 1867, Bertsch's machine is the same as that of M. A. Piche, except that the former substitutes "hardened rubber" for "paper covered with several layers of gum lac."

For a full description of the Holtz machine, the reader is referred to the "Journal of the Franklin Institute," Oct., 1867.

LIGHTNING-CONDUCTORS.

In a report addressed by M. Pouillet to the French Minister of War, in the name of a commission appointed to examine the best way of securing powder magazines from the effects of lightning, we find the following interesting remarks: —

"When, during a thunder-storm, a cloud charged with a given kind of electricity approaches the earth, the latter becomes at that spot charged with the contrary kind of electricity. This, finding the foot of the lightning-conductor dipping in a subterranean sheet of water, immediately escapes that way, being attracted by the contrary fluid overhead; it accumulates at the summit or point of the conductor. If the latter is gilt or made of platinum, the fluid, attracted by the cloud, exercises on the atmosphere, which is a bad conductor, a pressure sufficient to enable it (the electric fluid) to escape in the shape of a luminous egret, visible in the dark. This egret is rarely more than 20 centimetres in length. The air becomes strongly electrified thereby, and its particles are undoubtedly conveyed by attraction to the cloud, where they neutralize a part of the fluid it contains. It is this neutralization which constitutes the protecting or preventive action of the conductor. While the egret is formed, the influx of electricity is often so intense as to melt the point, in which case both the gold and platinum will trickle down the copper or iron rod to which they were attached, though platinum is the least fusible metal we know. In this state, however, the lightning-conductor is by no means rendered unfit for service, provided there be no solution of continuity; and provided, also, its lower extremity communicates freely with the sheet of water. A point, therefore, is not absolutely necessary, and the commission propose that a copper cylinder, 2 centimetres in diameter by 20 or 25 in length, be substituted for it, as this cannot melt, owing to its great conducting power. Lightning-conductors thus constructed should never be placed on the powder magazine, but outside the round-way; there should be 3, 5 metres in height, fixed to supports 15 metres high, and connected together by a metallic circuit joining their lower extremities."

DEATHS BY LIGHTNING.

Few people are aware how many are the deaths from lightning. It appears, from statistics kept in France, that during the last 30 years more than 10,000 people were struck by lightning, of whom 2,252 were killed outright. 880 were killed during the last 10 years, and of these only 243 were females. If lightning falls on a crowd it does more mischief among the men than among the women, the taller persons being most exposed. Again, animals are frequently stricken, while the persons in charge of them are spared. The old idea that the beech-tree is a protection is a fatal error, the neighborhood of all isolated trees being dangerous, except when they are in metallic connection with the soil. Railroads and telegraph wires are protectors, in so far as they are able to absorb and convey considerable amounts of electricity. Every locomotive does this unperceived, its metallic mass being an excellent conductor. Walking along a railroad track where it runs through a country without trees is as dangerous as taking shelter under a tall tree. That windows are dangerous is believed to be an error, for experience does not show that lightning strikes through open windows or follows a draft of air.

THE EFFECTS OF LIGHTNING ON WIRES.

In a paper addressed to the Academy of Sciences by M. F. P. Leroux, in which the author examines certain phenomena which natural philosophers have either hesitated to explain, or have confessed to belong to an unknown action of the electric fluid, one of the most curious of these phenomena is that of the undulations produced in the wires by the discharges, and the momentary diminution of length they experience in consequence. This shortening in the wires has been observed by others, who admitted the diminution of length, but failed to perceive the undulations. M. Ed. Becquerel, however, instead of keeping the wire stretched between the two poles, suspended it by one end, and simply stretched it with a very light weight, and in this way he was enabled to ascertain the existence of very perceptible undulations. M. Reis carried the matter further, and concluded that the diminution of length was but a consequence of the undulations. M. Becquerel found that under the influence of successive discharges the undulations would not only continue, but increase; at the same time, however, there is no perceptible oscillation; for, on observing the wire attentively at the moment when it becomes luminous enough under the influence of electricity to become visible, its shape appears distinctly defined. What is the cause of the undulatory deformation it undergoes? Our author at first suspected it to be owing to some action of terrestrial magnetism, and he therefore subjected the wire to the influence of powerful magnets, but without success. He then operated on wires left entirely free at their nether extremity, and the undulations under such circumstances became much stronger, two or three discharges being sufficient to render them quite perceptible; but their order is so irregular, and they assume such a variety of shapes, that no rule can be laid down regarding them. One thing, however, did not escape the author's notice, namely, that the temperature caused by the discharges was not without influence upon them; for, in order to obtain deep undulations, it must remain within certain limits, not below a dark-red heat, and not so high as to soften the metal much. In the latter case the undulations are exceedingly minute and close together; platinum wires being then best suited for the experiment. Our author, therefore, concludes that the phenomenon alluded to does not require any new principle for its explanation, and is a simple question of temperature. As the heat engendered by the discharges increases, the wire tends to increase in length by dilation; but as this power of dilation acts also transversely, there is also a tendency to increase in diameter, and it is to this double molecular action the undulations must be ascribed.

NEW FORMS OF THE HYDRAULIC PRESS.

At a meeting of the Massachusetts Institute of Technology, Prof. Rogers spoke of some novel forms of the hydraulic press, as exhibited at the Paris Exposition. In the old forms the intermittent action of the piston in the pump causes, of necessity, more or less shock with every movement, which rapidly wears out the apparatus, and renders it unserviceable. These French instruments dispense entirely with the pump, and use instead the displacing action of a solid plug or piston or some equivalent body, forced by a screw or other mechanism against or into the liquid (oil) with which the barrel of the press is charged. Thus, by the continuous action of a screw in one of these new presses, forcing a solid piston along a narrow tube connecting with the barrel, a steady and perfectly manageable pressure of great intensity is obtained.

He also described another instrument, in which the action is produced by means of a small catgut string, wound up by an outside winch acting on a reel within the cylinder; two cylinders may be used, so that, when the pressure is exerted in the one containing the wound coil of catgut, the other, which contains the unwound coil, is receiving, by a valvular arrangement at the bottom, the fluid necessary for the compressive action, when its turn comes to receive the additional substance of the wound coil. By this alternate winding and unwinding of a simple catgut coil, in two cylinders which communicate by separate tubes with the barrel of the pump, a pressure of any desirable amount can be slowly and steadily attained, as for testing the strength of bars of steel, etc.

CONDUCTION OF SOUND BY HYDROGEN AND AIR.

Prof. Tyndall, on a lecture on "Vibratory Motion," delivered at the Royal Institution, showed a novel experiment, illustrating the very low conductivity which hydrogen possesses for sonorous vibrations. A bell, struck by clock-work, was placed under the receiver of an air-pump, and the air exhausted as perfectly as possible. It was stated that by applying the ear close to the glass a faint sound could still be heard. The exhausted receiver was then filled with hydrogen, when the bell was again heard to sound, although faintly. On pumping out the hydrogen all trace of sound entirely disappeared, even though the ear were placed close to the receiver. Hydrogen being about 15 times lighter than air, it might be considered that sound would travel in an atmosphere of hydrogen as readily as it would in air exhausted to 2 inches barometric pressure. But on trying the experiment it was found that when 2 inches of air were passed into the receiver, it allowed far more sound of the bell to pass through it than did the full atmosphere of hydrogen, showing that conductivity for sound depended upon something more than mere density. It was then shown that sound travelled with almost the same ease through air exhausted to half its normal density that it did at the ordinary pressure. — *Chem. News.*

ON PERFECT HARMONY.

Mr. H. W. Poole, in the "American Journal of Science," for July, 1867, has written an interesting and elaborate article, supplementary to a paper on "Perfect Intonation," published in the same journal for March, 1850. He describes a new key-board, in which all the sounds contained in the organ are represented, and placed within control of the organist, without aid from pedals or any interior mechanism, and which is practicable for any extent of modulation or number of notes in the octave. It is uniform in all keys, and the same succession of melodies or harmonies is fingered the same in every signature.

Beside the so-called *triple diatonic scale*, formed of the fifths and thirds, or of the common chords of the key-note, dominant and subdominant, and represented thus, considering the key-note to make 48 vibrations in a given time: —

	Do	*Re*	*Mi*	*Fa*	*Sol*	*La*	*Si*	*Do*
Rel. vibrations,	48	54	60	64	72	80	90	96
Intervals,	8 : 9,	9 : 10,	15 : 16,	8 : 9,	9 : 10,	8 : 9,	15 : 16	

he describes what he calls the *double diatonic scale*, in which the subdominant harmony is suppressed, and the fourth and the sixth of the scale are replaced by the perfect seventh and the ninth of the dominant harmony, so that, if we still take *Do* as a starting-point, we require a new *Fa* and *La*, for which formerly there have been no names : represented thus: —

	Fa	*Sol*	*La*	*Si*	*Do*	*Re*	*Mi*	*Fa*
Rel. vibrations,	48	54	60	63	72	81	90	96
Intervals,	8 : 9,	9 : 10,	20 : 21,	7 : 8,	8 : 9,	9 : 10,	15 : 16	

In the last scale are five different intervals in place of the three of the first scale, by which more variety is secured; these two scales contain all that belongs to the major keys; the additional ones required to complete the minor keys as well as those called "accidentals" being afterwards considered. He gives a description of his complete enharmonic key-board, giving the lengths, the five different colors, the elevations, and the lettering and markings. This system does away with the common equal and mean tone temperaments, and gives the intervals practically perfect.

INFLUENCE OF SOUND UPON FLAME.

The following are extracts from a recent lecture by Prof. Tyndall before the Royal Institution: —

"Pass a steadily burning candle rapidly through the air, you obtain an indented band of light, while an almost musical sound, heard at the same time, announces the rhythmic character of the motion. If, on the other hand, you blow against a candle flame, the fluttering noise produced indicates a rhythmic action. When a fluttering of the air is produced at the embouchure of an organ pipe, the resonance of the pipe reinforces that particular pulse of the flutter whose period of vibration coincides with its own, and raises it to a musical sound. When a gas flame is introduced into an open tube of suitable length and width, the current of air passing over the flame produces such a flutter, which the resonance of the tube exalts to a musical sound. Introducing a gas flame into this tin tube 3 feet long, we obtain a rich musical note; introducing it into a tube 6 feet long, we obtain a note an octave deeper, — the pitch of the note depending on the length of the tube. Introducing the flame into this third tube, which is 15 feet long, the sound assumes extraordinary intensity. The vibrations which produce it are sufficiently powerful to shake the pillars, floors, seats, gallery, and the 500 or 600 people who occupy the seats and gallery. The flame is sometimes extinguished by its own violence, and ends its peal by an explosion as loud as a pistol-shot. The vibrations consist of a series of partial extinctions and revivals of the flame. The singing flame appears continuous; but if the flame be regarded in a mirror which is caused to rotate, the images due to the revivals of the flame are separated from each other, and form a chain of flames of great beauty.

"A flame may be employed to detect sonorous vibrations in air. Thus, in front of this resonant case, which supports a large and powerful tuning-fork, I move this bright gas flame to and fro. A continuous band of light is produced, slightly indented through the friction of the air. The fork is now sounded, and instantly this band breaks up into a series of distinct images of the flame. In this glass tube 14 inches long, a flame is sounding; I bring the flat flame of a fish-tail burner over the tube, the broad side of the flame being at right angles to the axis of the tube. The fish-tail flame instantly emits a musical note of the same pitch as that of the singing flame, but of different quality. Its sound is, in fact, that of a membrane, the part of which it here plays. Against a broad bat's-wing flame I allow a sheet of air, issuing from a thin slit, to impinge. A musical note is the consequence. The pitch of the note depends on the distance of the slit from the flame.

"Before you now burns a bright flame from a fish-tail burner. I may shout, clap my hands, sound a whistle, or strike an anvil; the flame remains steady and without response. I urge against the broad face of the flame a stream of air from the blow-pipe. The flame is cut in two by the stream of air. It flutters slightly, and now when the whistle is sounded the flame instantly starts. A knock on the table causes the two half-flames to unite and form for an instant a flame of the ordinary shape. By a slight variation of the experiment, the two side-flames disappear when the whistle is sounded, and a central tongue of flame is thrust forth in their stead. Passing from a fish-tail to a bat's-wing burner, I obtain this broad, steady flame. It is quite insensible to the loudest sound which would be tolerable here. I turn on more gas; the flame enlarges, but it is still insensible to sound. I enlarge it still more; and now a slight flutter of its edge answers to the sound of the whistle. Turning on a little more gas, and sounding again, the jumping of the flame is still more distinct. Finally, I turn on gas until the flame is on the point of roaring as flames do when the pressure is too great. I now sound my whistle; the flame roars and thrusts suddenly upwards eight long, quivering tongues. I strike this distant anvil with a hammer; the flame instantly responds by thrusting forth its tongues. Another flame is 18 inches long, and smokes copiously. I sound the whistle; the flame falls to a height of 9 inches, the smoke disappears, and the brilliancy of the flame is augmented. Here are two other flames. The one of them is long, straight, and smoky; the other is short, forked, and brilliant. I sound the whistle; the long flame becomes short, forked, and brilliant; the forked flame becomes long and smoky. As regards, therefore, their response to the sonorous waves, the one of these flames is the exact complement of the other. Here are various flat flames, 10 inches high, and about 3 inches across at their widest part. They are purposely made forked flames. When the whistle sounds, the plane of each flame turns 90 degrees around, and continues in its new position as long as the whistle continues to sound. Here, again, is a flame of admirable steadiness and brilliancy, issuing from a single circular orifice in a common iron nipple. I whistle, clap my hands, strike the anvil, and produce other sounds: the flame is perfectly steady. Observe the gradual change from this apathy to sensitiveness. The flame is now 4 inches high. I make its height 6 inches; it is still indifferent. I make it 10 inches; a barely perceptible quiver responds to the whistle. I make it 14 inches high; and now it jumps briskly the moment the anvil is tapped or the whistle sounded. I augment the pressure; the flame is now 16 inches long, and you observe a quivering which announces that the flame is near roaring. I increase the pressure; it now roars and shortens at the same time to a height of 8 inches. I diminish the pressure a little; the flame is again 16 inches long, but it is on the point of roaring. It stands as it were on the brink of a precipice. The whistle pushes it over. Observe it shortens when the whistle sounds, exactly as it did when the pressure was in excess. The sonorous pulses, in fact, furnish the supplement of energy necessary to produce the roar and shorten the flame. This is the simple philosophy of all these sensitive flames.

"Here, again, is an inverted bell, which I cause to sound by means of a fiddle-bow, producing a powerful tone. The flame is unmoved. I bring a half-penny into contact with the surface of the bell; the consequent rattle contains the high notes to which the flame is sensitive. It instantly shortens, flutters, and roars, when the coin touches the bell. Here is another flame 20 inches long. I take this fiddle in my hand, and pass a bow over the three strings which emit the deepest notes. There is no response on the part of the flame. I sound the highest string; the jet instantly squats down to a tumultuous, bushy flame, 8 inches long. Some of these flames are of marvellous sensibility; one such is at present burning before you. It is nearly 20 inches long; but the slightest tap on a distant anvil knocks it down to 8 inches. I shake this bunch of keys or these few copper coins in my hand; the flame responds to every tinkle. I may stand at a distance of 20 yards from this flame; the dropping of a sixpence from a height of a couple of inches into a hand already containing coin knocks the flame down. I cannot walk across the floor without affecting the flame. The creaking of my boots sets it in violent commotion. The crumpling of a bit of paper, or the rustle of a silk dress, does the same. It is startled by the plashing of a rain-drop. I speak to the flame, repeating a few lines of poetry; the flame jumps at intervals, apparently picking certain sounds from my utterance to which it can respond, while it is unaffected by others. In our experiments downstairs, we have called this the vowel flame, because the different vowel sounds affect it differently. I utter the words boot, boat, and beat, in succession. To the first there is no response; to the second, the flame starts; but by the third it is thrown into violent commotion. The sound 'Ah!' is still more powerful, the vowel sounds characterized by the sharpest overtones being the most powerful excitants of the flame. If the most distant person in the room were to favor me with a 'hiss,' the flame would be instantly shivered into tumult. This hissing sound contains the precise elements that most forcibly affect the flame. The gas issues from its burner with a hiss, and an external sound of this character added to that of a gas-jet already on the point of roaring, is equivalent to an augmentation of pressure on the issuing stream of gas."

SUMMARY OF NEW FACTS IN NATURAL PHILOSOPHY.

Electricity of Combustion. — Prof. Faraday has demonstrated that the electricity evolved during the combustion of a few grains of charcoal or a common candle, would, if arranged in a continuous circuit, exceed that of the most powerful batteries. The theory is that the heat generated by combustion is owing to the union of the two electricities. If a key to this source of power could be discovered, a new career, almost, would be opened to science and mechanics.

The Convertibility of Electricity and Heat. — This has been applied by General Morin so as to produce a self-registering electrical thermometer. A thermo-electric battery — developing electricity by the application of heat — is arranged with one extremity of the pile in a medium of uniform and low temperature (ice), and the other in the medium the temperature of which is to be measured. A needle is magnetized by the thermo-electric current produced by this temperature, and its consequent deflection from a certain natural position is registered by punctures made by it in a dial of paper which is caused by clock-work to complete a revolution in 24 hours, and also to rise to meet the puncturing point at equal intervals, hours, half-hours, etc., as may be desired. The punctures made at the several hours will indicate, by their variation from a circle, the changes of temperature throughout the day.

Telegraphic Meteorometers. — Prof. Wheatstone has devised a new class of instruments for taking observations in stations which for any cause are not accessible for very long periods. The telegraphic thermometer, a type of this class, consists essentially of two parts: the first is the magnetic-motor, constructed on a plan similar to that used by the inventor in his alphabetical magnetic telegraph, and is so arranged that by turning a handle the lever at the other extremity of the line will describe by regular steps a complete circle. The second part consists of a metallic thermometer, in which the unequal expansion of two different metals is made to move a lever or pin around a graduated circle which marks the degrees of temperature. The two parts are in such proximity that the telegraphic lever in passing around the circle must, at some point, come in contact with the pin, which is moved by means of the expanding or contracting metals. This contact breaks one circuit and completes another, and thus transmits to the other extremity of the telegraphic line information of the particular degree of heat at that instant indicated by the thermometer.

A Neutral Magnetic Chamber. — Faraday has shown that if a small cubical space be enclosed by arranging square bar magnets, with their like poles in apposition, so as to form a chamber, within that space all local magnetism inferior in power to the magnets employed will be neutralized. The same effect may be obtained with electro-magnets as with permanent magnets, and it is proposed in the "Mechanics' Magazine" thus to enclose the compass of an iron ship, as a remedy for the deviation by local attraction. A battery might be constructed to be excited by the sea water flowing through it, requiring no attention as long as the zinc plates lasted.

A New Bullet Detector. — A very ingenious piece of mechanism for the detection and extraction of bullets in wounds has been devised by Mr. Sylvan De Wilde. The probe, consisting of two steel wires insulated from each other, is connected with an electric horseshoe magnet and a bell, and when (introduced into the wound) it touches the bullet the circle is completed and the bell rings. The forceps act on the same principle, and are intended first to detect, then to seize, the bullet. They have curved points, and not pallets or spoons. The points of the probes are kept sheathed on introduction to a wound, and not uncovered until the supposed bullet is felt. This is effected by means of a sliding tube. Mr. De Wilde's probe is a sensitive artificial finger, which enters deeply into the tissues, and gives the signal at once when it detects the hidden source of mischief below. — *London Lancet.*

Magnetism of Gaseous Substances. — M. Chautard, professor of natural philosophy at the Faculty of Sciences of Nancy, sent to the Academy of Sciences a paper on certain experiments of his relating to the magnetism and diamagnetism of gaseous substances. He uses a large Ruhmkorff's electro-magnet, arranged for Faraday's experiments, and excited by from 25 to 30 Bunsen's elements. Taking Plateau's mixture of soap-suds and glycerine, and blowing it through a pipe so that the bubble formed on one of its extremities may be above the pole of the magnet, at a distance of from 2 to 3 millimetres, while at the other extremity of the pipe there is a bladder filled with oxygen, from which that gas may be supplied to the bubble, M. Chautard casts a quantity of light from an oxy-hydrogen lamp on the bubble in question, which then moves to and fro like a magnetic pendulum, its oscillation having, under these circumstances, been distinctly seen by upwards of 300 spectators.

Shape of Electric Perforations. — The curious fact has been observed, by means of the microscope, that perforations made by the electric spark are uniformly pentagonal in form.

Point of Absolute Cold. — This point or that of deprivation of all heat is estimated to be about 275° below zero Cent., equal to 463° below zero F.

Colors of Metal when Heated.—Pouillet measured the temperatures corresponding to the colors which metal takes when heated in a fire, and found them to be as follows: Incipient red, 525° Cent.; dull red, 700°; cherry red, 900°; dark orange, 1,100°; white, 1,300°; dazzling white, 1,500°.

New Use for the Sun. — Mr. Thomas Boyd, of Cambridgeport, Mass., has perfected a very simple mechanical contrivance by which an efficient system of ventilation can be secured by utilizing the heating power of the sun. It consists essentially of a double cone-shaped iron chamber, placed on the top of a chimney, painted black, in which are set many glass lenses about 2½ inches in diameter, which concentrate the rays of the sun, and produce within the chamber such a heating and rarefaction of the air, as by its ascensional powei to cause a strong upward current. The great advantage of this over revolving ventilators is that it acts most powerfully on still, hot, sunny days, when ventilation is most needed, and when other natural systems fail. In the absence of the sun and at night, the form and mechanical arrangement of the caps make it a superior ventilator. He considers it of great practical importance to have the source of heat so near the place of discharge. Any waste heat from gas-burners or furnaces may also be used in the absence of the sun. It is effectual with any system of heating. and is especially suited for tropical climates.

Induction Currents. — M. Regnault presented to the French Academy, in the name of Prof. Blaserna, of Palermo, results of experiments on the passage of induction currents. His conclusions are: 1. The time elapsed between the closing of the rupture of the circuit and the appearance of the current of induction, or the attraction of the armature for the bobbin of induction, is inappreciable, less than the fiftieth part of a second. 2. The current of induction, feeble at first, increases little by little, then diminishes, and is extinguished in an interval difficult to determine.

Magnetic Phantoms. — In "Cosmos" for July, 1867, M. Meunier gives the following method for preserving the figures, called "magnetic phantoms," produced when iron filings are scattered on a sheet of paper over a magnet. He prepares the paper by saturating it with a warm solution of ferrocyanide of potassium, and then thoroughly drying it. The magnetic figure is then made with powdered magnetite or natural loadstone; then a little pure gaseous hydrochloric acid is allowed to come upon the paper through an inverted funnel; this is removed after a few seconds, and the paper, freed from the magnetic powder, thoroughly washed. A dark-blue figure of remarkable perfection is thus obtained on a faint blue ground.

New Form of Battery. — According to M. Rouillon's observations, a mixture of two-thirds hydrochloric and one-third nitric acids, or three-fifths of the former and two-fifths of the latter, will easily dissolve gold and platinum, but will only superficially attack pure silver, — a superficial chloride being formed, protecting the rest of the silver like a varnish, for any length of time; if copper be present, the metal is attacked. He therefore makes a new battery in which pure silver in aqua regia replaces the platinum or carbon in the nitric acid of a Grove or Bunsen cell; after several months' use, the silver was not sensibly diminished in volume, and no chloride of silver was found in the porous cell. He considers it more constant than Bunsen's battery.

Improved Bunsen Battery. — M. Zaliwski uses two porous vessels, one within the other. In the inner one, which contains the carbon, he puts nitric acid, and in the outer sulphuric acid; in the outer vessel, containing the zinc, he places a solution of sal ammoniac. No effervescence, it is said, takes place, and no zinc is uselessly consumed.

Velocity of the Electric Current in the Atlantic Cable. — In ascertaining the exact longitude by means of the Atlantic telegraph cable, a distance of about 1,900 miles has been measured, and the measure is probably not more than 40 feet from the truth. The time required for a signal to pass through the cable has been discovered with still greater precision to be thirty-one one-hundredths of a second, which is probably not in error by one one-hundredth of a second. This is equivalent to a velocity of 6,020 miles a second, and is notably less than the velocity of the electric fluid upon land lines, which numerous observations have shown to average 16,000 miles a second.

On Saturday, Dec. 21, 1867, a message of 48 words of greeting was sent from the Royal Polytechnic Institution, London, to the President of the United States at Washington. The total time of transmission was 9½ minutes, divided as follows: from London to Heart's Content, 4½ minutes; from Heart's Content to Plaister Cove, 1½ minutes; at Plaister Cove one-half minute; Plaister Cove to New York, 1½ minutes; New York to Washington, 1½ minutes. A reply of 60 words was sent back from Washington to London in 20 minutes. On the same evening, a message of 22 words was sent from London to Heart's Content, and in 10 minutes a reply of 24 words was delivered in London.

Velocity of Sound. — M. Dulong, on causing organ-pipes to sound by means of different gases, found that the velocity of sound at zero was as follows: Carbonic acid, 856 feet in a second; oxygen, 1,040 feet; air, 1,093 feet; hydrogen, 4,163 feet.

Refraction of Sound. — The most notable observation lately made in the direction of reducing sound to form and measure, is the refraction of it by M. Sondhaus, by means of acoustic lenses made of spherical collodion envelopes filled with carbonic acid.

COHESIVE FORCE OF SEALING-WAX.

The cohesive force of the best red sealing-wax has been proved to be equal to 1,500 pounds per square inch, and that of the black sealing-wax rather more than 1,000 pounds to the square inch; the deficiency in the latter is attributed to the diminished quantity of lac used in the composition. The cohesive force of solid glue was found to be 4,000 pounds per square inch.

IMPROVED STEAM GOVERNOR.

At a recent meeting of the Massachusetts Institute of Technology, Mr. R. K. Huntoon exhibited and explained his patent governor for steam and water power.

The centrifugal or ball principle, adopted in the old style of governors, is in this entirely abandoned. The regulating weight is raised in a vertical line, and the valve-lever is sustained as easily at one point as another, by the action of a propeller revolving in a cylinder filled with oil (a mixture of lard-oil and kerosene), whose movements in a horizontal plane regulate the action of the steam valves. The speed of revolution, by this ingenious and novel arrangement, is the same whether the pressure of steam be 30 or 70 pounds, and whether the engine be heavily loaded or running light. The simple removal or addition of small weights will cause the engine to run slower or faster, the adjustment being speedily effected. However violent or sudden may be the changes in the work done by the engine, an experience of several months shows that this governor maintains the uniform speed at which it may be set. It is noiseless and safe, as there are no revolving balls.

The importance of uniformity of action in steam machinery can hardly be over-estimated, and none of the usual forms of ball governors have hitherto secured it. There are, however, some recent French modifications of this kind of governor, especially that of Farcot, which secure an unvarying height for the cone of revolution, and thereby a uniform velocity in all degrees of divergence of the balls; this, as reported on by Prof. Tresca, bore extreme changes of motive power and load without alteration of velocity.

The Huntoon governor may be expected to be especially valuable for marine engines, as the rolling of the vessel would not affect its action, and the pitching would hardly be noticed in so short a space as it occupies amidships. It acts equally well in its horizontal and vertical form.

TESTING IRON BY MAGNETISM.

The English engineering journals contain an exceedingly valuable paper, by Mr. F. A. Paget, C. E., upon a method of detecting faults in iron forgings by means of an examination of the bar, shaft, or whatever the work may be, with a magnetic needle; and not only does this method detect a fault in the welding, but it indicates the change which so often occurs in iron from the fibrous to the so-called crystalline condition. The extreme value of this discovery will be fully appreciated by all persons who have dealings with shafting, iron wheels, and axles, and the various combinations of machinery which depend entirely for safety upon the integrity of the iron work used in the construction. The method to which we refer was discovered by Mr. S. M. Saxby, R.N., and has been tested upon a great variety of forgings at the royal dockyards at Sheerness and Chatham. The process depends upon the very simple principle that when a bar or mass of soft homogeneous iron, of the best quality, and free from any flaws or defects causing a separation of the particles of the iron, is placed in the position of the dipping-needle, it is at once sensibly magnetic, — the lower end being a north pole in northern latitudes, and the upper end a south pole. The same action takes place in a bar hanging vertically, or in any other position, but to a less extent. With internal flaws, however, the bar is no longer one regular magnet, but several different magnets, with the different magnetisms separated from each other. When a delicately balanced magnetic needle is passed over the bar to be examined, the bar being placed east and west in the equatorial magnetic plane, if the bar is entirely sound the needle remains at right angles with the bar, that is, N. and S.; but the moment a flaw, or a separation between the particles of the iron, exists, the needle departs from its normal position and assumes a new direction, thus showing the place of the fault. A large number of trials at the shops of the royal dockyards were made in the presence of many engineers and iron-workers, and the place of the fault indicated by a chalk-mark; afterwards the bars were broken in a testing machine, and the result in every case showed the decision of the magnet to be entirely correct. In one case a round bar 14 inches long had a hole drilled into it, and a bolt of unmagnetized steel was inserted and welded up with the end of the iron bar. The needle detected the fact that a fault existed at the place where the bolt was put in; and upon cutting up the bar it was found that one end of the bolt was not welded to the iron.

A large paddle crank-shaft was decided by the magnet to be defective near one neck; and upon turning the metal down the defect was found. A bar was decided by the test to be bad, and it was afterwards found to have been made partly of good and partly of bad iron. Another bar was declared faulty, and was found to be solid, but "upset" in the middle of its length, and then hammered down to its original diameter at a temperature *below* welding heat.

The experiments upon rolled plates, upon steel, and cast iron, as far as made, are satisfactory, though farther examination is needed to make the test practically available in this respect. Perhaps the most valuable result of this mode of testing iron is the detecting of that change called crystallization, which is so often seen in iron, and is so important a matter to be regarded in the use of railway axles.

Some of the experiments seem to show that the ultimate tensile strength of a bar is greatest when the anvil upon which it is forged stands in an east and west position, but that the highest elastic limit is attained when the anvil stands in a north and south position. — *American Railway Times.*

FATALITY OF NUMBERS.

The laws governing numbers are so perplexing to the uncultivated mind, and the results arrived at by calculations are so astonishing, that it cannot be a matter of surprise if superstition has attached itself to numbers.

But even to those who are instructed in numeration there is much that is mysterious and unaccountable, much that only an advanced mathematician can explain to his own satisfaction. The neophyte sees the numbers obedient to certain laws; but *why* they obey these laws he cannot understand; and the fact of his not being able so to do tends to give to numbers an atmosphere of mystery which impresses him with awe.

For instance, the property of the number 9, discovered, I believe, by W. Green, who died in 1794, is inexplicable to any one but a mathematician. The property to which I allude is this, that when 9 is multiplied by 2, by 3, by 4, by 5, by 6, etc., it will be found that the digits composing the products, when added together, give 9. Thus: —

2	multiplied by	9	equals	18,	and	1	plus	8	equals	9
3	"	9	"	27,	"	2	"	7	"	9
4	"	9	"	36,	"	3	"	6	"	9
5	"	9	"	45,	"	4	"	5	"	9
6	"	9	"	54,	"	5	"	4	"	9
7	"	9	"	63,	"	6	"	3	"	9
8	"	9	"	72,	"	7	"	2	"	9
9	"	9	"	81,	"	8	"	1	"	9
10	"	9	"	90,	"	9	"	0	"	9

It will be noticed that 9 multiplied by 11 makes 99, the sum of the digits of which is 18 and not 9, but the sum of the digits 1 multiplied by 8 equals 9.

9	multiplied by	12	equals	108,	and	1	plus	0	plus	8	equals	9
9	"	13	"	117,	"	1	"	1	"	7	"	9
9	"	14	"	126,	"	1	"	2	"	6	"	9

And so on to any extent.

M. de Maivan discovered another singular property of the same number. If the order of the digits expressing a number be changed, and this number be subtracted from the former, the remainder will be 9 or a multiple of 9, and, being a multiple, the sum of its digits will be 9.

For instance, take the number 21, reverse the digits, and you have 12; subtract 12 from 21, and the remainder is 9. Take 63, reverse the digits, and subtract 36 from 63; you have 27, a multiple of 9, and 2 plus 7 equals 9. Once more, the number 13 is the reverse of 31; the difference between these numbers is 18, or twice 9.

Again, the same property found in two numbers thus changed is discovered in the same numbers raised to any power.

Take 21 and 12 again. The square of 21 is 441, and the square of 12 is 144; subtract 144 from 441, and the remainder is 297, a multiple of 9; besides, the digits expressing these powers added together give 9. The cube of 21 is 9,261, and that of 12 is 1,728; their difference is 7,533, also a multiple of 9.

The number 37 has also somewhat remarkable properties; when multiplied by 3 or a multiple of 3 up to 27, it gives in the product 3 digits exactly similar. From the knowledge of this the multiplication of 37 is greatly facilitated, the method to be adopted being to multiply merely the first cipher of the multiplicand by the first multiplier; it is then unnecessary to proceed with the multiplication, it being sufficient to write twice to the right hand the cipher obtained, so that the same digits will stand in the unit, tens, and hundreds places.

For instance, take the results of the following table: —

37	multiplied	by 3	gives	111,	and	3	times	1	equals	3
37	"	6	"	222,	"	3	"	2	"	6
37	"	9	"	333,	"	3	"	3	"	9
37	"	12	"	444,	"	3	"	4	"	12
37	"	15	"	555,	"	3	"	5	"	15
37	"	18	"	666,	"	3	"	6	"	18
37	"	21	"	777,	"	3	"	7	"	21
37	"	24	"	888,	"	3	"	8	"	24
37	"	27	"	999,	"	3	"	9	"	27

— *Curious Myths of the Middle Ages.*

FACTS ABOUT WATER.

The extent to which water mingles with bodies, apparently the most solid, is very wonderful. The glittering opal is only flint and water. Of every 1,200 tons of earth which a landlord has in his estate, 400 are water. The snow-capped summits of Snowdon and Ben Nevis have many million tons of water in a solidified form. In every plaster of Paris statue, which an Italian carries through our streets for sale, there is 1 pound of water to 4 pounds of chalk. The air we breathe contains 5 grains of water to each cubic foot of its bulk. Potatoes and turnips have, in their raw state, the one 75 per cent. and the other 90 per cent. of water. If a man, weighing 140 pounds, were squeezed in a hydraulic press, 70 pounds of water would run out, and only 35 of dry residue remain. A man is, chemically speaking, 45 pounds of carbon and nitrogen, diffused through 5½ pailfuls of water. In plants we find water thus mingling no less wonderfully. A sun-flower evaporates 1¼ pints of water a day, and a cabbage about the same quantity. A wheat-plant exhales, in 175 days, about 100,000 grains of water. An acre of growing wheat, on this calculation, draws and passes out about 10 tons of water per day. The sap of plants is the medium through which this mass of fluid is conveyed. It forms a delicate pump, up which the watery particles run with the rapidity of a swift stream. By the action of the sap various properties may be accumulated to the growing plant. Timber in France is, for instance, dyed by various colors mixed with water, and sprinkled over the roots of the tree. Dahlias are also colored by a similar process.

CHEMISTRY.

METHOD OF CRYSTALLIZATION.

M. Frémy communicated to the Paris Academy of Sciences a paper on this subject, an abstract of which is given in the "Quarterly Journal of Science" for January, 1867, as follows: —

"I have thought that if I could slowly effect the precipitations and decompositions which render bodies amorphous, because they are instantaneous, I should place myself in the same conditions as nature, and that I should obtain, in a crystallized state, bodies which instantaneous precipitations rendered amorphous. For this purpose I first introduce two bodies which react on each other in liquids of different densities, containing gum, sugar, or gelatine. Then I separate them by beds or partitions of porous bodies, such as wood, unglazed porcelain, etc., or by leaves of unsized paper, which in imbibing them, little by little, renders the decomposition slow, and nearly always produces crystallized bodies. The porous vessels allow the liquid which they contain to run out very slowly, and often produce beautiful crystallizations, which are found in the interior of the vessels when the liquid has left them. I have thus obtained insoluble bodies in a crystallized state, and often of very perfect forms, such as sulphate of barytes, sulphate of strontian, carbonate, borate, and chromate of barytes, magnesia, sulphur, etc. This method appears to me very generally applicable. I have tried to apply it to the alkaline silicates, by submitting them to the action of certain acids, in porous vessels, with the hope of obtaining quartz or crystallized silica, which is so common in nature. Slowly decomposing, they have formed white crystalline masses hard enough to scratch glass. I hoped to achieve the production of real quartz, but the crystals dissolved in the alkaline liquids, and they were highly hydrated. There were silicates of soda, containing silica 68, soda 5, water 29; the proportions of silicate and water being the same as in $Si O^3$, $2 H O$. These experiments confirm the provisions of our illustrious confrère, M. Chevreul, who, to explain the presence of oxalate of lime in certain plants, supposed that a soluble oxalate slowly traversing the coating of a vegetable cell, or a bundle of fibres, could react on a calcareous salt, found in a cavity, and give birth to crystallized oxalate of lime. I believe I can say, in conclusion, that the method which I have published will permit all bodies which are found crystallized to be artificially produced, whether in the earth or in organic tissues, and consequently that it will afford us much useful knowledge respecting their modes of production."

RIGHT AND LEFT-HANDED POLARIZATION.

M. de Gernez has made the interesting discovery that a supersaturated solution of left-handed double tartrate of soda and ammonia does not crystallize in contact with a fragment of the same salt right-handed, and *vice versa*. From an inactive supersaturated solution of double racemate of soda and ammonia, a fragment of a right-handed crystal determines only the precipitation of right-handed crystals; while a portion of the same liquid in contact with a left-handed crystal produces a deposit of the left-handed salt. By this simple process either of the two constituent parts can be separated at will from the double racemate of soda and ammonia. — *Quarterly Journal of Science*, 1867.

LUMINOSITY OF PHOSPHORUS.

From the experiments of Dr. Moffat, as stated at the meeting of the British Association for 1867, phosphorus in a luminous state produced phosphorous and phosphoric acids and ozone also; it is also non-luminous in a temperature below 39° F., and luminous above 45° F., — the temperature of luminosity and non-luminosity varying with the atmospheric pressure and with the direction of the wind. From a series of experiments extending over four years, it appears that the equatorial or sea wind is that of phosphorescence and ozone, and that the polar or land wind is that of non-luminosity and no ozone. The ocean being the reservoir of ozone, he suggested the probability that this phosphorescence is the chief source of its development, and that, were it not for the modifying influence of the polar or trade winds, ozone at sea would be a constant quantity.

Sir William Thompson remarked, in connection with the paper, that the phenomenon of luminosity stored up in ice, and produced after its melting, was certainly one of the most startling in physical science, the luminosity having been induced by the previous presence of non-luminous phosphorus at a low temperature.

MICROSCOPICAL EXAMINATION OF COAL ASH FROM THE FLUE OF A FURNACE.

When coal is burned in a furnace to which atmospheric air has free access, a portion is converted into gaseous and volatile matter, and the incombustible substance which remains is the ash. The amount of ash in coals from different localities is very variable; it is said to range from 1 to 35 per cent. The ash or dust, which is the subject of this paper, was collected from the flue of my steam-boiler furnace, in which common engine coal is used as fuel. This coal leaves a considerable amount of incombustible matter. The dust is of a reddish-brown color, and free from soot or carbonaceous particles. When this dust is examined under the microscope with a power of 40 or 50 diameters, it is found to consist of ferruginous matter and crystallized substances, some particles transparent, others white and red. It contains also a number of curious-looking objects, which vary considerably in size and color: the majority of these bodies are spherical, and, when separated from the irregularly shaped particles forming the bulk of the dust, they become interesting objects for the microscope. I shall confine my remarks more especially to these globular bodies. Some of these are as perfect in form as the most carefully turned billiard balls, and have a brilliant polish. The various colors which these globules exhibit give additional interest to their examination. Some are transparent crystal spheres, others are opaque white, many are yellow and brown, and variegated like polished agates or cornelian of different shades. The most abundant of the highly polished balls are black; there are others which look like rusty cannon-balls; some of these have an aperture in them like a bomb-shell, and many are perforated in all directions. To obtain these objects, the dust must be washed in a bowl, and all the lightest particles allowed to float away; the remainder consist of fragmentary crystalline and ferruginous substances; mixed with these are the polished balls described, which, under the microscope, by a brilliant reflected light, look like little gems. To separate the spherical bodies from the irregular ones, it is only necessary to sprinkle some of this material on an inclined glass plate, and by gentle vibration the balls roll down, and can thus be collected. Having satisfied ourselves with the examination under the microscope, it is natural that we should desire to know more about these novel objects. What is their elementary constitution? Why are they spherical? How do they get into the flue? I have not attempted a chemical analysis of these minute bodies, many of which are less than the 100th part of an inch in diameter. I can only, therefore, offer an opinion as to their probable constitution, judging from what is known of the chemical analysis of coal ash, and from the appearance they present under the microscope. Referring to the chemical analysis of coal ash, we find that it sometimes contains silica, magnesia, alumina, sesquioxide of iron, lime, soda, potash, sulphate of lime, anhydrous sulphuric acid, anhydrous phosphoric acid, sulphur, and sometimes traces of copper and lead. The vegetable origin of coal is now generally admitted, and, doubtless, some of the substances I have just named have been taken up by the coal plants, while other portions may have collected in the locality where the coal was formed. As this is not immediately connected with our present inquiry, I proceed to speculate as to the constitution of these globular bodies. The transparent spheres I imagine to be silicates of soda or potash; the opaque white are most likely silicates of soda or potash combined with lime and alumina; the yellow and brown are silicates colored by iron in different proportions. The black globes are not all alike in composition; some of these are silicates colored by carbon, others are iron balls coated externally with a silicate. Many of these rusty cannon-balls are probably ferrous oxide formed by the action of heat on the iron pyrites in the coal. There are also balls of black magnetic oxide; the perforated shells are probably ferrous sulphides. The globular form of these bodies suggests that they have been thrown off in scintillations, such as are seen during the combustion of iron in oxygen gas, and while in a fluid state they assume a spheroidal form. They are carried by the draught into the flue, and, being of greater specific gravity than the carbonaceous matter forming the smoke, they fall before the current of air has reached the chimney. Some of the dust has been a considerable time in the flue, exposed to the intensely heated circulating flame; the reducing action of this would probably convert some of the oxide into metallic iron. Many of these balls have the appearance of reduced oxides. The flue dust contains a larger amount of ferruginous matter than can be accounted for by the analysis of coal ash. I think the surplus may be regarded as representing the wear and tear of the iron work about the furnace, such as fire-bars, boiler-plates, etc. The brick-work and cement about the boiler and flues may also supply some of the silica, alumina, and iron for these balls, numbers of which are merely thin shells. The movements of these objects, caused by the approach of a magnet under the stage of the microscope, are somewhat amusing, and it is at times startling to see the crystalline objects, both spherical and irregular, exhibit magnetic attraction; probably they contain particles of iron imbedded in them; if they do not, may we not imagine that there is some magnetic compound in which the crystalline matter predominates? When we consider the accidental condition under which this matter has combined, it is just possible that some new molecular arrangement or combination of elements may have taken place. It is very probable that many of these polished balls are much more complex in their elementary constitution than I have stated. They are, in fact, a kind of glass, and many of them merely bulbs. Pelouze states that glass is probably an indefinite mixture of definite silicates. Glass, containing small quantities of ferrous oxides and sodic sulphates, when exposed to sunlight, becomes yellow, and possibly some of these balls may have changed in color since they came from the flue. Hydrochloric and nitric acid exert very little action on the ferruginous globes; this may be due in some measure to the high temperature at which the oxides have been formed; in other cases they are no doubt protected by an external coating of some silicate. It would require much time and patience to collect a sufficient number of each kind of these minute objects for a chemical analysis; but the spectroscope might probably assist in revealing their constitution. — *J. B. Dancer.*

THE TAR ACIDS — CARBOLIC AND CRESYLIC ACIDS.

Mr. William Crookes, F.R.S., who was appointed by Her Britannic Majesty's commissioners, charged with investigating the history, nature, and remedy of the cattle plague that has recently caused such havoc among the herds of England, to make a thorough examination of the disease, furnished to the commissioners a valuable report, from which the following is an extract: —

"These two bodies are so commonly known under the name of acids, that I shall continue so to designate them, although by chemists they are more generally classed with the alcohols. They have great similarity, and only within the last few months have they been met with separately in commerce, having hitherto been both called carbolic acid. Creosote, prepared from coal tar, was thought to be impure carbolic acid, until 1854, when Professor Williamson and Mr. Fairlie, in an investigation of it, discovered that it was a mixture of carbolic and cresylic acids. It was then taken for granted that Reichenbach's creosote, from wood tar, had a similar composition, until Hlasiwetz, in 1858, showed that this creosote was a different body from carbolic or cresylic acids. Finally, Dr. Hugo Miller, in 1866, discovered that true creosote and its analogue guaiacol belonged to a different class of bodies, and consisted of methyl-oxy-phenic and methyl-oxy-cresylic acids.

"Pure carbolic acid is a white crystalline solid, melting at 34° C., and distilled at 180° C.; a trace of water or oily impurity renders it liquid, and for disinfecting purposes it is always supplied in this form, to avoid the extra expense and trouble needed for the separation of the last traces of impurity. Cresylic acid is liquid, boils at 203° C., and closely resembles carbolic acid in odor and other properties. Before the commencement of these inquiries, it was thought to be of little or no value as a disinfectant, but Dr. Angus Smith has lately shown that it rivals, if it does not surpass, carbolic acid in antiseptic properties. For the present purpose of cattle plague disinfection, it is immaterial which acid is used, and, to avoid unnecessary repetition, I shall use the term carbolic acid to express either acid, or the commercial mixture of the two acids.

"From time immemorial carbolic acid, creosote, or bodies containing them, have been used as antiseptics. Carbolic acid is the active agent in tar, which, either in its ordinary state, or burnt as a fumigator, has always held high rank among disinfectants. Pitch and tar were the most popular medicines in use against the cattle plague when it visited this island in the last century; the animals being preserved against contagion by having their noses and jaws rubbed with tar, whilst the cow-houses were disinfected by burning pitch and tar in them (in which process a certain quantity of the vapors of carbolic acid would escape combustion). The well-known efficacy of smoke in preserving meat is entirely due to the presence in it of this agent.

"Pitch oil, oil of tar, and similar products, owe their value entirely to carbolic acid. This body may in fact be called the active principle of tar, just as quinia is the active principle of bark, or morphia of opium, and it has the advantage of being easily prepared in any country where coal or wood can be obtained.

"Sulphurous acid probably owes some of its antiseptic value to its affinity for oxygen, whereby the oxidation of the matter under treatment is retarded. It has been suggested that the value of carbolic acid is due to a similar property, and that it acts merely by preventing oxidation. It being important to a thorough understanding of its action that this point should be settled, the following experiments were made: —

"I. Lumps of metallic sodium were cut with a sharp knife; the progress of the oxidation could be readily followed by the change of color of the surface. The experiment was tried several times in an atmosphere strongly charged with the vapor of pure carbolic acid and of cresylic acid; comparative experiments being made at the same time in pure air. No difference in the rate or amount of oxidation could be detected.

"II. A colorless solution of subchloride of copper in ammonia was prepared and divided into two parts; one being mixed with a little carbolic acid. On pouring them through the air into flat white dishes, no difference in the progress of the oxidation could be detected.

"III. A mixture of pyrogallic acid and solution of potash was shaken up in a large stoppered bottle. It was then opened under water, and the amount of absorption of the atmospheric oxygen noted. The same experiment was repeated after the addition of carbolic acid to the potash solution. The same quantities were used and the agitation continued for the same time. On again opening the bottle under water the absorption was found to be the same as before.

"IV. The last experiment was repeated, substituting crystals of sulphate of iron for pyrogallic acid. The result showed equally that the presence of carbolic acid exerted no retarding influence on the oxidation.

"V. Iron filings were shaken up in water with the same result.

"VI. A 'philosophical lamp' was made by arranging a platinum spiral over the wick of a spirit lamp, containing alcohol mixed with a little ether; on lighting, and then blowing it out, the platinum continued to glow brightly. Pieces of solid carbolic acid were then carefully placed in the cup of the brass wick-holder, surrounding, but not in contact with, the wick. The heat soon melted the acid and raised its vapor round the platinum spiral, but without occasioning any alteration in the brightness of its glow.

"VII. Lead pyrophorus was poured into two long and narrow jars of air, one of which had its interior moistened with liquid carbolic acid. Not the slightest appreciable difference could be detected between the rapidity of oxidation in the two jars.

"VIII. Paper moistened with sulphate of manganese solution, and dried, was dipped into caustic ammonia, both with and without carbolic acid. No difference whatever could be detected in the rate of its darkening.

"These experiments prove conclusively that the tar acids have no special power of retarding oxidation.

"Other experiments were then instituted in the endeavor to understand more clearly the mode of action of carbolic acid.

"IX. Some meat was hung up in the air till the odor of putrefaction was strong. It was then divided into two pieces; one was soaked for half an hour in chloride of lime solution, and was then washed and hung up again; the offensive smell had entirely gone. The other piece of meat was soaked in a solution of carbolic acid containing 1 per cent. of the acid; it was then dried and hung up.

The surface of the meat was whitened, its offensive odor was not removed, though it was masked by the carbolic acid. In two days' time the bad odor had quite gone, and was replaced by a pure but faint smell of carbolic acid. In a few weeks' time the pieces of meat were examined again. The one which had been deodorized with chloride of lime now smelt as offensively as it did at first, while the piece treated with carbolic acid had simply dried up, and had no offensive odor whatever. It was then hung up for another month and examined; no change had taken place.

"X. A piece of fresh meat was soaked in a 1 per cent. aqueous solution of carbolic acid for 1 hour; it was then wrapped in paper and hung up in a sitting-room in which there was a fire almost daily; at the end of 10 weeks it was examined. It had dried up to about one-fourth of its original size, but looked and smelt perfectly good and fresh, a very faint odor of carbolic acid being all that was perceptible. It was soaked for 24 hours in water, and then stewed with appropriate condiments and eaten; it was perfectly sweet, and scarcely distinguishable from fresh meat, except by possessing a very faint flavor of carbolic acid, not strong enough to be unpleasant.

"XI. Animal membranes in forms of gut, skin, and bladder, were perfectly preserved if immersed direct in aqueous solution containing 1 per cent. of carbolic acid; but if previously moistened with water, and then immersed in dilute carbolic acid, the preservation of the skins was not so complete.

"XII. Animal size and glue, mixed, in the form of solution, with small quantities of carbolic acid, were perfectly preserved from change even in hot weather.

"These are important questions. They point out in a striking manner the difference between mere deodorizers and antiseptics. Hitherto attention has been almost entirely confined to the deodorization of gases arising from putrescence. The effect has been combated, whilst the removal of the cause has received scarcely any attention. Chloride of lime, one of the strongest of the class of deodorizers, acts, as has been shown, only on the gases of existing putrefaction, but it has no influence over the future. Carbolic acid, on the other hand, has scarcely any action on fetid gases; but it attacks the cause which produces them, and, at the same time, puts the organic matter in such a state that it never reacquires its tendency to putrefy."

ON FRUIT ESSENCES.

The products known under the name of fruit essences are alcoholic solutions of different ethers, to which is sometimes added certain acids, or certain natural essences. Glycerine is found in all; it appears to blend the different odors, and to harmonize them. It is necessary to state, that the alcohol used, as well as all the other substances, must be chemically pure.

Each column represents in cubic centimetres the quantity to be added to 100 cubic centimetres of alcohol.

Names of the Essences.	Chloroform.	Nitric Ether.	Aldehyde.	Acetate of Ethyl.	Formiate of Ethyl.	Butyrate of Ethyl.	Valerianate of Ethyl.	Benzoate of Ethyl.	Œnanthylate of Ethyl.	Essence of Persicot.	Sebacic Ether.	Salicylate of Methyl.	Amylic Alcohol.	Acetate of Amyl.	Butyrate of Amyl.	Valerianate of Amyl.	Essence of Lemon.	Essence of Orange.	Alcoholic Solutions saturat. in the cold of				Glycerine.
																			Tartaric Acid.	Oxalic Acid.	Succinic Acid.	Benzoic Acid.	
Pine-Apple	1	..	1	..	..	5	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	3
Melon	..	..	2	..	1	4	5	..	..	..	10	..	..	..	..	..	..	..	..	..	..	..	3
Strawberry	..	1	..	5	1	5	..	..	..	..	..	1	..	3	2	..	..	..	..	..	..	..	2
Raspberry	..	1	1	5	1	1	..	1	1	..	1	1	..	1	1	..	..	..	5	..	1	..	4
Gooseberry	..	..	1	5	..	..	..	1	1	..	..	..	..	..	..	..	..	..	5	..	1	1	..
Grape	2	..	2	..	2	..	..	..	10	..	..	1	..	..	..	..	..	..	5	..	3	..	10
Apple	1	1	2	1	..	..	..	..	..	..	..	..	..	..	..	10	..	..	..	1	..	..	4
Orange	2	..	2	5	1	1	..	1	..	..	..	1	..	10	..	..	..	10	1	..	..	..	10
Pear	..	..	..	5	..	..	..	..	..	..	..	..	..	10	..	..	..	..	..	..	..	..	10
Lemon	1	1	2	10	..	..	..	..	..	..	..	..	..	..	..	10	..	..	10	..	1	..	5
Black Cherry	..	..	..	10	..	..	..	5	2	..	..	..	..	..	..	..	..	..	..	1	..	2	..
Cherry	..	..	..	5	..	..	..	5	1	..	..	..	..	..	..	..	..	..	..	..	..	1	3
Plum	..	..	5	5	1	2	.	..	4	..	..	..	..	..	..	..	..	..	..	..	..	..	8
Apricot	1	..	..	..	..	10	5	..	1	..	..	2	..	..	1	..	..	..	..	1	..	..	4
Peach	..	..	2	5	5	5	5	..	5	..	1	2	..	..	..	..	..	..	..	..	..	..	5

—*Dingler's Polytech. Journal*, clxxx. p. 407.

ABSORPTION OF GASES BY SOLIDS.

Among the interesting observations of Mr. Graham, Master of the British Mint, upon the passage of liquids and gases through solids, is the fact that atmospheric air, by passing through India-rubber, becomes super-oxygenated, and will rekindle smouldering wood like pure oxygen. Any kind of light India-rubber receiver, in which a vacuum may be obtained, the size being sustained by mechanical means, will collect super-oxygenated air; the better if the India-rubber be thin and the temperature high. Mr. Graham makes the suggestion that the solid films pass gases through them by first condensing them to a liquid form within the substance, and then passing them off on the other side by evaporation. Hydrogen passes through red-hot platinum, while oxygen and nitrogen do not, or not in appreciable quantities; hence their compounds with hydrogen are readily dialysed by this method. The passage of carbonic acid, chlorine, hydrochloric acid, vapor of water, ammonia, coal gas, and hydro-sulphuric acid, is also inappreciable, while the hydrogen, in compounds containing it, passes. One volume of red-hot platinum absorbed 0.207 volume of hydrogen, retained it while cold, and gave it off on reheating. One volume of palladium absorbed 643 volumes of hydrogen, sensibly increasing its weight, and, when heated afterward, gave off the most of it in a continuous stream. On the other hand, osmium-iridium does not absorb hydrogen, and copper absorbs it very slightly. Gold absorbs hydrogen and nitrogen slightly. Silver absorbs 0.289 of its volume of hydrogen, and then presents a beautifully frosted appearance. Oxygen is taken up in the proportion of 0.745. Red-hot iron and steel pass hydrogen as readily as platinum does. — *Scientific American.*

WHAT IS CHARCOAL?

Mr. W. Skey, in the "Chemical News," denies that charcoal is merely impure carbon, and maintains that carbon in charcoal must exist, in part, at least, in chemical combination with the oxygen, hydrogen, and nitrogen, which the latter is known to contain, and which cling to it at high temperatures with a tenacity unknown in any compounds formed among themselves. He suggests, therefore, that charcoal is a carbonaceous compound, or more probably a series of such, comprising both acid and basic substances in equipoise, so as to form a neutral salt or salts. The remarkable absorbent capacity of charcoal, under this theory, would no longer be assumed as mechanical, but would be explained chemically. For if charcoal consist of carbonaceous salts, the constituents, acid or basic, will be as insoluble in water as the combination, and consequently their affinities will be feeble even for each other, and when other substances present themselves, possessing superior acid or basic properties, they will immediately attach themselves to these supposed constituents of the charcoal.

ACETYLENE.

This gaseous compound, the richest carburetted hydrogen known, contains 4 atoms of carbon for 2 atoms of hydrogen. Although this product exists always, but in small proportions, in common coal gas, still M. Berthelot asserts — and no doubt with truth — that its presence increases materially the brilliancy of common coal gas, owing to the large proportion of carbon it contains, and which, by floating in the flame, radiates light and thereby increases its brilliancy. This substance is characterized by giving, with a solution of protochloride of copper dissolved in ammonia, a beautiful coppery precipitate, which is highly explosive. Acetylene, also, when mixed with chlorine, and the mixture is exposed to the action of light, or to any flame containing chemical rays, such as those produced by the combustion of magnesium or sulphuret of carbon, gives rise to violent explosions, with the production of hydrochloric acid and a deposit of carbon. This fact will be a means of distinguishing this substance from another one, which is the chief illuminating constituent of coal gas, and called ethylene, or heavy carburetted hydrogen. Acetylene does not exist merely in coal gas; M. Berthelot has proved it to exist in a great number of instances, and to be a constant product of the slow combustion of most organic substances.

Further, this substance offers a peculiar interest, for it is the first ever produced by chemists by the direct union of carbon and hydrogen. Up to the time of this discovery, chemists were acquainted with a great number of carburetted hydrogens, either obtained naturally from the organic kingdom, — such, for example, as otto of roses, the essences of lemon, bergamot, cloves, neroli, and the solid substances called caoutchouc, gutta-percha, as well as a great number of others obtained through the destructive distillation of organic matters, as well as coals, — such as ethylene, amylene, propylene, etc. M. Berthelot obtained acetylene by passing through a glass globe a slow current of hydrogen gas, in which globe there were the two carbon points of an electrical battery in a state of incandescence, producing what is usually called the electrical light. Under this intense heat and electrical current the hydrogen introduced by him combined with the carbon of the points, and produced acetylene, which he collected by passing it through an ammoniacal solution of protochloride of copper, getting a coppery precipitate, or acetylide of copper, from which he easily isolated acetylene, thus proving to the chemical world the possibility of the artificial production of a carburetted hydrogen.

This discovery, which astonished the scientific world, was soon followed up by a series of facts most interesting to relate. M. Berthelot placed in a small flask, to which was attached a tube to give exit to any gas which might escape, some acetylide of copper, together with zinc and ammonia, and on heat being applied a chemical reaction ensued by which two atoms of hydrogen were added to acetylene, converting it into ethylene or heavy carburetted hydrogen, also called olefiant gas.

This, though existing in large quantities in common coal gas, cannot be isolated, owing to the numerous compounds with which it is mixed. Therefore it is necessary to adopt some chemical reaction to produce it in a pure state. To attain this end, 1 part of alcohol is mixed with 3 parts of vitriol or sulphuric acid, and on heat being applied each chemical equivalent of alcohol loses 2 equivalents of water; the remaining element of that alcohol, being olefiant gas, is liberated, and can be examined. What gives interest to this chemical reaction is, that whilst you thus unfold, under the influence of heat, alcohol into olefiant gas and water, you can, if we follow M. Berthelot's process, — namely, of placing at the bottom of a large glass globe a small quantity of concentrated sulphuric acid, and then fill the capacity of the large glass globe with olefiant gas, and keep the same in a constant state of agitation, — you will, after having imparted to the vessel some 40,000 or 50,000 rotatory motions, find that the olefiant gas has been absorbed by the vitriol; that it will have fixed two equivalents of water, and that it will have thus converted the olefiant gas into alcohol, which can be isolated by subsequent chemical manipulations. Therefore from carbon and hydrogen you will notice that we first produced acetylene, and this substance we have converted into olefiant gas, and which in its turn has been transformed into alcohol, which alcohol you can easily convert into ordinary ether, or into acetic ether, spirit of nitre, or nitric ether, etc.; or you can also by oxidizing convert it into a substance called aldehyde. To convert alcohol into ether, all you have to do is to remove from alcohol one chemical proportion of water, and the elements which remain — namely, one of olefiant gas and one of water — constitute ether.

From carbon and hydrogen mineral elements a great number of organic substances can be produced. In fact, from acetylene the following series of compounds have been obtained: —

Acetylene can be transformed into			(C_4H_2)
Ethylene	"	"	(C_4H_4)
into			
Aldehyde	"	"	($C_4H_4O_2$)
into			
Acetic acid	"	"	($C_4H_4O_4$)
into			
Glycolic acid	"	"	($C_4H_4O_6$)
into			
Oxyglycolic acid		"	($C_4H_4O_8$)
into			
Oxalic	"	"	($C_4H_2O_8$)

— *Lecture by Dr. Grace Calvert.*

PRESERVATION OF SULPHURETTED HYDROGEN SOLUTION.

At the last meeting of the Pharmaceutical Society of Paris, M. Lepage, of Gisors, brought forward a process which he has adopted for preserving solutions of sulphuretted hydrogen. All chemists know that this useful reagent cannot be preserved long in aqueous solution. The author has adopted for some years an artifice which enables sulphuretted hydrogen solution to be kept for 12 or 15 months with scarcely any loss of strength. Instead of using water, he saturates a mixture of equal parts of pure glycerine and water with sulphuretted hydrogen gas, and uses it in the ordinary manner. None of the reactions are interfered with in the least, whilst the solution possesses almost perfect stability. The dilute glycerine dissolves less gas than distilled water will; representing the solubility in the latter liquid by 100, that in the former will be 60.

Glycerine likewise prevents solution of sulphide of ammonium from becoming colored, and M. Lepage believes that it has a similar action on the sulphides of potassium and sodium. — *Chemical News.*

ORIGIN OF PETROLEUM.

M. Berthelot regards petroleum as the result of purely mineral reactions. Believing, with Daubrée, that the alkaline metals exist in a free state in the interior of the globe, he shows that by the action of these on carbonic acid and earthy carbonates, at a high temperature, acetylides of the alkalies are produced; these coming in contact with the vapor of water, acetylene would be set free. But as hydrogen and steam must also be present, and at a very high temperature, the acetylene cannot subsist, and in its place we find the products of its condensation, and also the products of the reaction of hydrogen upon it. For example, hydrogen, reacting upon acetylene, forms ethylene and hydride of ethylene; a new reaction of hydrogen will form hydrocarbons of the marsh gas series, the same which constitute American petroleum. An almost unlimited diversity in these reactions is possible; and it would seem that all that is necessary for the formation of the natural carbides of hydrogen is the intervention of heat, water, alkaline metals, and carbonic acid. — *Ann. de Chimie et Physique.*

ON THE IGNITING-POINT OF PETROLEUM. BY DR. JOHN ATTFIELD.

It is now well known that petroleum, as it issues from the earth, and as met with in commerce in the crude state, emits a vapor of powerful odor, which is inflammable, and which, consequently, when mingled with air in certain proportions, forms an explosive mixture. The combustible properties of this vapor closely resemble those of common coal-gas. As with coal-gas, so with petroleum vapor, — a small quantity in a large quantity of air gives odor to the air, but does not form an explosive mixture. Again, coal-gas, as supplied to the consumer, always contains a small percentage of air, and yet the mixture is not explosive; so petroleum vapor, even though containing a small quantity of air, burns very well as a jet (so long as the petroleum which supplies the vapor is kept boiling), but the vapor itself is not explosive. In short, petroleum itself, or petroleum vapor itself, is no more inflammable than common air; it is the *mixture* of petroleum vapor and air that is dangerous. It is almost as easy to show that a jet of air will burn in an atmosphere of petroleum vapor as it is to show that a jet of petroleum vapor will burn in an atmosphere of air.

Now, crude petroleum generally gives off, at common temperatures, quite enough vapor to form an explosive mixture with air, if the air be in a confined space, as in a partially empty lamp, bottle, or cask. For this, among other reasons, crude petroleum is always refined before it is sold to the general public; it is distilled, and the portion which first rises into vapor is collected apart, and, under the name of petroleum spirit, used as a substitute for turpentine. The next and larger portion which distils is the refined petroleum, so extensively sold under various names as a cheap illuminating oil. The residue is heavy oil used for lubricating purposes.

Refined petroleum still has the characteristic odor of petroleum. Even at the coldest temperatures it emits sufficient vapor to be most obviously perceptible to the nose, but not sufficient to form with the air in the vicinity of the oil an explosive mixture. But as we rise to the warmth of summer, or of a hot room, or to the still higher temperature in the neighborhood of a lighted lamp, a point may be reached at which the oil emits vapor at such a rate that before it can diffuse away into the air of the apartment, explosive proportions are arrived at, and, on a flame being brought into contact with the mixture, explosion results. Now this point, the point to which the petroleum must be raised in temperature before its vapor is emitted rapidly enough to form an explosive mixture with the air in the vicinity, will of course vary according to the quality of the petroleum, will vary with the proportion of "spirit" removed by the refiner. If enough has been boiled off, the oil is perfectly safe; but, unfortunately, it is not to the interest of all parties to remove the spirit; hence much of the petroleum sold in retail shops is dangerous to use. Should a lamp fed with it become a little warmer than usual, an explosive mixture forms in the chamber of the lamp, and any flame brought accidentally or thoughtlessly into contact with the mixture, gives rise to explosion. Hence the legislature of this country has wisely ordered that large quantities of crude petroleum shall not be stored within fifty yards of a dwelling-house or warehouse except under license; and the act states that "Petroleum shall include any product thereof that gives off an inflammable vapor at a temperature of less than 100° of Fahrenheit's thermometer." That is to say, refined petroleum, such as is commonly vended in retail shops as "Crystal Oil," "Photogen," "American Paraffine Oil," etc., etc., for illuminating purposes, must not be kept in or near a house in larger quantities than 40 gallons, unless proof is forthcoming that it does not give off inflammable vapor below 100° F. If it will stand this test, then the liquid is not petroleum within the meaning of the act, and the owner of it runs no risk.

The ordinary methods of ascertaining the point of ignition are uncertain, and therefore not safe. The time employed in the operation of taking the point, as usually practised, is the first cause of variation. That is to say, if the petroleum be rapidly raised in temperature, it will explode at a lower heat than if it be raised slowly. The rate of escape of vapor, as produced by agitation, will also promote explosion, because more is given off in a given time than when the fluid is quiet. The shape of the vessel also makes a difference. Thus in a bottle the explosion will take place, other things being equal, at a lower temperature than in an open dish. The arrangement of the vessel over the source of heat makes a difference; the distance of the test-flame from the petroleum, and the amount of petroleum operated on.

These, then, are causes, amply sufficient in number and nature, of the variation in the igniting-point of petroleum, as observed by different experimenters, or by the same experimenter at different times. They fully explain the fact that I have found a specimen of petroleum to ignite at almost any degree between 78° F. and 124° F. Before proceeding to suggest a modified method of observation which shall give constant results, it may be instructive to give a table of the igniting-points of several specimens of refined petroleum recently circulating in wholesale and retail commerce, the experiment on each specimen being taken under three conditions: — first, heating in an open earthenware bowl; second, heating in a two-ounce, wide-mouth, white glass phial, without shaking the petroleum; and third, as the second, except that before introducing the test-flame the stopper was inserted in the bottle, and the whole well shaken for three or four seconds. It will be noticed that differences of igniting-point in any one specimen are obtained, varying from 10° to 30°. The table shows that, as much of it "gives off an inflammable vapor at a temperature of less than 100° of Fahrenheit's thermometer," the law has not yet had the effect anticipated, namely, the exclusion from retail trade of that quality of petroleum which is so badly refined as to have dangerous, because unsuspected, properties.

TABLE OF GRAVITIES AND IGNITING-POINTS OF COMMERCIAL PETROLEUM.

Name, Brand, or Distinctive Mark.	Specific Gravity (Water=1000).	Igniting-point of vapor in degrees Fahrenheit.		
		In open bowl.	In bottle.	
			Without agitation.	With violent agitation.
"Woodville,"	796	80	76	70
A.	797	98	83	78
"Standard,"	798	96	95	85
"Cayuga,"	798	81	80	70
B.	799	101	87	71
"Denmark,"	799	94	86	85
"Hutchinson,"	800	90	86	84
"Lucifer,"	801	91	81	78
"American Paraffine Oil,"	801	92	80	68
"Commercial,"	803	104	81	79
"American Petroleum,"				
" " No. 1,	804	134	134	111
" " No. 2,	805	93	90	74
" " No. 3,	806	83	76	66
"Common Paraffine Oil,	806	105	90	83

And now with regard to a method of taking the igniting-point of petroleum vapor, which shall be reliable and constant in the results of its application.

As petroleum is not a definite chemical compound, but a varying mixture of several hydrocarbons; as, in short, it has no constant chemical or physical property of which advantage might be taken in devising a ready method of taking igniting-points, it follows that the method selected must be more or less arbitrary, empirical, conventional.

The only feasible plan would seem to be, to select a direct method, simple in principle, easy of execution, occupying little time in performance, and inexpensive; and, when this is found, to take steps for accomplishing a far more difficult task, namely, securing its universal adoption. Now the ignition method is sufficiently simple in principle; but from the foregoing, and many other experiments, I would advise the rejection of its application in an open dish, saucer, basin, or bowl. Even if this experiment could be always similarly performed under constant conditions, which is impossible, the rapidity with which vapor escapes from the surface of the liquid renders a thermometric reading, taken under the experiment, an unfair indication of the temperature at which inflammable vapor would be given off from the petroleum in a lamp or other closed or partially closed vessel. Of course experiments made without a thermometer are not sufficiently delicate for the purposes of the analyst. Again, the petroleum must not be heated in a common bottle, on account of the great liability of the latter to fracture; nor is it necessary to use a vessel contrived for violently agitating the oil and air together. But if the bottle be substituted by a short, wide tube of glass, thin, so that it can be heated with safety, — by, in short, a rather wide variety of the common test-tube of our analytical laboratories, — then, if equal quantities of petroleum be operated on, the liquid be well stirred and shaken, and the test-flame be always introduced to the same distance from the surface of the liquid, constant results may be expected. The same tube may be used in which to insert a hydrometer to take the specific gravity of the oil; and thus, with a naked thermometer somewhat longer than the test-tube to act also as a stirring-rod, we have a compact and inexpensive apparatus.

I will conclude by giving detailed directions by which to take both the igniting-point and specific gravity of a specimen of petroleum or paraffine oil. Into a test-tube of thin glass 6 or 6½ inches long, and 1⅛ inches in diameter, pour the liquid until the tube is half full. Stir the liquid well with a naked thermometer, having the usual degrees marked on the stem, shaking also so as to keep the upper part of the tube well wetted with the liquid, and note the temperature. Now introduce a flame (of a thin splint of wood, or, far better, a small gas flame a quarter or an eighth of an inch long) into the mouth of the tube to within half an inch of the surface of the liquid, quickly withdrawing it, and noticing whether a thin blue flame runs between the test-flame and the surface of the oil. If not, warm the tube by passing the bottom of it gently through a spirit-lamp, or other flame, or by dipping the lower portion of the tube into hot water, constantly stirring the liquid with the thermometer, frequently noting the temperature, and introducing the test-flame every minute or so. The temperature at which the thin blue flame appears will be the igniting-point of the petroleum, the point at which it gives off inflammable vapor. To correct this result, let the tube gradually cool, introducing the test-flame as before. The lowest temperature at which the vapor takes fire is the true igniting-point. To ascertain the specific gravity, pour the petroleum or paraffine oil into the test-tube until the latter is about three-fourths full; insert a thermometer, and warm or cool until the temperature is about 60°; * now immerse the hydrometer, and take care that it fairly floats in the liquid; the point on the stem of the hydrometer cut by the under surface of the liquid will be the specific gravity.

This particular hydrometer might be termed a *petroleometer*.

* Five degrees of temperature make about one degree difference of specific gravity. At 70° F. an oil will be about two degrees lighter in specific gravity than at 60° F., and at 50° F. two degrees heavier.

The most accurate method of taking specific gravities is of course the specific gravity bottle; but a hydrometer, if well made, gives, I find, numbers varying not more than 1° from those of the bottle, while its use involves far less trouble and expense.

As an indication of the extent to which confidence can be placed in an igniting-point of petroleum, taken in the manner recommended, I may state that two different observers, experimenting at different times on three different specimens of petroleum placed before them without distinguishing marks, gave igniting-points in which the greatest limit of variation was 1°. It would doubtless be easy for an analyst, by processes of fractional distillation, to obtain, even from safe petroleum, vapor that would be inflammable at 60° F., or even at freezing temperatures; but it would be absurd to regard such petroleum as dangerous, or to use such a fact as evidence of the weakness of any method of determining the igniting-point of refined petroleum. What I claim for the method above described is, that it accurately shows the temperature at which petroleum, as used by the public, is dangerous. It surely is not too much to expect that the method will be adopted by the trade, and that no mineral oil will be supplied to the public unless guaranteed to give off no inflammable vapor below 100° of Fahrenheit's thermometer. Only by some such means will explosions in lamps, etc., be avoided,— explosions which are always alarming, frequently the cause of loss of property by fire, and occasionally resulting even in loss of life. — *Pharm. Jour. and Trans.*

NEW PROPERTIES OF ALUMINIUM.

At a recent meeting of the Lyceum of Natural History, Dr. Henry Wurtz read a paper upon "Some new Properties of Aluminium, with the discovery of a new allotropic modification of this metal." Dr. Wurtz is the discoverer of the use of sodium amalgam in the working of gold and silver ores, and in the development of his process has had occasion to manufacture large quantities of amalgam, with which he has tried numerous experiments upon metals.

The behavior of aluminium toward sodium amalgam revealed to him certain new and surprising properties of the first-named metal. In order to understand the nature of the discovery, it is necessary to say a few words about the metal aluminium. Professor Wöhler, of Göttingen, first prepared aluminium as a gray powder in 1827. He gave its specific gravity as 2.5, and stated that it decomposed water, but afterwards remarked that the metal in solid form did not possess this property.

The difficulty of preparing aluminium prevented the application of the metals in the arts, until Deville improved the methods of its manufacture and reduced its price to 10 or 12 dollars a pound, when it suddenly assumed great importance and attracted universal attention.

Aluminium is a bluish white metal, malleable, ductile, a remarkable conductor of electricity, fusing at nearly the same temperature as zinc. Although it is with extreme difficulty that we can separate aluminium from oxygen, yet when the metal is once prepared, it exhibits no disposition to reunite with that element. It does not decompose water, and does not readily tarnish in the air. It will not form an amalgam with mercury, but is converted by mercury into a modified condition, in which it oxidizes with so much violence as to glow and burn the hand. Dr. Wurtz showed that, contrary to common belief, aluminium absorbs pure quicksilver with avidity, just as lead will absorb it, and a piece of rolled aluminium sheet rubbed with mercury is split into its component laminæ. The internal surfaces of aluminium thus enfilmed with quicksilver possess properties altogether different from the usually passive metal. On exposure to the air, they at once take fire spontaneously, and burn with evolution of heat. A coating of hydrate of alumina appears on the surface of the foil in a bulky, feathery mass, with a growth so rapid as to be visible to the naked eye. Aluminium foil, which, in its ordinary condition, will not oxidize in the air, when rubbed with mercury is converted into an active metal, and seizes oxygen so rapidly as to take fire and burn spontaneously.

The author of this important discovery founds upon it a new theory of aluminium. He considers ordinarily aluminium to be in an electro-negative or passive state, like what is known as passive iron, and that quicksilver induces an electro-positive or active state, in which latter condition it resembles sodium or potassium. His experiment showed that no amalgam of aluminium is formed, but that the quicksilver is merely absorbed beneath the outer crust of the metal, and this phenomenon he believes to be analogous to the celebrated lead-syphon experiment of Professor Henry, in which quicksilver was slowly conducted through the pores of the lead, bent in the form of a syphon, as water would be conducted through a syphon tube.

Dr. Wurtz's deductions from his new theory are of great interest and importance. He holds out the idea that we may confidently hope to obtain iron in a passive form, — a discovery the importance of which in all departments of the arts can scarcely be exaggerated. Iron in this state would not corrode or rust, and could be applied to many purposes for which it is not now available. We may also some day obtain sodium and potassium in a passive state, so as to handle and expose them just as we now do aluminium. If a metal can be converted from a passive to an active state, why not from the active to the passive?

The interesting discovery of Dr. Wurtz opens the door to an extensive field of research, and will attract the attention of scientific men everywhere. — *New York Post.*

WHOLESOME WATER.

The exercise of common sense in the investigation of the conditions to which water has been exposed, aided by the results of analysis, and some knowledge of physiological investigations and the laws of nature, will lead to the following conclusions with reference to this matter: —

1. All water that has received drainage containing animal and vegetable matter in a state of putrefactive decomposition, and especially excrementitious matter, either is or is liable to be in a state unfit for use as drinking water, and the chemist cannot determine by analysis whether the dangerous state exists or not.

2. All rivers necessarily receive drainage, and they are generally contaminated with sewage and other decomposing organic matter, which may render the use of such water injurious to health.

3. Shallow wells situated in large towns are subject to pollution from infiltration, from leakage of sewers, and other similar causes; and as these waters are stagnant, the organic matter present, if it has not passed, is liable to assume, its most dangerous conditions.

4. Spring-water, when favorably situated, is free from suspicion of its containing organic impurity that could prove injurious to health.

5. Rain-water, if properly collected and stored, is the best and safest water to use for domestic purposes, and especially for drinking.

6. In the absence of rain-water or good spring-water, the best and most palatable water should be selected from other sources, choosing that which is most free from organic matter, and which has been least exposed to sewage contamination. In order to guard as far as possible against the influence of living germs, by which it is supposed that disease may be propagated, it is recommended on the highest authority that when water to which a suspicion attaches is used for drinking purposes, it should be previously boiled, the heat of boiling water being destructive to the vitality of such germs. A supply sufficient for the day should be daily submitted to the boiling temperature, and this, after it has cooled, may be rendered more palatable by the addition of a little syrup of lemon, or even a few drops of diluted sulphuric acid. —*London Journal of Pharmacy.*

Whatever be the nature and quantity of the earthy substances held in suspension in turbid water, it becomes fit to drink in from 7 to 15 minutes if to each litre there be added .04 grammes of finely powdered alum, care being taken to agitate the liquid when the alum is introduced (this is about three-fourths of a pound per ton of water). If potash alum is used, the alum is decomposed into sulphate of potash, which is all dissolved by the water, and sulphate of alumina, which, by its decomposition, purifies the water. The alumina separates in an insoluble form, and carries down with it, as it precipitates, the matters which render the water troubled, and the organic matter. The acid attacks the alkaline and earthy carbonates, and transforms them into sulphates. The water becomes slightly richer in bicarbonates and free carbonic acid, whilst all organic matter is destroyed. 7 parts of sulphate of alumina will purify as much water as 10 parts of rock alum or potash alum, and the sulphate of alumina does not introduce any alkaline sulphate into the clarified water. — *Technologiste.*

CARAMEL COLORS.

In London caramel is made by roasting sugar of coarse description in cylinders similar to those used for roasting coffee, chiccory, and cocoa; this yields a very inferior preparation both for coloring as well as for admixture with coffee. So prepared it contains assamar and other pyrogenetic products which are very bitter. On the continent apples of inferior description are treated as described, yielding a product superior to that obtained from sugar. Sugar, however, is the only fit material to prepare caramel, and for this purpose the sugar is best heated in capacious, roomy vessels made of copper (in Vienna copper lined with silver is preferred), the vessel containing the sugar being placed in an oil bath containing a thermometer to indicate the temperature. The latter must not be below 410° nor above 428° F. The heating of the sugar is continued as long as aqueous vapors are given off. The crude caramel so obtained is best purified by being placed upon a parchment paper dialyser, which is placed on water. The undecomposed sugar and intermediate compounds are thus got rid of; they dissolve out with facility, and what remains on the filter is, weight for weight, five times as strong in coloring matter as the crude caramel. While the sugar is being exposed to heat it is preferable to stir it with a spatula.

Another mode of obtaining pure caramel, free from bitter produce (assamar and the like), is to heat the sugar as above, and to treat the powdered caramel with alcohol (pure methylated spirits), to digest it for 3 to 4 hours therewith, and repeat this till all bitter taste is gone. An aqueous solution containing 10 per cent. of purified caramel is gummy, and forms a jelly. When a solution of caramel in water is evaporated *in vacuo* (small vacuum pan as used in sugar refineries), it dries up to a black shining mass, freely soluble again in water, hot or cold; but if the solution is evaporated on a water-bath to dryness in contact with air, the whole mass becomes insoluble in water either hot or cold.

A very small proportion of caramel gives to a large bulk of water the dark-brown tinge known as sepia. An impure but pretty strong solution of crude caramel (that is, not purified by dialysis or alcohol — hence the term impure for the solution) is sold in London under the name of coffeena in small bottles at 1s. per bottle, to be had in many oil and color shops in the metropolis; it is used in teaspoonfuls to improve coffee, dispensing with chiccory. Treacle is not very manageable to use for the making of caramel. The sugars should be first dried at 212° F. On the continent dry glucose is sometimes used instead of cane or beetroot sugar for the purpose of making caramel. — *Chemical News*.

NEW CHEMICAL TOY.

"Pharaoh's serpents" and "Vesuvian tea" have paved the way for the reception of a new Chinese wonder in the shape of "ferns growing out of burning paper." This is a neat little experiment, free from many of the disadvantages appertaining both to the

"Devil's-tears" and the lozenge-shaped crystals of bichromate of ammonia, which may chance to prove too inviting to children's tastes. The instructions direct us to crimp or fold the yellow papers backward and forward, so that when opened out they may be supported upright in a zigzag form. One of these slips is then placed upright on a plate, and ignited in two or three places along the upper edge, but without being allowed to blaze. It will burn slowly down with a red glow, diffusing an agreeable perfume, while the ash of the paper assumes the most fantastic arborescent shapes, together with a green color, which, to a lively imagination, may be suggestive of the growth of ferns or lichens. We had no difficulty in imitating this effect by saturating thin cartridge paper, in the first instance, with an alcoholic solution of gum benzoin, and, when dry, applying an aqueous solution of the bichromate of ammonia. The decomposition of the latter substance by heat, in contact with burning paper, affords an explanation of the phenomena observed. — *Chemical News.*

CRYSTALLIZATION OF RED PHOSPHORUS.

M. Blondlot has succeeded in crystallizing red phosphorus, which has hitherto been considered amorphous, by sublimation in an atmosphere of nitrogen. He introduces about 2 grammes into a small matrass, and then closes the neck hermetically by fusion, which can be done without igniting the phosphorus, provided the matrass be held vertically. Allowing the apparatus to stand, it fills with white vapors, luminous in the dark, which are due to the oxidation of the phosphorus, and in 24 hours all the air is absorbed. The phosphorus may then be melted in a water-bath, while the upper part of the matrass is protected from the heat. The phosphorus is deposited in transparent crystals of a cubical form, which, in a few days, form magnificent arborescences, and shine with the lustre and color of the diamond. This state may be preserved by avoiding the light, but by the sunlight, or even by diffused light, they pass to a brilliant garnet-red color, and resemble rubies. A crop of colorless crystals may be got upon the surface of these. — *Journal of the Franklin Institute.*

THE CRYSTALLIZATION OF GLYCERINE. — BY WM. CROOKES, F.R.S.

My attention has been drawn to the hitherto unobserved fact of the crystallization of large masses of glycerine during the recent cold weather.

About 5 tons of glycerine, in casks of 8 cwt. each, were recently imported from Germany. When they left the factory the contents were in their usual state of viscid fluidity; but, on arriving in London, they were found to have solidified to a solid mass of crystals, so hard that it required a hammer and chisel to break it up.

A large block of this solid glycerine, weighing several hundred weight, suspended in a somewhat warm room, took two or three days to liquefy, and a thermometer inserted in the fusing mass indicated a constant temperature of 45° F. In small quantities the crystals rapidly fuse when the bottle containing them is placed in warm water. The original glycerine was pale brown; the crystals formed from it are nearly white, whilst the liquid which drains away from it is dark brown. In quantity, the solid glycerine looks very like a mass of sugar candy. The isolated crystals are sometimes as large as a small pea; they are brilliant and highly refracting; when rubbed between the fingers they are very hard, and they grate between the teeth. Their form appears to be octahedral, but this is difficult to ascertain accurately, owing to the viscidity of the mother liquid which adheres to them.

The crystals, separated as much as possible from the mother liquor, and then fused by heat, form a clear and nearly colorless liquid, slightly more viscid than usual, which, as far as I have been able to ascertain, possesses all the physical and chemical properties of pure glycerine. It is perfectly miscible with water and alcohol. It has been especially tested for sugar and glucose (common adulterants) with negative results; lead is also absent, and nitrate of silver only produces slight turbidity in its aqueous solution. I believe it to be almost chemically pure anhydrous glycerine.

Some of the fused crystals have been exposed for several hours to a temperature of 0° F. without solidification taking place. The only result was that the liquid became more viscid.

The cause of the crystallization is not very clear. The most probable explanation is that the vibration of the railway journey across Germany, added to the intense cold to which the glycerine was simultaneously subjected, enabled the particles to arrange themselves in a regular form. The phenomenon then becomes analogous to the crystallization of wrought iron under the influence of vibration, the gradual solidification of syrupy solutions of organic alkaloids, and the familiar crystallization of refractory platinum salts in a watch-glass by judicious friction with a stirring rod. Experiments are about to be tried to see if the crystallization of glycerine can be determined by exposing it to a low temperature, and at the same time setting the particles in a state of vibration.

Should the above view of the cause of this curious phenomenon be correct, we may imagine that, during the railway transit, the vibratory movement was determining at the same time the crystallization of the glycerine and the railway axles, the rapidity of the action being in the inverse ratio of the viscidity of the two bodies. — *Chemical News.*

NEW REAGENT FOR GLUCOSE.—BY L. B. FRANCQUI AND L VANDE VYVERE.

After noticing the several reagents used, and pointing out their special inconveniences, the authors propose a solution containing oxide of bismuth as being free from these defects. "We have found," they say, "that hydrate of bismuth dissolves in caustic potash, under the influence of certain organic bodies, such as glucose, cane-sugar, dextrine, tartaric acid, etc." These solutions do not form a precipitate on boiling, except in the case of glucose.

Guided by these results, we are induced to recommend, for the detection of glucose in urine, the following process, which cannot give rise to any fallacy: —

Prepare the reagent by precipitating a solution of acid nitrate of bismuth by a great excess of caustic potash, and pour a solution, drop by drop, into the moderately heated solution until the precipitated hydrate of bismuth is completely redissolved.

To recognize a diabetic urine, heat a portion with the above solution.

After a few minutes' ebullition, the urine becomes brown, and metallic bismuth is then precipitated in the form of a black powder of crystalline appearance, adherent to the glass, if glucose is present.

We have satisfied ourselves that the principles contained in normal urine, such as urea and uric acid, do not precipitate the above reagent. Albumen only causes a brown color and a slight turbidity, which we consider to be due to the formation of sulphide of bismuth.

Sulphuretted urines also give a black precipitate in a solution of oxide of bismuth in potash and tartaric acid; but this reaction cannot be confounded with that caused by glucose.

It is, besides, easy to recognize and (if desired) to separate the albumen. Thus, on bringing to ebullition the urine of a person suffering from Bright's disease, the liquid becomes turbid, opalescent, and deposits coagulated albumen.

As to sulphides and sulphuretted hydrogen, these are easily recognized by means of hydrate of lead, which these compounds darken. — *London Chemical News, from Gazette Médicale.*

ACTION OF SUNLIGHT UPON GLASS.

At a meeting of the Massachusetts Institute of Technology, early in 1867, Mr. Thomas Gaffield made a communication upon the action of sunlight upon glass, giving the results of his experiments, now extending over several years. He commenced his experiments, then original as to their method and extent, more than three years ago, and has prosecuted them to the present time. Isolated cases of change of color in window-glass had long been known, but they were attributed to some defect in the manufacture; his attention was directed to the subject by observing the change in glass of a very superior quality. He began by exposing several specimens of plate, crown, and sheet glass during the month of July, and he found that a month's exposure to the hot sun would change the best white French plate and white sheet glass to a more or less yellow color; the dark-green shades did not experience any change. Experiments for a longer period confirmed these results, the hue becoming darker, according to the time of exposure. That the color permeates the body of the glass, and is not confined to the surface, or produced by reflection therefrom, has been proved by grinding off about one-sixteenth of an inch from both surfaces, and the four edges of a duplicate exposed specimen, which, after repolishing, exhibited the same color. The glasses exposed were what are called colorless window-glasses, though varying in hue from the whitest French plate to the darkest green English sheet-glass. Long exposure of really colored glasses caused no change, except in the purple becoming darker; but it is possible that time would effect a change even in these, — a fact which he hoped to ascertain by examination of some of the old stained glass of European churches. Familiar examples of these colored window-glasses, of a pinkish hue, may be seen in many houses in Boston fronting the Common; in many windows several colors may be seen, according as each pane has been exposed for a longer or shorter time. Under our sunny skies, the change is much more rapid than in the more humid and less clear atmosphere of England.

He finds his first results confirmed by subsequent experiments, that almost all kinds of the glass above mentioned undergo this change from the influence of sunlight. The cause of this change has been referred to the presence of oxide of manganese, the oxide of iron, sulphur, etc. Some think there are not facts enough accumulated to decide the question of cause. It is most likely due to the presence of the oxide of manganese, which is used to give glass a white color; if the materials were perfect this substance would be unnecessary, and the change would not occur; thus we find that the glass made from the very pure Berkshire sand very seldom changes. No change is observed in lead glass, unless manganese is also present. This change must not be confounded with what is called "rust" in glass, which is a mere mechanical disintegration of the surface, from the washing out by the rain of the soda in the glass.

The phenomena illustrated by these experiments are very interesting; and he suggested that the examination by spectrum analysis might solve the problem as to the cause of the change of color.

In the "Comptes Rendus" for Jan. 14, 1867, M. Pelouze (who must have been acquainted with Mr. Gaffield's account, published years before) makes a communication on glass, in which, after stating his opinion that there is no glass, in commerce, which does not change its color on exposure to the sun, goes on to say that *pure glass*, free from alkaline sulphate and oxide of iron, is not colored by the solar rays; that, for equal weights, the sesquioxide of iron colors it less than the protoxide, and that the yellow color manifested is much more intense than would have been produced by the same amount of iron in the state of peroxide; that a mere trace, almost imponderable, of sulphuret will color glass yellow. In glass which grows yellow on exposure to the sun there is protoxide of iron and sulphate of soda; light causes chemical reaction, whence results peroxide of iron and sulphuret of sodium; heat causes an opposite reaction, reproducing the sulphate of soda and the protoxide of iron, with a return in the glass of the original color. Analysis shows in the colored glass a very small proportion of a sulphuret, of which the glass before insolation shows no trace. The metalloids, charcoal, silicium, boron, phosphorus, and even hydrogen, color glass yellow, reducing the alkaline sulphate which it always contains to sulphuret; these deoxidizing substances have no effect on glass free from iron and from sulphate.

Faraday, in 1822, drew attention to the violet and purple tints produced in window-glass by the action of the sun. Pelouze (1867) states that this coloration is found in glass which contains both oxide of iron and oxide of manganese. When a batch of glass threatens to be too dark-colored for sale, the workmen add "glassmaker's soap," or binoxide of manganese, in such quantity that all the iron passes to the maximum, and all the manganese to the minimum of oxidation; the glass is thereby whitened, since the protoxide of manganese does not color it, and the peroxide of iron tinges it much less than the protoxide. All his specimens, thus colored by the sun, become un-colored by the action of a dull red heat, or that required for annealing; the glass rendered colorless by heat again becomes tinted on exposure to the sun, loses the color on reheating, and so on repeatedly.

M. Bontemps, in "Comptes Rendus," Feb. 4, 1867, attributes the yellow coloration of glass by the sun to the presence, not of oxide of iron, nor of sulphate of soda, but of oxide of manganese. The violet coloration of glass, alluded to by Faraday, he attributes also to manganese, and explains the difference in coloration by the fact that insolation colors glass with a potash base violet, and glass with a soda base yellow.

OZONE AND ANTOZONE.

The Abbé Moigno, in Dec., 1845, soon after the publication of Schönbein's observations, wrote to the "Epoque," as follows: "It is necessary to return immediately to the ideas of Ampère, and consider the atoms of bodies as having two states, — first, with the essential primitive electricity, or in a nascent state; second, with their electricity more or less disseminated, or their atmosphere of electricity in a neutral state. The ozone of M. Schönbein is, in our eyes, only a molecule of oxygen in a nascent state, with only negative electricity in its atmosphere." In July, 1847, in the "Nouvelle Revue Encyclopédique," he says more explicitly: "Sufficient attention has not yet been paid to the important fact that oxygen disengaged by plants is not in a neutral state. We are perfectly convinced that this nascent oxygen, without its positive atmosphere, is the ozone discovered by M. Schönbein, with an odor *sui generis*, and possessing, in the highest degree, all the properties of electro-negative substances." He claims to have, therefore, first made known the nature and application of ozone.

According to M. Soret, of Geneva, the density of ozone, as obtained in absorption experiments, is 1½ times that of oxygen. He has now redetermined it by means of Graham's law, that the "velocity of diffusion of a gas is inversely as the square root of its density." He ascertained the coefficient of diffusion of chlorine into oxygen, and of ozone into oxygen. He found that in 45 minutes for every cubic centimeter of chlorine contained in one of the two diffusion tubes, 0.227 of chlorine diffused into the upper tube, while for ozone the quantity under the same circumstances was 0.271. Now the ratio .227 to .271 = .8382 : 1; and if we assume ozone to have $1\frac{1}{2}$ times the density of oxygen, Graham's law would give us $\sqrt{35.5} : \sqrt{24} = 1 : .8222$, a remarkably close approximation, considering the difficulties of the method. We may, therefore, fairly regard the density of ozone as $1\frac{1}{2}$ times that of oxygen, or 1.657, if air be taken as 1, and 24 if hydrogen be unity. While, therefore, the molecule of free oxygen contains 2 atoms, that of ozone contains 3.

According to the experiments of Dr. Daubeny, the quantitative estimation of ozone by means of Schönbein's and Moffat's paper is rendered very uncertain in consequence of the action of light on the papers; both are quickly acted on by direct sunlight, and yet such papers may be seen exposed to full sunlight at the offices of important public departments, and the results are given as the action of ozone. To get strictly ozonic effects, the papers must be protected from direct sunlight: diffused light seems to promote the action of ozone on the paper. The source of ozone (not the only one, however) Dr. Daubeny finds to be the respiration of growing plants, which is abundantly proved by his experiments; and he therefore concludes that vegetable life counteracts the injurious effects of the animal creation on the air we breathe, not only by restoring to it the oxygen which the latter had consumed, but also by removing, through the agency of the ozone which it generates, the noxious effluvia arising from the processes of putrefaction and decay.

M. Schönbein has recently discovered that ordinary oxygen is without action upon the protoxide of thallium, while ozonized oxygen combines rapidly with it, forming the peroxide of thallium, of a brown color. Did not the carbonic acid of the air transform this oxide into carbonate, which passes more slowly to the state of peroxide, paper, steeped in a solution of oxide of thallium and exposed to free air, would be an excellent ozonometric paper.

Our knowledge regarding the different conditions in which oxygen may exist is constantly receiving new accessions. Not the least important of these is the fact, recently discovered, that the oxygen in the peroxide of manganese is in a very different condition from that in the peroxide of barium, — a circumstance which is strongly confirmatory of the theory of Schönbein, that oxygen may exist in two opposite states, which are termed ozone and antozone, — oxygen in its ordinary state being a combination of both. It has been proved by recent researches that the oxygen in the peroxide of barium is in the form of ozone, and that in the peroxide of manganese in the form of antozone. The consequences which follow from these discoveries are of a most interesting description, since, if the two kinds of oxygen enter into combination, it is probable that the elements with which they combine exist in two allotropic states. The facts which demonstrate that the oxygen elements in the peroxides of manganese and barium are in very different states are very remarkable, and are such as admit of no doubt. Thus the oxygen in the peroxide of barium has a less affinity for hydrogen and chlorine, since, when it is acted on by the latter, hydrochloric acid will be formed, oxygen being given off; while, on the contrary, hydrochloric acid is decomposed by peroxide of manganese, chlorine being evolved. It is worthy of remark that the oxygen given off by the peroxide of barium is in the form of ozone. Again: if peroxide of barium is treated with hydrochloric acid, peroxide of hydrogen will be formed; but if peroxide of manganese is treated with the same acid, ordinarily water will be formed, and chlorine evolved. Sulphovinic acid, if treated in presence of peroxide of barium, affords either bicarburet of hydrogen or other substances; but, if in presence of peroxide of manganese, aldehyde.

Peroxide of hydrogen may be formed by means of either peroxide of barium or peroxide of manganese; but the two peroxides of hydrogen thus obtained are very different, since each will be decomposed by the peroxide employed in forming the other; and, what is still more remarkable, they will decompose each other.

ON THE ORIGIN OF METEORITES.

In his researches on diffusion, Graham has shown that certain metals, such as iron, platinum, and gold, which occur native in the soft colloid condition, readily absorb or occlude gases. Hence by examination of the gases evolved from a meteorite, for example, the character of the atmosphere through which the ignited mass has passed may be determined. The well-known Lenarto meteorite is admirably adapted for such an experiment, being very pure and soft. A piece 50 millimetres long, 13 wide, and 10 thick, was cut off from the mass, cleansed, and placed in a porcelain tube connected with a Sprengel aspirator. The tube was then heated in an ordinary combustion furnace by ignited charcoal. Gas was freely evolved, which in 2½ hours amounted to 16.53 cubic centimetres. This gas burned like hydrogen, and when analyzed gave 85.68 hydrogen, 4.46 carbonic oxide, 9.86 nitrogen in the 100. As the volume of the iron was 5.78 c.c., it appears to yield 2.85 times its volume of gas, of which 86 per cent. is hydrogen. Now, since hydrogen has been shown by spectrum analysis to be present in the fixed stars, and by Secchi to be a principal element in some of them, we may fairly suppose that the Lenarto meteorite has brought to us the hydrogen of those distant bodies. Moreover, it is found that malleable iron can scarcely be made to occlude more than its own volume of hydrogen under the ordinary atmospheric pressure. But the meteorite gave three times this quantity. Hence Graham infers that it must have originated beyond the limits of the light cometary matter of our solar system. — *Chemical News.*

Daubrée has found peridot in all the meteorites examined by him, and this crystal occurs in some of the lowest rocks. Assuming meteorites to be planetary specimens, peridot seems to be ubiquitous, and to be, as Daubrée calls it, the universal scoria. Oxygen, essential to organic nature, has played an important part in the formation of meteorites, and by inference of planetary bodies generally.

VOLCANIC FLAMES.

Dr. Percy, in a lecture on Chemical Geology, observes, "There is still a question whether flame is ever really seen in volcanic eruptions. I know that, in newspaper reports of eruptions, flame is stated to be seen; but there may not be flame notwithstanding. What is supposed to be so may be merely the vapor of water illuminated by incandescent matter below, and it is not very easy to distinguish between the two. Still, if hydrogen be evolved, which there is no ground for disputing, there is no reason, considering the high temperature, why flame should not be produced."

SPECIFIC HEAT OF SOILS.

According to Pfaundler, "Pogg. Ann., cxxix., 1866," the specific heat of soils ranges from 0.1923 to 0.5069; the most common value is 0.25 to 0.30. Soils free from humus have the lowest specific heat, whether they consist of sand or lime; the richer the soil in humus, the higher is its specific heat; loamy soils have a high specific heat. So great a variation in this important physical property will explain why a plant sensitive to changes of temperature may be unable to grow on soils of low specific heat, however excellent it may be in other respects.

COBALT AND NICKEL IN IRON.

The results of the chemical examination of irons are of great importance to the mechanic and engineer. The chemist Weiske has recently examined irons more especially for cobalt and nickel. These are present in English irons in very small quantity, according to previous observers; but Weiske states that he finds both cobalt and nickel present in all irons, but in very varied proportions. He found the smallest amount in English pianoforte wire, but in some Saxony iron he found as much as 7 grammes of the two metals in a hundred weight of the iron. As these two metals are known to give hardness to iron, their presence, even in small amount, may confer some valuable properties.

EFFECT OF EXPOSURE ON COAL.

Prof. Rockwell, in the "American Journal of Mining," has called attention to the deterioration which coal suffers from exposure to the weather, and to the importance of keeping it as dry as possible. Anthracite suffers the least; bituminous the most. According to the experiments of Grundmann, in Germany, coal exposed to the weather in heaps lost during a period of nine months 50 per cent. of its value as fuel, and about as much as a gas-making material; it undergoes a process of slow combustion, taking up oxygen, and giving off the volatile products of oxidation, — air and moisture playing the principal part, and warmth promoting it; the valuable combustible ingredients are lost, and the injurious ones, as sulphur, oxygen, and ash, are relatively increased. Coke from weathered coal is of inferior quality, losing its coherence.

EXTRACTION OF POTASH FROM FELSPAR.

M. Daubrée placed felspar and distilled water together in a cylindrical vessel, which he made to rotate rapidly on its axis. Under this movement he found that the felspar underwent decomposition; the water became alkaline, and he was enabled to separate considerable quantities of potash or soda, according to the rock operated on. The supply of potash becomes a more important question every year, as the vegetable sources of this substance are gradually disappearing; in the felspathic rocks there is an inexhaustible supply, but hitherto it has not been possible to extract it profitably. If M. Daubrée's process can be made to answer on the large scale, an important industrial problem is solved. He remarks that this fact may throw some light on the changes which are taking place on the surface of the earth. For instance, he asks, what may be the effect of the constant movement of the sea dashing against the rocks? Probably not merely disintegration but decomposition must be produced. — *Comptes Rendus, Feb.* 25, 1867.

PREPARATION OF OXYGEN.

M. Mallet has published in the "Comptes Rendus," Feb., 1867, the following cheap and easy mode of preparing oxygen on the large scale. Cuprous chloride absorbing oxygen from the air to become converted into the oxychloride, which oxygen is driven off on the application of heat, he mixes the cuprous chloride with sand or kaolin, and places it with a little water in a horizontal iron retort, where it is agitated while a current of air is made to pass. The formation of the oxychloride is completed in an hour or two, when heat is applied, and the oxygen collected. The oxychloride may afterward be revived by the same process. A kilogramme of the cuprous chloride is said with each operation to yield 28 to 30 litres of oxygen; the loss of material is very slight, 100 grammes of the chloride losing only 9 grammes in the repeated revivifications necessary to furnish 36 litres of gas.

Another process is given by Winkler. Binoxide of manganese, heated with sulphuric acid, yields oxygen; but the sulphate of manganese produced forms a hard cake liable to break the retort. He uses bisulphate of soda in the place of sulphuric acid, three parts of the dry bisulphate being mixed with one of manganese;

the bisulphate readily fuses with the heat of a spirit-lamp, and remains liquid to the end of the process, pure oxygen being quietly evolved.

Another oxygen process is reported in the "Chemical News." On heating a concentrated solution of chloride of lime, with only a trace of freshly prepared moist peroxide of cobalt, the hypochlorite of lime is completely decomposed into chloride of calcium and oxygen, and no chloric acid is formed. The evolution of oxygen commences about 70° or 80°, and continues in a regular stream, with a slight frothing of the liquid. The peroxide made use of in one experiment may be employed again to decompose a fresh quantity of hypochlorite of lime.

PURIFICATION OF WATER.

The London "Builder" says that Mr. Thomas Spencer, the discoverer of electrotype, has made another important discovery. He has ascertained that the magnetic oxide of iron, which abounds in rocky strata and in sands, etc., attracts oxygen, whether it exists in water or in air, and polarizes it; that this polarized oxygen is the salubrifying ozone; that this ozone, so formed, destroys all discoloring and polluting organic solutions in water, and converts them into the sparkling and refreshing carbonic acid of the healthful spring. It is claimed that even sewerage water can be thus almost instantaneously purified.

Moreover, Mr. Spencer has discovered that the apparently mechanical process of filtration is itself magnetical, and it is now known that all substances are constitutionally more or less subject to magnetical influence; thus all extraneous matter suspended in water may be rapidly attracted in filtration, and so separated; and this may be done whether on a great scale or a small, either by the magnetic oxide or black sand of iron, by a mixture of this with ordinary sand, or by various other means; and Mr. Spencer has discovered a solid porous combination of carbon with magnetic oxide, prepared from Cumberland hæmatite, which is said to have very great filtering power.

Mr. Booth, of Birmingham, England, has also recently promulgated a process for purifying water, for which meritorious claims are also put forth, and which may be very properly introduced in this connection. He placed in the water a neutral solution of bisulphate of alumina, in the proportion of 1 ounce to 435 gallons. The sulphuric acid of the sulphate decomposes the bicarbonate of lime in the water, and forms an insoluble sulphate of lime instead. The hydrate of alumina being set free, forms with the organic matter in the water another insoluble compound. Both these fall to the bottom, and the remaining freed element, carbonic acid, lends an agreeable quality to the water.

WATER AS A GAS ABSORBER.

Set a pitcher of water in a room, and in a few hours it will have absorbed nearly all the respired and perspired gases in the room, the air of which will have become purer, but the water utterly filthy. The colder the water is, the greater the capacity to contain these gases. At ordinary temperatures, a pail of water will contain a pint of carbonic acid gas, and several pints of ammonia. The capacity is nearly double by reducing the water to the temperature of ice. Hence, water kept in the room awhile is always unfit for use. For the same reason the water from a pump should always be pumped out in the morning before any of it is used. Impure water is more injurious than impure air. This shows the economy and the convenience of a modern ice pitcher,— a splendid invention, which, as it seems, is more than ornament and show, — aye, it is really and absolutely a necessity.

A NEW REAGENT.

Professor Bottger has prepared a new and highly sensitive chemical test for acids and alkalies, from the leaves of an ornamental plant named, in honor of the Dutch horticulturist, Verschaffelt, *Coleus Verschaffelti*. The reagent is prepared by digesting the fully developed leaves in alcohol, and impregnating slips of Swedish filter-paper with the decoction. This test-paper differs from litmus — prepared from a certain species of lichen — in having a beautiful red tint, which becomes green under the influence of an alkali or alkaline earth. It is not affected by free carbonic acid, so that it may be used in detecting traces of carbonate of lime in water. A strip of this paper moistened in water, and held over a burner from which gas is issuing, assumes in a very short time a green tinge, in consequence of the ammonia, from which, perhaps, no gas is altogether free.

PRESERVATION OF WINES.

We translate from "L'Invention" the following article by Mons. Pasteur, on experiments made by him to find the causes of deterioration of wines. If his views be correct, other liquids of vegetable origin may probably be preserved by the process he recommends. He says: —

"I have previously communicated to the Academy divers notes relative to the changes which wine undergoes by age, and to its causes of deterioration, and to the practical processes which may be adopted for its preservation. The results of my studies may be stated briefly: 1. Wine is changed from the state of new wine to that of old wine almost exclusively by the influence of the oxygen of the air. 2. Wine is not changed by any action within itself, due to unknown causes. Whenever it becomes deteriorated, it is by the action of parasitic vegetations that are developed under diverse influences. 3. The deposits in wine are caused exclusively either by oxidation produced by the oxygen of the air, or by the parasites, or, more frequently, by both combined. 4. The deposits due to the influence of oxygen in most cases adhere to the vessel; and those due to parasites always float, and are consequently injurious, both chemically and physically. 5. The problem to be solved for the preservation of wines, therefore, consists solely in preventing the development of the parasites; in other words, in the destruction of their germs, or the suppression of their vitality.

"It is said that wine is a liquid whose diverse principles continually react upon each other by mutual slow affinities, as when ether is slowly formed by the mixture of acid and alcohol. This opinion of the nature of wine and the progressive changes of its properties is altogether erroneous. New wine, shut up in close vessels, out of contact with air, neither makes a deposit, nor changes color, nor loses its bouquet. On the contrary, the same wine, when submitted to the influence of the oxygen of the air, whether in the dark or the light, but most rapidly in the light, deposits so much as to become turbid, and loses entirely its taste of new wine, and its color becomes like that of wine ten or twenty years old, and it acquires in a high degree the taste and bouquet of the dry wines of Madeira and Spain, or of wines that have been on voyages. All these exaggerated effects of the maturing of wines by the action of the oxygen of the air may be realized in a few weeks.

"But the influence of oxygen is constantly joined, though in different degrees, with the slow action of the cryptogamous vegetations in the wine, which are the cause of all its alterations. It is indispensable to destroy the germs of these parasites, if we would have the wine mature promptly and surely, without ever deteriorating.

"I have announced to the Academy that this desirable result was easily obtained by heating the wine to a sufficiently high temperature. But I have been reserved as to the industrial value of this process, because I thought that my experience had not been sufficiently long to be relied on. The communication which I now have the honor to make to the Academy has for its principal object to confirm my former views on this point.

"It was necessary to resolve a previous question, that of the immediate effect of the elevation of temperature. It was not easy to believe in preserving wine by a process which might in some respects impair the proper qualities of the wine. Now, multiplied trials of French wines, of very diverse origins, enable me to say with assurance that wine which has been heated and cooled has not changed its color, nor lost any of its bouquet, nor made the least deposit; and, finally, that it is so like the same wine that has not been heated that it was necessary to submit them to a simultaneous comparison in order to perceive the least difference in their properties. If that difference were against the wine that had been heated, there would have been little hope of the success of the process; but an expert taster in seven samples out of nine gave the preference to the wine that had been heated. The arrangements were made by myself, so that the expert had not the least idea of the nature of the wines of which he had to judge, and in the two cases in which he preferred the wine that had not been heated, he admitted that he was at a loss as to which was best. Moreover, he did not perceive a taste of cooking, even when his attention was called to the possibility of a flavor of that nature.

"If the change which a momentary heating gives is too slight to give an amelioration that is immediately perceptible, it is quite different when we consider it in reference to the preservation of the wine. It suffices that the wine be heated for a few minutes to the temperature of 140° to 158° F., to give it an extraordinary resistance to all the deteriorations to which wine is liable. And that is true of all wines whatever, whether white or red, strong or mild, new or more or less old. I may add from my latest experiments that the temperature of 113° F. will suffice; and that glass vessels may be made in which this heat may be given by the sun, without the expense of artificial heat.

"I announced to the Academy on the first of May last that I had made comparative experiments on the wines of Pomard, heated and not heated; part of the bottles were rather old. All the bottles of the two sorts which were not heated are now rapidly changing, as will be seen by these photographs of the parasite ferment which produces the change. On the contrary, the same wines, that had been heated to 149°, remain without the least deposit, while the loose deposit of parasitic vegetation is as thick as a finger at the bottoms of the bottles that were not heated. And all this deposit has been formed in three months. Finally, the wine which was heated has preserved all its qualities, while the other is bitter and disagreeable to the taste.

"I also announced to the Academy, but diffidently, the opinion that the heated wine had become so little alterable that it might be kept in partly filled vessels, in contact with air. I can now speak positively as to that result. The germs of the vegetations being destroyed by the heat, the wine exposed to a limited volume of air, as happens when part of the wine is poured from a bottle, cannot be altered by the propagation of the germs held suspended in that volume of air; and if that volume of air contains nothing of the nature of those which could be developed in the wine, it would remain unaffected by the vegetation, and subject only to the direct chemical action of the oxygen of the air. This is precisely what happens; and, nine times in ten, the wine which has been heated and put in partly filled vessels does not suffer the least acidification, even when exposed for months in a room at a temperature of 85° to 96°.

"In conclusion, I consider that the problem of the indefinite preservation of wines, and their easy transportation to all countries, is solved completely and satisfactorily. It now remains for wine-producers to profit by these results of science." — *Druggists' Circular.*

ELECTRIC CURRENT FROM ORGANIC SUBSTANCES WHILE DECOMPOSING.

Experiments on filtering-paper, elder-pith, gum-arabic, wheat starch, albumen, and glue, at the ordinary temperature, under water, prove that evolution of hydrogen gas takes place, the presence of which is ascertainable by the resulting galvanic current, and an indication of from 12° to 15° on the multiplicator. Ligneous fibre resists most tenaciously, when undergoing oxidation, and since its oxygen is insufficient to convert all the carbon into carbonic acid, various compounds of hydrogen result, undoubtedly aided by a coëtaneous decomposition of water. From starch another acid is produced besides carbonic, noticeable for great solubility of its lime salt.

The decomposition of nitrate of silver in solution by organic substances seems to be due to a disengagement of hydrogen gas, which reduces the nitric acid to a lower oxide of nitrogen; a process probably analogous to that which affects nitre in the soil or manures. This reducing action in watery infusions ceases after a time, apparently in consequence of the appearance of some algæ. Those sulphurets which at ordinary temperature exhale the peculiar odor, appear to do so because they decompose water on the surface; in their solution the presence of hydrogen is readily indicated by the galvanic test. Though usually negative compounds, the solutions (of pentasulphide of potassium) show positive electricity. — *Henrici, Poggendorf's Annalen.*

SUMMARY OF CHEMICAL NOVELTIES.

Treasure in the Blast Furnace. — On page 168 of Dr. Percy's work on Iron and Steel, he notices the discovery of Sonnenschein at one of the furnaces of the Marienhute, in Upper Silesia. He tapped the hearth below the tap-hole, and obtained a considerable quantity of lead and silver, which had settled to the bottom in virtue of its superior specific gravity. Not that lead and silver are contained in all iron ores; but in the ores of Weardale there are indications of lead, silver, and zinc, as well as manganese, and so Mr. William Thomas, manager of the Tow Law Furnaces, some time ago determined to see what he could find by tapping his hearth at the very bottom. He drew off a charge of lead containing a considerable percentage of silver, and he sold it for more than we dare repeat, but it was a good deal. The discovery of large quantities of silver in their blast furnace hearths caused no little excitement. Mr. Thomas is now tapping his lead and silver daily from below the iron, and he is selling his furnace fume, which contains half its weight of metallic zinc. — *Engineering.*

Glyconine — A New Glycerole. — To contain this compound, M. Edmond Sichel employs 4 parts (by weight) of yolk of egg, and 5 parts of glycerine, which he mixes simply in a mortar. It has the consistence of liquid honey, and is unctuous like the fatty substances, over which it has the advantage of being easily removed by water. It is unalterable, a specimen having been left exposed to the air for 3 years with impunity. Applied to the skin, it forms on the surface a varnish, which protects it from the contact of the air. These properties render it serviceable for broken surfaces of all kinds, particularly for burns, erysipelas, and cutaneous affections. — *American Journal of Pharmacy.*

Green Vitriol from Iron Slag. — A sulphate of iron, which is esteemed by dyers, according to M. Ch. Mène, may be produced from the slag of iron forges more cheaply than in any other way.

It is pulverized and mixed with sulphuric acid, then heated in an oven to eliminate the hydrated silica, the residuum treated with boiling water, and made to crystallize.

A Curious Chemical Observation. — Becquerel, senior, has found that chemical decomposition and combination take place actively, and with peculiar results, between two solutions connected by an inappreciable fissure, or water-tight joint. A tube with such a fissure in its bottom, being filled with a solution of nitrate of copper, none of the liquid pours mechanically; but on immersing the bottom of the tube in liquid proto-sulphuret of sodium, an electrical action takes place, and a double decomposition and recomposition ensues, indicated by the appearance of crystals on both sides of the fissure, which are not always of the nature required by theory, but are modified by the capillary action of the surfaces.

Oxygen in the Market. — A company has been formed in Paris, under the style of Jos. de Susini & Co., for the manufacture and sale of oxygen to be mixed with ordinary illuminating gases. The calculation is that an addition of one-third oxygen will be equivalent to multiplying a given quantity of illuminating gas 8 times, the price of oxygen being fixed at only 2½ times that of ordinary gas.

Ozone. — In an English patent, issued some time since, for decolorizing sugar by means of ozone, the generator employed for the purpose consists of a number of flat sheets of glass, coated with tin-foil, and piled one on the other, but slightly separated. Each plate represents a Leyden jar, and when the whole number are electrified, a stream of air forced through from one end to the other becomes so strongly ozonized that breathing it is painful and dangerous. The stream of ozonized air thus produced can be used for bleaching and other chemical purposes.

Cinnabar. — Cinnabar of a beautiful vermilion color is found in an unusual form in Idaho, being abundantly spread throughout a gangue so massive, compact, and homogeneous, that specimens may be cut and polished like marble.

Sulphurous Acid. — This may be produced on the large scale by heating together 2½ parts of dry sulphate of iron and 1 part of sulphur; the reaction is $Fe\ O, So_3 + 2S = Fe\ S + 2SO_2$.

Treatment of Gelatine and Gum. — A useful invention, capable of wide application, has recently been patented in England. It consists in the use of sulphate of sesquioxide of chromium, or chrome alum, for rendering gelatine or gum (Senegal or Arabic) insoluble in water. It is applicable to the fixing of dies and pigments for textile fabrics; to the tanning of skins; to the fixing of photographs and prints produced in gelatinous ink; and to the preparation of insoluble varnishes.

Paper which turns Pale Ink instantly Black. — This is effected by introducing into the glazing a neutral carbonate which effects a prompt oxidation of the ink without injuring the paper. It is called by Mr. J. E. Hover, its inventor, carbonized paper.

Tests for Wood in Paper. — Wood is coming into extensive use in the manufacture of paper, and a test for its presence may be useful. Schapringer recommends sulphate of aniline, but Behrend states that ordinary nitric acid is a more delicate and certain reagent. Paper containing wood is rapidly colored brown by this acid, especially when the paper is warmed.

Effect of Freezing on Beer. — The experiments of C. Lermer show that freezing it so far as to obtain a crust of ice on the surface is a ready way of converting small beer into strong ale. He bored holes through the crust of ice, and withdrew the fluid below, which exhibited the following composition, as compared with the beer before freezing: —

	Before freezing.	*After freezing.*
Specific gravity	1.0243	1.0489
Extractive matter, per cent.	5.68	15.21
Alcohol, per cent.	3.5	9.43

The extractive matter when burned gave 3.27 per cent. of ash, which was almost entirely composed of phosphoric acid and potash.

Easy Mode of producing Aniline. — A simple process for the reduction of nitro-benzole to aniline is given by Kekulé, namely, by adding an acid solution of chloride of tin to nitro-benzole; a strong reaction ensues in a few moments, great heat is developed, and aniline is produced. In applying this process on the large scale, some precautions are necessary to moderate the violence of the action.

NEW METALLURGIC PROCESS.

At a recent meeting of the Massachusetts Institute of Technology, Dr. James D. Whelpley read a paper on the chemical process for obtaining red oxide of copper from the ores at Harvey Hill, Canada East, where the first trial was made, on a large scale, of a new metallurgic process, which promises to effect a complete revolution in the working of metallic ores, especially the sulphides.

The furnace at Harvey Hill was 20 feet high, formed within and without like a shot tower. Under this tower, through which the burning fuel and ores descended, was a bath of water chemically prepared. The tower formed an enormous blowpipe, having a flame 30 feet long made by the rapid oxidation of excessively fine particles of fuel and ore, which plunged at a red or white heat into the chemical bath. The principal copper ore at Harvey Hill consists of a blue sulphide of copper, in which the proportion of sulphur is 16 for every 32 pounds of the metal; one-third by weight is sulphur, the rest metallic copper,— the chemical equivalents of a protosulphide. In the old method of concentration from one-fifth to one-fourth of all the copper was lost. The new process stops at the production of red oxide of copper; the red and black oxides are subsequently reduced to metal and refined by a well-known process. The black oxide generated by combustion is dissolved in the brine bath of common salt and water, to which chloride of calcium is added, and precipitated therefrom as red oxide.

The process has four divisions, more or less novel, as follows:

1. The use of attritive force, or of the mechanical reduction of stony materials by their own attrition; the working of this principle is illustrated by the moving sands of the desert, and by the mutual action of the sea-shore pebbles. 2. By the new system the dust of sulphur and of sulphides, and of all inflammable stones and rocks, is burned, floated upon currents of air through heated chambers; by it stones are converted into powerful fuels, whereby the iron, sulphur, phosphorus, arsenic, and other combustibles, are made heat generators of nearly equal power with carbon itself, developing all the heat of which they are practically capable at the moment and at the place where they are needed, — showing as great a step in the thermotic as in the mechanical branch of metallurgy. 3. Sulphurous gas is thoroughly applied as a metallurgic solvent as general in its application as sulphuric acid. Berzelius claimed that the quantity of sulphuric acid used by a nation would be the measure of its civilization: this must now be modified by another observation, namely, that the extent of the metallurgic industry of a nation may be measured in part by the quantity of gaseous sulphur used; the enemy or demon of the metals, sulphur, is made the chief instrument of their reduction. 4. Chemical agents are so employed as to continually recover them in the process itself; chlorine, the most powerful agent of solution, is used and recovered with only the losses of manipulation. In the mechanical division tangential force is substituted for gravity; in the thermotic, rapid and instantaneous alembic and stillatory processes are combined with the combustion of iron and other substances not hitherto clearly recognized as fuels; in the chemical, a new solvent has been made to take its place at the head of metallurgic solvents.

He gave details on some of the interesting chemical results of these processes: as the absorption of sulphurous gas by the bath of cold water, forming a sulphite of water or sulphurous acid; the intense heat produced by the combustion of native sulphides of copper and iron, the intensity of the combustion being in proportion to its rapidity and the minute division of the particles; a cubic inch of solid sulphide may be so divided by the machinery used as to offer 800 square feet of surface to the action of radiated heat; the action of sulphurous gas upon the solutions of the chlorides, and the effect of the addition of chloride of calcium to the briny bath. Upon the fact of the powerful absorption of sulphurous gas by the chlorides of the metals rests the entire chemical system of the new branch of metallurgy.

From lack of economy in reduction of ores, it is estimated that the aggregate loss on the production of bullion in this country for the present year will reach the sum of 25,000,000 dollars.

Prominent among the causes of loss is the inability hitherto to burn fine and waste coal in these processes. In relation to this subject the "American Railway Times" has a long article in a recent issue, of which the following is an abstract: —

"The present loss of coal is, in point of fact, a greater evil than the national debt of Great Britain or the United States. It appears hardly credible, and yet we cannot refuse the statistical evidence that discloses the fact, that the waste of coal in Great Britain at the mines and elsewhere exceeds 30,000,000 tons annually. The waste in the United States sometimes exceeds 45 per cent., and always 25 per cent., of the amount actually mined. This loss falls most heavily upon the finer quality of coal, which, from its mechanical constitution is more subject to comminution and waste in handling and transportation, so that the higher the value of the coal as a heat-producing agent, the greater is the percentage of loss. From the fact that the present method of combustion requires the use of grate bars, open for a passage of air, an incidental waste arises from the formation of slag or clinker, which carries off into ash some portions of combustible matter, and by impeding the draft causes all the losses from imperfect combustion, which amount to 5, and in extreme cases to 25, per cent.

"We have seen the results of a series of carefully conducted trials, made by a board of engineers appointed by the Navy Department to examine into the various methods of employing anthracite and bituminous coals as fuels. Competitive trials, of 48 hours each, between a given quantity of bituminous coal, selected and employed in lumps of 4 inches cube, burned with a forced blast under an ordinary tubular boiler, and an equal quantity of the same sort of coal, one-third in lump and two-thirds slack pulverized, and driven in above the fire by a similar forced blast, were instituted, and the temperature of feed water, uptake, engine, and fire-rooms carefully taken; a uniform pressure of 40 pounds was maintained on the boiler, and an equal number of strokes made by the engine in each experiment. The trials showed that an evaporation of 8¼ pounds of water from a temperature of 140° F. could be effected with a pound of coal burned in lump at the rate of 12 pounds to the square foot of grate surface, while with one-third burned in lump and two-thirds pulverized, an average evaporation of 9¼ pounds of water to the pound of coal was reached. The conditions of the experiments were as nearly alike as practicable in both cases. During the last part of the last experiment the percentage in favor of pulverized fuel was raised to 20 per cent., and during 6 consecutive hours an evaporation of upward of 11 pounds of water to the pound of coal was reached, which would give more than 33 per cent. gain. This was owing to the skill acquired by the firemen in the course of the experiments. The result of the experiments seems to have decided these points:—

"1. With ordinary care a complete rapid combustion can be effected. The loss of combustible matter, either from the lump coal alone or from the lump and pulverized together, was hardly sufficient to discolor the ash, and the entire residuum of coke at the end of 48 hours' constant burning at the rate of 66 pounds an hour was not 12 pounds in either case, and the residuum ashes collected and weighed was about 8 per cent. of the weight of coal used,—the lump coal giving a trifle the most. This indicates the care with which the experiments were made.

"2. The employment of two-thirds of the coal pulverized and blown over the fire by an air-blast, gives an increased useful effect of at least 12 per cent., and from that to upward of 30 per cent.; one cause of this is obviously a more even distribution and extension of the flame under the surface of the boiler, and a nearer approach, as machinists say, of the power to the work.

"As these experiments were conducted with limited amounts of fuel, far below the capacity of the furnace, it is to be expected that larger advantages will be shown, as from other trials it was observed that the velocity of combustion was enhanced, and a greater efficiency produced, as the amount of fuel burned was increased.

"These results establish the fact that the cheaper varieties of coal can be made even more efficient than the qualities now in the market. They give us a stock of fuel already mined and ready at once for consumption, amounting at least to a third of the fuel used in this country during the past year, and probably to ten times that amount.

"Take the amount of coal mined by any one mine this year, allowing that one-third of it is waste, not now used, by burning the waste as pulverized fuel with one quarter of the lump which would now alone be used, and we find that the result is an actual increased efficiency of more than 50 per cent. in the coal mined.

"To employ pulverized fuel requires a slight modification of the ordinary form of furnace, which was found to give results with lump coal far above the common average, and no change whatever is made in the ordinary horizontal grate bars. The works of Messrs. Whelpley & Storer, at East Boston, were placed at the disposition of the board of engineers for these experiments, and the method of burning waste coal was the one adopted and for several years used by them in their metallurgic operations and for the generation of steam.

"The inventors are now preparing a machine to employ this method of using fuel in locomotives, where, as is well known, the loss from smoke, imperfect combustion, and other causes is enormous. It is somewhat singular that the prophetic mind of the greatest authority in practical steam engineering that has yet appeared, foresaw the conditions under which the fuel problem must be solved, while he did not by any means understand the details and mechanism of the solution which has now been reached. In 'Bourne on the Steam Engine,' ed. 1861, p. 358, we read: 'Nearly all of the expedients hitherto introduced for burning smoke in locomotives are adaptations of the devices heretofore in use for burning smoke in land engine furnaces. But the rapid combustion which a locomotive boiler requires renders the burning of the smoke by any of these ancient devices a matter of very difficult attainment, and it seems to be indispensable that a method founded on a totally new principle should be introduced. It appears to us that the fuel and air must be fed in simultaneously, and the most feasible way of accomplishing this object seems to be in reducing the coal to dust and blowing it into a chamber lined with fire brick, as the coal dust may be ignited by coming into red-hot surfaces, after having been mingled with the quantity of air necessary for combustion. This, however, in common with other improvements upon the locomotive, requires to be worked out.'

"It will be observed that in burning fuel by this method no sparks will ever escape of sufficient size to set fire to any wood-lots, structures, bridges, houses, depots, etc., along the line of the road, and it is evident that an exceeding economy will result from the perfect combustion of the pulverized fuel in the fire-boxes."

For a description of the above furnace, see "Annual of Scientific Discovery" for 1866–67, pp. 47–50.

A NEW MINERAL FROM BORNEO.

This mineral is found mixed with the native platinum brought from Borneo. It forms small grains or globules of a dark black-gray color, and of considerable lustre. Many of these grains show brilliant crystalline facets, which are the faces of regular octahedra. The new mineral is very hard and brittle. Its powder is dark-gray. Its density exceeds 6, according to an approximate determination. When heated it decrepitates like galena; it does not fuse before the blowpipe, but diffuses a strong odor of sulphurous acid, and then of osmic acid. It is not attacked by aqua regia, nor by bisulphate of potash. Fused in a silver crucible with hydrate of potash and nitre, it dissolves to a green mass. After cooling, the mass is brown, and it dissolves in water with a magnificent orange color. The solution has the odor of osmic acid, and nitric acid produces in it a black precipitate. From this it may be concluded that the new mineral contains as its principal elements osmium and ruthenium. It also contains sulphur. To estimate the latter I heated the mineral to redness in a current of hydrogen until no more sulphuretted hydrogen was disengaged. The residue was exhausted many times by aqua regia; there remained metallic ruthenium. A portion of this metal was estimated in the orange solution. This was evaporated, then neutralized by ammonia and brought to dryness, and the residue calcined in a covered crucible in an atmosphere of carbonate of ammonia. There remained ruthenium. The osmium which volatilized was determined by difference. From this analysis the new mineral contains: —

Sulphur	31.79
Ruthenium	65.18
Osmium	3.03
	100.00

These numbers appear to show that the mineral is sulphide of ruthenium, $Ru_2 S_3$, 12 molecules of which are associated with one molecule of sulphide of osmium, OsS_4. — *F. Wöhler, in Chemical News.*

INDIUM.

Two very interesting specimens of this new metal were exhibited to the "Academie des Sciences" in April, 1867, by M. Richter. They consist of two prisms, having a length of about 4 inches; their section is that of a trapezium, with a height of half an inch, and with bases respectively half an inch and three-quarters of an inch in breadth. It is well known that sulphate of zinc, or white vitriol, may be prepared either by dissolving the metal in sulphuric acid, or, more economically, by roasting the native sulphide or blende, which, by absorbing oxygen during the progress, becomes in a great measure converted into a sulphate of the oxide. When the former method is employed — as it generally is on a small scale, and in the laboratory — a compound precipitate is obtained containing traces of indium. M. Richter is the first who has succeeded in isolating this metal, and those who know the difficulties attending upon all such experiments can well appreciate the dexterity in manipulation and the skill necessary to accomplish so proud a feat for the chemist as the giving of a new element to the scientific world. The metal bears a great analogy to cadmium, and there is an important fact to be borne in mind respecting the similarity of their properties, more especially when the manner in which indium is produced is taken into consideration. It is that cadmium generally accompanies the ores of zinc. The question that will at once arise is, — perhaps after all indium is nothing else than cadmium. Fortunately, however, there is no doubt in the matter. The only oxide which is known formed by indium is insoluble in excess of that substance; moreover, the spectrum of indium is distinguished by a brilliant indigo ray; its color, smell, and other properties, somewhat resemble those of tin, to which cadmium also bears a resemblance, but is rather harder. The two specimens are of exceeding purity, and M. Richter estimated their total value at £800. They were obtained from the Freiberg blendes.

ITACOLUMITE. — A SOURCE OF THE DIAMOND.

In "Silliman's Journal" for July, 1867, Dr. C. M. Wetherill has published a paper on this subject, from which the following are extracts: —

"The rock which derives its name from the mountain, Itacolumi, in Brazil, is certainly one of the most interesting with which we are acquainted. As the companion (probably the matrix) of the diamond, a study of its origin and nature might possibly solve the problem of the formation of that gem; and its flexible character is at such variance with our ordinary experience of the stability of rock, that it is wonderful to those even who are most familiar with it.

"According to the authorities, itacolumite is a laminated quartz rock of the talcose series, owing its lamination to a little talc or mica (Dana), to which material its flexibility is also due (Dana, Percy, and others). It occurs in extensive formations in Brazil, the Urals, and in the United States, in Georgia and North Carolina, and appears particularly to accompany the diamond.

"Specimens may be split more readily in one direction, yielding slabs, and there are occasionally small fissures at right angles to these layers. There is also, in one of my specimens, a plane, forming an angle of 15° with the plane of readiest cleavage, and perpendicular to the planes of the fissures. It appears to be a joint, and is covered with small crystals of quartz. Scattered through the rock are small scales of mica, which are comparatively few in number, but of uniform size, thin, and determine the cleavage of the rock. These plates lie in parallel planes, as they would settle naturally from a liquid. Where they are abundant in any plane the rock splits there readily. If a piece, thus split, be rubbed down perpendicularly to the cleavage plane, no scales of mica are perceived upon this new surface, because the observer is looking at the edges of the micaceous plates, but the lamellar nature of the rock is thus made very apparent.

"The chief constituent of the rock under the microscope is quartz in very sharply fractured and fine grains, together with a little mica. Occasionally are to be seen very minute black grains. The specific gravity of the North Carolina specimen, taken in the ordinary manner, is 2.61. The analysis yields the following results: —

Vol. at red heat (water)	0.17
Silica	95.89
Sesquioxide of iron	2.78
Lime	0.84
	99.68

"The relative hardness of the siliceous grains in the mineral appears to be that of agate, which may be scratched slightly with them. On one occasion the bottom of an agate mortar received a very decided scratch, which gave color to the supposition of a minute diamond as the cause. The rock is quite porous when compared with other sandstones; water placed in an excavation will filter very readily through the stone, even in a direction perpendicular to the plane of stratification. Gases diffuse very readily through these pores.

"The flexibility of this rock is attributed universally to the mica which it contains,— an inference which the microscope shows to be unwarranted. This flexibility is due to small and innumerable ball-and-socket joints, which exist throughout the mass of the stone very uniformly. Each joint permits a slight movement, which is always greater in one direction. The accumulation of joints suffers a limited motion in every direction. This mobility is not perceptible in thick slabs, unless they are large as to their other two dimensions. This jointed structure is so wonderful that it would warrant the name 'articulite' to be given to the mineral.

"Under the microscope, a fragment of the mineral is seen to be composed of small botryoidal masses or congeries of grains of sand. The observer can hardly divest himself of the impression that he sees a loose layer of sand, until the stage is again inverted and jarred, which demonstrates that the grains are interlocked. By managing the reflected light with which the object is illuminated, the plates of mica can be distinctly seen; they are very few in number, and take no part whatever in determining the motion.

The articulation is not that of basaltic columns. The component grains are arranged so that most of the groups have cavities and projections, and so that the projection of one group engages in the cavity of its neighbor. Each group appears to be composed of from 20 to 50 grains of sand not very strongly agglutinated; the individual grains are very sharp fragments of silica, not flat plates, and of great uniformity with respect to size. The scales of mica are flat and nearly square fragments; they average in area $(.08)^2$ mm., and vary from $(.26)^2$ to $(.065)^2$ mm.

"The most interesting relation of this rock is to the diamond which it accompanies. This gem, found at first in the disintegrated rock, has at length been discovered *in situ* in the itacolumite itself; thus showing that this sandstone is at least *one* of the sources of the diamond.

"The physical conditions which have led to the peculiar jointed character of the itacolumite may have had an important bearing upon the crystallization of the diamond, and hence it is of interest to ascertain what those conditions were, with the hope of throwing light upon the origin of the gem.

"I confess to be at a loss to offer a very reasonable hypothesis with respect to these conditions. It is difficult to see why the siliceous fragments cohere to form definite groups or congeries. It would appear that the sand which formed this rock contained something diffused in a regular manner (and which was subsequently removed), which prevented the uniform contact of the siliceous grains. It is possible to conceive that *petroleum* might have that effect when added to sand of a certain degree of moistness, forming a kind of emulsion, and that the petroleum was afterward slowly removed by a process which permitted a crystallization of a portion of its carbon.

"I made this supposition before acquaintance with De Chancourtois's hypothesis that the diamond may have been formed from hydrocarbons, and that its origin is thus connected with the existence of petroleum-bearing schists. My hypothesis therefore receives a certain support from the views of De Chancourtois.

"I have heated several of my specimens of itacolumite to ascertain whether any petroleum odor was evolved, but with negative results. If the diamond proceeded from a slow and gradual oxidation of the hydrocarbon, perhaps we should not expect to find any petroleum left.

"In this connection the small and rarely occurring black specks, seen with the microscope, are to be noted. Are they minute black diamonds, and have they any relation to the experiment where the agate mortar was so deeply scratched?"

BAUXITE.

At a recent meeting of the New York Lyceum of Natural History, Dr. Ferdinand Mayer made some remarks upon a new mineral which had recently been found in France, and was sold in commerce under the name of bauxite. It may be regarded as a hydrated oxide of alumina, in which iron has been replaced by the alumina. No deposit has been found in this country, for the reason that no search has been made for it. The proper place to look for it would be in beds of clay iron ore and yellow iron stone. The remarkable thing about it is the entire absence of silica, so that it does not resemble kaolin or potter's clay. It appears to bear about the same relation to kaolin that the hydrated oxide of magnesia (brucite) does to serpentine, if we omit all mention of the iron and other impurities.

Bauxite has numerous applications in the arts. It is employed in the manufacture of aluminium. The oxide of alumina behaves like an acid, and will expel many acids at a white heat, without itself being decomposed. It forms a soluble compound with barytes, by which the alumina can be separated from iron.

By fusing bauxite with soda ash the aluminate of soda is produced, — an article of commerce which finds extensive application in calico printing, and which could be employed in making glass and ultra-marine.

It is proposed to fuse bauxite with common salt, as one step in a new process for the preparation of soda ash.

Chile saltpetre, or nitrate of soda, is decomposed by bauxite, nitric acid being expelled, and aluminate of soda resulting from the fusion.

Doubtless, by fusing common salt, nitrate of soda and bauxite, soda, aluminate of soda, chlorine gas and nitric acid would be produced, and if the aluminate of soda were to be decomposed by carbonic acid, the alumina could be employed a second time. The extensive manufactures in Newcastle now prepare 60 tons of sulphate of alumina every month from bauxite. They also manufacture aluminate of soda, lime, and baryta and sulphite of alumina. The latter salt is extensively employed in the manufacture of beet sugar. Bauxite will find application as a substitute for alum, and it can be employed for the decomposition of chloride of potassium in working up kelp and the residues from salt works. It is also proposed to use it for the decomposition of barytes.

Very few minerals of recent discovery have attracted so much attention, and it is to be hoped that deposits of it will be discovered, in the United States.

GYPSUM IN NOVA SCOTIA.

At the November meeting of the Nova Scotian Institute of Natural Science, Dr. How presented a paper, in which it was stated that both gypsum and anhydrite are found in Nova Scotia in quantity, exclusively in the carboniferous rocks, in close association with the sedimentary limestones. Gypsum has also been found in small amount, in the fibrous form, in the trap rocks of Blomidon, and as selenite, imbedded in the same rocks at Two Islands. The local term for gypsum is soft plaster, — for anhydrite, hard plaster. The former is sulphate of lime with water; the latter, sulphate of lime without water.

The county of Hants is the chief gypsum raising county in Nova Scotia, and Windsor the principal port of shipment. Operations have been carried on at the Clifton quarry at Windsor about 40 years. The principal rock is gypsum, the anhydrite, a hard plaster being found in lenticular masses from 2 to 10 feet thick in the centre, and sometimes 50 feet long, imbedded in the soft plaster.

Gypsum is exported as blue and white gypsum; the former is the kind chiefly used for agricultural purposes, and, before the recent civil war in America, was being thought of as a manure for cotton. The white gypsum is burned or boiled, by which the water is expelled, and plaster is made by the addition of water. The composition of pure gypsum was stated to be: —

Lime	32.55
Sulph. acid	46.51
Water	20.94
	100.00

A compact opaque white gypsum, called (locally) alabaster, occurs in Antigonish, and has lately been found about 3 miles from Windsor. Selenite, which is the finest kind of gypsum, is abundant in the quarries at Windsor. Other varieties differ in composition from the admixture of oxide of iron, and carbonate of lime and magnesia. Analyses were given of plaster exposed to the weather, which did not vary from that of pure gypsum, of black gypsum, and of hard gypsum (not anhydrite). The composition of anhydrite was stated to be: —

Lime	41.18
Sulph. acid	58.82
	100,00

True anhydrite can give no water. It makes a very good substitute for marble in in-door work; does not admit of being made into plaster by burning, but is equally good if not more valuable than gypsum for agricultural purposes.

No deposit of rock salt of any importance has been found with the gypsum; but the brines of the gypsiferous districts have furnished excellent salt at River Philip and Springhill, Cumberland.

PERCHLORIDE OF LEAD.

M. Nicklés, Professor of Chemistry at Nancy, recently announced to the Academy of Sciences that he had succeeded in obtaining perchloride of lead, derived from the only compound of lead and chlorine, and which now must be called protochloride. The latter is obtained directly by subjecting lead to the influence of chlorine by the application of heat, or else by treating litharge with hydrochloric acid. It crystallizes in needles, is volatile, and cannot be decomposed by heat. M. Nicklés has obtained the new compound by exposing the protochloride to the action of a current of chlorine in a solution of chloride of lime. The perchloride thus obtained is a yellow liquid emitting a strong smell of chlorine, and is a powerful agent for communicating that element to other substances. It will dissolve gold, and produces with aniline and the analogous compounds those beautiful colors for which those substances are so remarkable. With morphine, it yields a color similar to that of the horizon at sunrise; and with brucine, a rich cherry-red. Now, brucine and strychnine, both vegetable bases extracted from nux vomica, are very difficult to distinguish from each other, and here perchloride of lead steps in as a useful agent; for it so happens that it does not produce red with strychnine as it does with brucine, and may therefore be used to distinguish one substance from the other. It serves the same purpose with regard to morphine and the other alkaloids of opium; it will likewise detect bicarbonate of lime in potable water by producing a yellow tint, and help to distinguish salts of lead from those of bismuth, since it precipitates the former from their solutions and not the latter. It will carbonize cane-sugar and not glucose, and blacken aniline without producing any effect either on fecula, starch, or dextrine. Like other perchlorides, it combines with ether to form a very caustic compound, which attacks both gold and platinum, beside other metals.

NEW AND RARE MINERALS.

Partzite. — Mr. Albert Arents describes, in the "American Journal of Science" for May, 1867, a new mineral discovered early in 1865, in the Blind Spring Mountains, in Mono County, California, to which he gives the name of *Partzite*, from Dr. A. F. W. Partz, who first denoted it as a silver ore. It is found in amorphous masses, generally without lustre and rarely of a glistening appearance. Its fracture varies from conchoidal to even, and its color from yellowish-green to blackish-green and black, — the lighter-colored portions containing the most silver; the amount of silver ranges from 4 to 12 per cent. Specific gravity 3.8; hardness 3 to 4. The following is its formula: $(CuO, AgO, PbO, FeO)_3\,SbO_3 + 3HO$. It occurs with argentiferous galena, in veins of a magnitude varying from 9 inches to 8 feet, and has become the object of extensive mining operations.

Ekmanite. — Igelström gives the name of Ekmanite to a new mineral from the iron mine of Brunsjö, in Grythyttan, Sweden. It occurs in veins and bands, penetrating the magnetic iron ore of the mine. The general formula is $2\,(2RO, SiO_3) + 3HO$; in this RO represents the protoxides of iron, manganese, and magnesia.

Alloy of Platinum and Steel. — When these two metals are in a state of fusion, they unite in all the proportions tried. This alloy takes a fine polish, does not tarnish, and its pure color peculiarly fits it for mirrors; its density is 9.862. If two pieces, one of steel and the other the alloy of steel and platinum, be placed in dilute sulphuric acid, the alloy is violently attacked, while the steel remains untarnished. This alloy is thus attacked by acids in all proportions, until 90 parts of platinum with 20 of steel are united.

Ledererite identical with Gmelinite. — Prof. Marsh ("American Journal of Science," Nov., 1867), from several analyses, states that in chemical constitution Ledererite differs from normal Gmelinite only in having a considerable part of the soda replaced by lime. He also lays particular stress on the occasional presence of silica as an impurity in this mineral, interesting not only in its bearing on the paragenesis of minerals, but for the explanation it suggests of many difficulties hitherto experienced in reconciling the results of analyses, especially of silicates.

LEAD, SILVER, AND GOLD.

In a lecture on Chemical Geology, delivered by Dr. Percy at the Royal School of Mines, London, this singular fact is announced, namely: "It may be laid down as a universal proposition, without any exception so far as is known, that all galena contains silver—*all*. There are varieties which contain a very small quantity of silver, and which are therefore said to be 'poor;' still, if search be made for the metal even in the poorest kinds, you never fail to obtain not only traces, but far more than traces, of silver. The silver in the sulphide of lead must, of course, exist as sulphide of silver. Galena is a source of a very large supply of silver in different parts of the world. It may be laid down, also, not merely as a general rule, but, I believe, as a universal proposition, that all galena contains gold—*all* galena. Some years ago Mr. Smith and myself set to work to examine this point, and we made a great many determinations with respect to the presence of gold in the ore of lead, and in various commercial compounds of lead. Forty specimens or more were examined, and every one yielded palpable, visible, unmistakable traces of gold. Still, the quantity of gold is so small as to be utterly worthless in a commercial point of view. Here are the evidences of these facts. Every single specimen of gold extracted in these experiments has been carefully preserved in hermetically sealed tubes, and the condition specified. It requires rather careful manipulation. In these experiments there was no possibility of error. There was nothing added in the way of chemical reagent, which might vitiate the result. The process consists of taking the compound of lead, and simply submitting it to the well-known operation called cupellation, by which silver is extracted from lead. There remains behind a very small globule of silver, and in that globule we are enabled to detect the gold by the simple action of a solvent of silver, nitric acid, which leaves the gold. It has to be taken up with great care, and transferred to a piece of blotting-paper. It is afterward gummed on to a piece of paper and then burnished, when the characteristic color of gold immediately appears. It is a remarkable circumstance that gold is detected not only in the ore of lead, but also in the various commercial compounds of lead,—white lead, red lead, sugar of lead; nay, we have even gone farther, and found it in lead fume, that is, the smoke that is volatilized from lead in the process of its extraction. We may then, I think, safely conclude that lead contains always silver and gold. Perhaps you may object to the deduction with regard to gold as not being sufficiently supported. It is founded on 40 examinations under various conditions. At all events, the proof is strong, if not conclusive."

THE PRECIOUS METALS.

From the earliest times to the commencement of the Christian Era, the amount of the precious metals, obtained from the surface and bowels of the earth, is estimated to be 4,000,000,000 dollars; from the commencement of the Christian Era to the discovery of America, another sum of 4,000,000,000 was obtained; from the date of the latter event to the close of 1842, an addition of 9,000,000,000 was made; the discovery and extensive working of the Russian gold mines in 1843 added to the close of 1852, 1,000,000,000 more; the double discovery of the California mines in 1848, and the Australia mines in 1851, added, to the close of 1867, 4,000,000,000; making a grand total, to the close of 1867, of 22,000,000,000 dollars. The average loss by abrasion of coin is estimated to be a tenth of one per cent. per annum; and the average loss by consumption in the arts, and destruction by fire and shipwreck, at from 2 to 8,000,000 dollars per annum. The amount of the precious metals in existence is estimated to be 12,000,000,000 dollars, which is estimated to be about equally divided between gold and silver. Of the amount now in existence, 7,000,000,000 are estimated to have been obtained from the continent of America, 2,000,000,000 from Europe, 2,000,000,000 from Asia, and the remainder from Africa and other sources.

The following statement will exhibit the annual product of the precious metals throughout the world in 1867: —

Countries.	Gold.	Silver.	Total.
America	61,000,000	47,000,000	108,000,000
Europe	29,000,000	7,000,000	36,000,000
Asia	15,000,000	5,000,000	20,000,000
Africa	6,000,000	2,000,000	8,000,000
Australia	66,000,000	1,000,000	67,000,000
Other countries	12,000,000	1,000,000	13,000,000
Grand Total	189,000,000	63,000,000	252,000,000

The following statement will exhibit the annual product at other periods: —

A. D.	Gold.	Silver.	Total.
14	800,000	4,200,000	5,000,000
500	200,000	2,800,000	3,000,000
1000	120,000	880,000	1,000,000
1492	100,000	150,000	250,000
1600	2,000,000	9,000,000	11,000,000
1700	5,000,000	18,000,000	23,000,000
1800	15,000,000	37,000,000	52,000,000
1843	34,000,000	39,000,000	73,000,000
1850	88,000,000	47,000,000	135,000,000
1853	236,000,000	49,000,000	285,000,000
1863	180,000,000	60,000,000	240,000,000

The value of gold assessed for Internal Revenue the past year has been 81,389,541 dollars. Of this amount, 70,032,805 were assessed on the Pacific side; 25 per cent. of the whole product being estimated as having escaped assessment. Adding this, and allowing about half the gold assessed in the East to be foreign, the total domestic production is estimated at 93,219,374; an increase of 19,675,015, in comparison with 1865.

The different states and territories have yielded in the following order: California about one-third; Nevada, one-fourth; Montana, one-sixth; Idaho, one-twelfth; Colorado and Oregon, one-sixth of the total amount.

TIN IN THE UNITED STATES.

There has been recently discovered in Missouri an extensive system of tin-bearing veins, under conditions which characterize similar deposits in Cornwall, Zinnwald, and Attenberg. The annual imports of tin, and its manufactures, into the United States, now exceed 5,000,000 of dollars, four-fifths of which is imported from Great Britain. If this demand could be supplied from the product of our own country, it would contribute essentially to the national industry and wealth. The ore is found in the form of oxide and sulphuret, associated with tungsten and its ores, copper, iron, soapstone, kaolin, asbestos, and serpentine.

GEOLOGY.

METAMORPHISM.

Mr. J. Geikie, in the "Proceedings of the Geological Society," communicates a paper "On the Metamorphic Lower Silurian Rocks of Carrick, Ayrshire," which furnishes important evidence in support of the opinion that metamorphism is due to hydrothermal action. In his opinion, the examination seems to prove: 1. That the strata (felspathic, dioritic, serpentinous, and calcareous rocks) owe their metamorphism to hydrothermal action. 2. That the varying mineralogical character of the rocks is due principally to original differences of chemical composition, and not to infiltration of foreign matter at the time of metamorphism. 3. That the highly alkaline portions of the strata have been most susceptible of change. 4. That in beds having the same composition, but exhibiting various degrees of alteration, the intensity of the metamorphism has been in direct proportion to the amount of water passing through the strata. 5. That in some places the rocks have been reduced to a softened or pasty condition.

ANTIQUITY OF LIFE UPON THE EARTH.

At the annual meeting of the Swedish Academy of Science, M. Nordenskiold announced that a discovery of great importance to geological science had been made in the hill of Nullaberg, Sweden. A large deposit of bituminous gneiss, 33 metres in thickness, has been found imbedded in layers of gneiss and mica schist. It is composed, in addition to felspar, quartz, and mica, of a black, coal-like substance, containing carbon and hydrogen, — in fact, a real organic substance, formed of the remains of plants or animals coeval with the deposit. He added that there could be no doubt as to the antiquity and geological situation of the strata of Nullaberg; infiltration was impossible. The inference was that the crystalline stratified rocks of Scandinavia were formed when there existed animated creatures, but at a long time anterior to the period when life is supposed to have first existed on the earth.

PRIMITIVE CLIMATE OF THE EARTH.

The primitive atmosphere of the earth was greatly richer in carbonic acid than the present, and therefore unfit for the respiration of the warm-blooded animals. The agency of plants in purifying this atmosphere was long ago pointed out, and the great deposits of fossil fuel have been derived from the decomposition of this excess of carbonic acid by the ancient vegetation. In this connection the vegetation of former periods presents the phenomenon of tropical plants growing within the polar circle. Prof. T. Sterry Hunt considers as unsatisfactory the ingenious hypotheses proposed to account for the warmer climate of ancient times, and thinks that the true solution of the problem is to be found in the constitution of the early atmosphere, when considered in the light of Dr. Tyndall's researches on radiant heat. He has found that the presence of a few hundredths of carbonic acid gas in the atmosphere, while offering almost no obstacle to the passage of the solar rays, would suffice to prevent almost entirely the loss by radiation of obscure heat, so that the surface of the land beneath such an atmosphere would become like a vast orchard-house, in which the conditions of climate necessary to a luxuriant vegetation would be extended even to the polar regions.—*Mech. Mag., August*, 1867.

NATURE OF GRANITE.

The effect of the internal heat of the earth upon the buried sediments in early geological times would be to soften them, produce new chemical reactions between their elements, and convert them into what are called crystalline or metamorphic rocks, such as gneiss, greenstone, granite, etc. It is often said that granite is the primitive rock or substratum of the earth, but this is not only unproved, but, in the opinion of Prof. T. S. Hunt, extremely improbable. He considers that the composition of this primitive rock, now everywhere hidden, must have been much like that of a slag or of lava, and that there are good chemical reasons for the belief that granite is in every case a rock of sedimentary origin,—made up of materials deposited from water, including in its composition quartz, which, so far as known, can only be generated by aqueous agencies, and at comparatively low temperatures.

Prof. Ansted read a paper before the British Association, in 1867, on the conversion of stratified rock into granite. Geologists until recently have spoken of granite as a primitive rock, as the nucleus of the earth, and as having been from time to time erupted, playing an important part in the general disturbances by which the framework of the earth is supposed to have been constructed. The observations of Daubrée and Sorby show that all true granite had been elaborated with water under great pressure, at a temperature below melting heat; that it had neither been ejected, nor had it formed a framework. There are granites of all ages, and of many kinds. Numerous observations show that granite alternates with and passes into stratified rocks, and must itself in such cases be stratified rock, and that its production does not necessarily involve the destruction and obliteration of all the stratified rocks with which it is associated. This view of the nature of granite will greatly affect the theories of geology.

ORIGIN OF MOUNTAINS AND VALLEYS.

Mr. A. Geikie, in a lecture at Dundee, in September, 1867, alluded to the popular idea which refers mountains and valleys to great convulsions, throwing up huge masses of matter and forming vast chasms between. The arguments which he considers conclusive against this theory, as exhibited in the geological structure of Scotland, he arranged under three heads. 1. While the hills and uplands consist for the most part of hard rocks, the broad valleys are generally found on the soft rocks. In the highlands, for example, the formations are mostly hard and crystalline metamorphosed rocks, while the lowlands, which run along their edges, are of red sandstone and other soft rocks, — the distinction between the two being strikingly marked by the physical configuration. 2. The hills and mountains are not due to corrugations of the earth's crust, nor to the form assumed by melted rock when forced from beneath to the surface, as the mountains lie in the troughs, while valleys are found where, if the popular theory were true, mountains ought to be. Volcanic action cannot account for the arrangement of the rocks, which must owe their form to some general agency affecting all alike. 3. Valleys are found to run across faults at all angles, and to have no relation to them whatever, and their systems are altogether inconsistent with the idea that they were due to any subterranean causes. He considers the present outlines of Scotland as having resulted mainly from denudation, modified by local peculiarities, — the agents in this extensive process having been the sea, the atmosphere, rain, frost, rivers, glacier-ice, etc.; the shaping of the land depending, not on primeval terrestrial convulsions, but on the slow and silent progress of the same agencies of waste which are at present changing the outlines of the country.

COURSE OF RIVERS.

M. Babinet stated before the French Academy, as a general rule, that rivers always tend to turn to the right, and consequently to deposit toward the left their alluvium. M. Leymerie ("Comptes Rendus," May 27, 1867), confirms this opinion by observations in the valleys of the Garonne and the Tarn, and also in the smaller valleys of the Pyrenees. It is evident that the force which produced this tendency to the left in quaternary periods must have had considerable energy, and its study cannot fail to be of great geological interest.

GEOLOGICAL RELATIONS OF THE MASTODON AND FOSSIL ELEPHANT OF NORTH AMERICA.

Prof. Hall, at the meeting of the "American Association for the Advancement of Science," at Burlington, Vt., in August, 1867, began by remarking upon the general opinion at first popularly expressed and generally adopted by geologists, that the mastodon had lived during the present epoch, and that the skeletons or bones found in the peat marshes or swamps were the remains of those animals which had frequented these places in search of food or saline water, as the deer frequent the salt licks, and becoming mired in the soft mud, their remains had been preserved. Although accepting this view of the subject, he had never regarded it as a philosophical one, and with our former knowledge there were many circumstances irreconcilable with that view. He showed the relation of these peat swamps to the surrounding and underlying deposits of drift, remarking that from the few instances in which bones or teeth had been found in gravel it had been supposed that they were derived from their original position in the swamp by the more recent breaking up of the deposit and their distribution in modern streams. He showed, moreover, from the nature of the surrounding deposits, that whatever might have been the original distribution of the bones of those animals, none would have been preserved except those covered by the mud and peaty deposit. He also adverted to the fact that a few teeth or bones had been found in the midst of a bog under circumstances that had proved them to have been deposited as they were found, and not to have come there as a part of the entire animal. Adverting to the conditions surrounding the Cohoes mastodon, he showed that the river for some miles west of Cohoes, and thence to the Hudson River, was now running in a modern channel, having left the old channel, which was filled with drift. This modern channel has cut deeply into the rocks of the Hudson River group which form the bed and banks of the stream. On the south-west side of the river, and at an elevation of about 125 feet above its bed, the plateau of rock had been excavated for the foundation of a mill by the Harmony Mills Company of Cohoes. The entire area of more than 400 feet in length, and more than 200 feet in width, was marked by pot-holes penetrating to a greater or less depth into the rock, — some of them only a few feet in depth, and others 40 or 50 feet deep, with a diameter in some parts nearly as great. Many, if not all these pot-holes, are smaller at the top than below. In some cases several smaller pot-holes have been worn into one. During this excavation in September, 1866, the lower jaw of a mastodon was found in one of the smaller pot-holes, which communicated with a larger one, and at the depth of about 25 feet below the original surface of the rock. In continuing the excavation there was found in the bottom of an adjacent larger pot-hole a large part of the skeleton of the mastodon, including the skull, many of the vertebræ and ribs, one scapula, and a nearly complete fore limb, one-half the pelvis, and one hind limb, with the femur of the other, beside a few other bones. These were all on one side of the pot-hole, while at a distance of 20 feet on the other side several bones were found. This point was about 25 feet below the level at which the lower jaw was found, and some 60 feet or more distant from and to the eastward of the point where the jaw was found. Several months later, in excavating on the outside of the mill, a part of the bones of the fore leg were found in a pot-hole at or near the same level on which the jaw was found, and 50 feet or more distant to the southward of that point. These bones evidently all belonged to the same individual. In each case the lower part of the pot-hole was filled with gravel, on which rested a deposit of river ooze and mud, in which the bones were imbedded. Upon this, in all the pot-holes, was a deposit of peaty matter and mud, and in the larger pot-hole were trunks of trees of several species, and in great abundance. The distribution of these bones in the manner described could never have taken place according to the usually accepted mode of the imbedding of the animal in swamps, etc., and Prof. Henry argued that they could have been thus disposed either by the action of moving water or of ice. He was inclined to the latter view, and that the remains in question had been frozen into the ancient glacier covering the country, as the remains of the mammoth in Siberia; and that, on the melting of the glacier, these bones were dropped and carried into the cavities where they have now been found.

Prof. Agassiz coincided with the latter supposition, but thought that Prof. Hall did not go far enough in his views on the glacial action. Not only was the disposition of the bones the result of that action, but the pot-holes were also formed by glaciers. They were caused by water-falls, as the formation of precisely similar holes by these means, in Switzerland, fully demonstrated.

Both conclusions, as to the age of the mastodon and those relating to the glacial action in the distribution of the bones, being disputed, Prof. Dawson, of Montreal, declared himself a disbeliever in the American glacial theory. Other eminent geologists held the same opinion, and the mastodon was in turn referred to several ages before, after, and during the glacial periods.

If the views of Prof. Hall be accepted, it will place the age of the mastodon anterior to the last glacial epoch. The remains of the mammoth, or fossil elephant, occur under similar circumstances, and were no doubt coëval with the mastodon.

SILURIAN FOSSILS.

According to Dr. Bigsby's catalogue of silurian fossils from all parts of the world, as published in the "Proceedings of the Royal Society," No. 90, 1867, there are 3,145 known American species, and 4,325 European, of which only 179 are common to the two regions. In the primordial zone, the first in which a true fauna has been discovered, we find evidence of the existence of more than 900 species. He finds that 12 per cent. of the whole number of species occur in more than one horizon, and that the same species may be typical of one horizon in one country, and of more than one in another. Of the species which pass into the Devonian period, he has identified 42, and only one of these (*Chonetes sarcinulata*) is known to have lived in the carboniferous period. These extra-epochal species, as he calls them, were of migratory habits, few being found in two epochs in the same country, but in different countries.

MIOCENE FLORA OF NORTH GREENLAND.

In the Journal of the Royal Dublin Society, Prof. O. Heer describes a collection of fossil plants from the arctic regions, from Atanekerdluk, in lat. 70° N., and from a height of 1,080 feet. He has recognized 63 species, and believes that the plants grew on the spot where their remains are found. Adding 3 species before described, out of the 66, 18 are found in the miocene of central Europe, 9 being common to the upper and lower molasse, while 4 have not as yet been noticed in the upper molasse; he therefore infers "that the fossil forest of Atanekerdluk flourished in that high northern latitude at the lower miocene epoch," and that north Greenland had a much warmer climate during the miocene period than it has at present. He estimates that a rise of temperature of 30° F. would suffice to render possible the existence of these plants in that locality. There were found two species of *Sequoia*, one of which (*S. Langsdorfii*), found fossil as low as central Italy, is the most common tree at Atanekerdluk; it is so closely allied to the redwood (*S. sempervirens*) that he regards the latter as its lineal descendant. This tree requires a summer temperature of 59° or 60° F., and for the ripening of its fruit and seeds one of about 64°; the winter temperature must not fall below 31°, and the mean annual temperature must be about 49°. The climate of Greenland, therefore, must have been at least as warm as that of Lausanne, and was probably somewhat warmer. He says, "It is impossible, by any rearrangement of land and water, to produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner;" and concludes with the remark, "that we are here face to face with a problem whose solution, in all probability, must be attempted, and we doubt not completed, by the astronomer."

GOLD REGION OF CANADA.

In the region of Hastings, Upper Canada, gold occurs in rocks of the Laurentian age, associated, 1, in the black carbonaceous matter; 2, in the reddish ochrey oxide of iron, found in the same crevices as the latter; 3, in plates in the midst of crystalline ferriferous bitter-spar. These singular relations are thus explained by T. Sterry Hunt, Esq.: "The black matter, probably in the form of bitumen, was first introduced into the fissures, which were subsequently filled with the ferruginous bitter-spar, whose deposition was contemporaneous with that of the gold, and whose decomposition no doubt yielded the ochreous oxide of iron."

GOLD IN NOVA SCOTIA.

Mr. Thomas Belt, in a paper read before the Nova Scotia Institute, accounts for the poverty of the gold deposits of that province by the absence of true alluvial deposits there. He maintains that the drift, had it been deposited from floating icebergs on a submerged land, must have been levelled when, at the time of elevation, it was exposed to the action of the waves on the coast. The sparing dissemination of grain gold through the drift affords another argument in favor of the supra-marine theory.

In Australia the most important deposits of alluvial gold have been found in valleys immediately above the bed rock, beneath beds of gravel and clay; and much richer deep sinkings have been discovered in the vicinity of surface washings, — a seemingly necessary result of the sorting arrangement of water. In Nova Scotia, though denuded auriferous quartz lodes are abundant, no similar deposits have been found; the gold is either distributed throughout the superficial deposits, or occurs in greatest abundance at the surface. In Australia the denuding agent was water, which carried off the ground-up rocks, but left the gold behind. In Nova Scotia the denuding agent was glacier ice, which carried off both the stony masses and their metallic contents. The drift beds left contain only the same proportion of gold as existed in the original rocky mass, excepting where aerial denudation has concentrated it on the surface.

AGE OF THE "TRAIL" AND THE "WARP."

Rev. O. Fisher, in the "Geological Magazine," May, 1867, maintains that the palæolithic period was more ancient than the formation of the "trail," and formed some part of the interval between 100,000 and 200,000 years before A. D. 1800. Then, after the glacial era of the trail, followed a period of equable seasons, of about 80,000 years' duration, which would have been that of the submarine forests and their occupants. After this came the period of the warp, a short period of severe winter cold; and, finally, the period of the last submergence of our valleys had passed away about 8,000 years ago.

CANADIAN FLORA.

According to Dr. Dawson, who has published in the "Canadian Naturalist" a list of some of the plants found in the Leda-clay deposit, on the Ottawa, the species found are the most hardy ones of the present flora. He shows that this is not an accidental selection, nor due to the river bringing refuse from more northern latitudes. He infers from this that there has been refrigeration,— a fact which seems borne out by what would occur were the land again submerged to the extent that it was at the time of the deposition of the Leda clay; a climate like that of Labrador would be the result.

ANCIENT VEGETATION OF NORTH AMERICA.

At a meeting of the Lyceum of Natural History, in New York, in May, 1867, Prof. Newberry presented a paper on the above subject. The most important facts cited were as follows: —

Vegetables only have the power to assimilate inorganic substances in nature, the animal kingdom being wholly dependent on the vegetable for its subsistence, and could not exist without it. Plants must therefore have preceded animals upon the globe; and spontaneous generation, if it were possible, should result in the production of plants first, of animals only from them. Remains of plants occur in the oldest rocks, but only of the lowest types, seaweeds.

The first land plants appear in the upper devonian rocks, conifers, ferns, lycopods, etc., the advance guard of the carboniferous flora, and having the same general character. From the variety and comparatively high organization of these plants we must infer either the somewhat sudden creation of an elaborate flora, or a great hiatus in geological history, in which its origin and development are lost.

The carboniferous flora of America is essentially the same as that of the coal measures of the Old World. Of 600 species recognized here, at least one-third are considered identical with European forms, while the genera are nearly all the same.

The carboniferous period was one of depression in this country, the western part of the continent being all beneath the ocean, though extensive land-surfaces had existed there before. A belt of country north of the St. Lawrence was then — as it has constantly been since the beginning of the palæozoic ages — out of water, as was most of New York, and part of New England. The coal-plants grew in marshes on the western margin of the land, at the sea level; a gradual submergence producing a succession of vegetable deposits, one above another. The climate was moist, uniform, and warm, but not hot, as vegetable matter would, in that case, have decayed and not bitumenized. The atmosphere was also more highly carbonated than now. From the similarity of the flora of the coal measures in different countries we must conclude that all the vegetation of the world at this period was of the character indicated by these specimens, and that more highly organized plants had not yet been called into existence.

The permian flora was not represented in any collection made on this continent; but from the plants obtained from the permian rocks abroad, it was evident that the flora of that period was, like the fauna, but a continuation of that of the carboniferous.

In passing the interval which separates the mesozoic from the palæozoic ages we enter a new world, in which all the aspects of nature were quite unlike those of the preceding periods. New molluscs and new fishes swam in the seas; reptiles were the monarchs of animated nature, — swimming, walking, flying, carnivorous and herbivorous, in size ranging from the mouse to the whale, they filled the places now occupied by reptiles, birds, and mammals. The vegetation of the triassic and jurassic periods was as peculiar as the fauna, and constituted a distinct chapter in the botanical history of the world. The most conspicuous plants of this flora were the cycads, which had no existence before, and have since formed but an insignificant portion of the vegetation of the earth's surface.

With the commencement of the cretaceous period the flora of the world was again revolutionized, and the highest order of plants — the angiosperms — made their first appearance, in Europe mingled with the remains of the preceding flora, in America in overwhelming numbers. In the lower cretaceous rocks of this continent we have already discovered nearly 100 species of broad-leaved dicotyledonous plants, including several genera now living in our forests, such as willows, poplars, tulip-tree, sassafras, magnolia, sycamore, beech, etc. From these facts it appears that the vegetation of North America had not greatly changed from the beginning of the chalk period to the present time, showing great permanence in the physical condition of the country.

Of our eocene flora we have obtained few specimens. The flora of Europe during that period was decidedly tropical in character.

The miocene flora of America has been very fully illustrated by the collections made in Mississippi, on the Upper Missouri, near the mouth of Frazer's River, on the McKenzie, and on Disco Island, off the west coast of Greenland. Over 100 species have been obtained from these localities, some of which were common to them all. Several of these species are now living in our country, and quite a number have been found in the miocene tertiary of Europe.

The most important part of Dr. Newberry's paper was that which included a comparison of the miocene flora of America with that of Europe of the same age, and both with living floras of the two continents. The conclusions derived from their comparisons are briefly as follows: —

1. The living flora of North America is the legitimate progeny of the cretaceous and tertiary floras of the same continent; most of the genera of the earlier floras being continued into the present one, and many species of the miocene being apparently identical with some now living.

2. In the miocene epoch the European and American continents were connected at the north, and over this bridge the American flora passed to Europe, leaving its records on Disco Island, Iceland, the Island of Mull, etc. This flora is that of a temperate climate, and, following a depression of temperature, it replaced the eocene tropical flora of Europe, and for a time covered the surface of that country with American plants, magnolia, liquid amber, sassafras, etc.

3. That at a subsequent period the connection between the two continents was severed by a depression of north-west Europe, and the American flora was nearly exterminated by the present flora of Europe, which is mostly of Asiatic origin.

4. The present flora of China and Japan, as Professor Gray has shown, has many American elements, probably the living representatives of the miocene flora. One genus (*Glyptostrobus*), a conspicuous feature in the miocene flora in America and Europe, is now living only there; and several American miocene and living species now form part of the flora of Japan. These plants are probably the descendants of American miocene emigrants.

THE TACONIC SYSTEM.

At a meeting of the Boston Society of Natural History, in December, 1867, Rev. Mr. Perry read a paper upon the red sandstone of Vermont, and its relations to other rocks. Mr. Perry claimed that the red sandstone was the equivalent of the Potsdam sandstone of the New York geologists, and that the adjacent formations to the eastward were not highly metamorphosed rocks of a more recent period, as has been constantly asserted, but were older than the red sandstone, and lay unconformably beneath it. These opinions were the same in general as those persistently though unsuccessfully urged by the late Dr. Emmons. Mr. Perry further maintained that the beds underlying the red sandstone could not be considered as an extension of Potsdam sandstone downward, but that with it they constituted a grand division of rocks, to which Emmons's name of Taconic might be applied, and which was equivalent to the "Primordial Fauna" of Barrande.

The Potsdam sandstone was the uppermost member of this group, and clearly distinct from the overlying lower silurian or Champlain system. By a careful study of the rocks in place, and of their limited series of fossils, Mr. Perry had discovered that the Taconic system, as developed in north-western Vermont, was divisible into three groups, stratigraphically unconformable to each other. The lower division consisted of talcoid slates and conglomerates, and was destitute of fossils; the middle should probably be separated into two series, the black slates and the Georgia slates, each with its distinctive fauna; the fossils of the upper division, or Potsdam sandstone, again represented new forms of life.

ATMOSPHERIC ACTION.

The carbonic acid of the air slowly attacks the rocks above the ocean level, and thus turns them to clay, forming carbonates with the soda, potash, lime, and magnesia set free, and carries these down as carbonates to the sea, where the carbonate of soda decomposes the chloride of calcium of its waters, and forms common salt and carbonate of lime. This series of actions is the source of the salt of the sea, of all clays, and of limestones which are chemical and not organic in their origin. Organic living things do not generate the carbonate of lime, but appropriate it, when formed for them by chemical reactions; and thus great portions of our limestone rocks are made up of fossil remains. In 44 feet of limestone, there is separated and condensed from the air a large atmosphere of carbonic acid gas; the early atmosphere was therefore very dense and unfit for the sustenance of the higher forms of life, until by far the greater portion of this gas had been removed by the formation of the carbonate of lime and vegetable matter now constituting coal and petroleum.

GLACIERS IN THE TROPICS.

Dr. Newberry, in remarks on the facts which had been considered as proof of the existence of glaciers in the tropics, said that such a depression of temperature on the earth's surface as would fill the valley of the Amazon with ice would so profoundly affect the life-history of the globe, that we could only accept it as an established fact on the most unquestionable evidence; that, if the fact were proved, we must accept it with all its consequences, for the true attitude of the man of science was that of a patient and teachable child, sitting at the feet of Nature, and receiving her instructions without prejudice or passion; but, until the evidence of the former existence of glaciers in Brazil is proved beyond a doubt, we must continue to give weight to the facts which seem incompatible with it. These are: —

1. That nearly all forms of vegetable and animal life on the globe would necessarily have been destroyed by a degree of cold that would produce a glacier filling the valley of the Amazon; whereas nearly all the fossil plants and molluscs of the strata deposited immediately anterior to the glacial epoch are undistinguishable from species now living in the same region. To make this fact consistent with glaciers in the tropics, we must suppose a new creation of undistinguishable species, in similar relative numbers and distributed precisely as the pre-existent ones were.

2. Though unmistakable marks of glacial action are found on all parts of the North American continent, down to the parallel of 39 degrees, and on the mountains of California to the 35th parallel, they are not found further south, as they should have been if the "ice period" froze the waters of the Amazon.

VOLCANIC ERUPTION IN NICARAGUA.

In the city of Leon, on the afternoon of the 14th November, 1867, the people were startled by the sudden and almost instantaneous breaking out of a number of volcanic rents on the western or Pacific slope, near the base of the long extinct twin volcano of Rosa, the middle one of the chain of volcanic cones which follow each other in close succession from the northern extremity of the lake of Managua to the Volcan el Viejo, the most prominent of either, and a landmark for strangers desiring to enter the port of Realejo.

The first intimation of the eruption to the inhabitants of Leon, only 10 miles distant in a direct line from the scene of the eruption, was a low rumbling sound like distant thunder, shortly followed by quick, sharp, and continuous reports, resembling the roar of a not far distant battery of heavy artillery; these reports, and subsequent ones, were distinctly audible, on clear nights, at the port of Corinto.

On the night of the 14th, as soon as darkness followed the day, there was revealed a sight which but few people in Central America or elsewhere ever witnessed. Two large volcanic fires, with several smaller ones scattered about on the plain, shed their lights on the surrounding country, and even lit up with a warm glow the towers of the cathedral in the plaza of Leon.

Thus far the eruptive matter consists only of large masses of molten lava, scoria, and ashes, unaccompanied by any lava stream. The latest information states that a cone of about 20 feet of elevation had been formed round the principal orifice, but whether caused by upheaval, or by the deposition of scoria and ashes, is not stated.

THE ERUPTION OF VESUVIUS.

A letter from Naples, dated November 20, 1867, gives the following particulars of the eruption of Vesuvius.

During the last two years a small cone has been formed by the matter gradually ejected from this sulphurous hole. We could scarcely see its head above the walls of the large crater, but within the last week it has shot up above the large crater, and this it is which has been fuming and spluttering and storming since last Wednesday. It has sent forth an immense quantity of lava, converting the surrounding crater into a lake of fire. At first the high circling walls kept it within bounds, but gradually it has risen and risen until it is now flowing in several directions where the abrupt and irregular wall admits of a passage.

Ascending by the usual road, we were compelled, on approaching the summit, to skirt a little round to the south-east, for two reasons, — first, to get on the blind side of the wind, which might have brought down upon us an inconvenient shower of stones; and, secondly, to obtain a better view of the main stream, which was fed, not only by the great crater, but by another orifice opened outside, about 20 feet in diameter. From this spot the stream of living fire, full 20 to 30 feet in width, poured down to the bottom of the mountain rapidly where it met with no obstacles, and, where it did, struggled energetically until it carried everything before it. To the edge of the crater it was impossible to approach; the heat was scorching, and the lava threatened to boil over and come down upon us. It was difficult, therefore, to form any fair estimate of its size, but one might have supposed that it was not over 70 feet in diameter. It was not a moment, however, for figures, when nature was exhibiting her power in one of its grandest forms. There was a roar and a shock, and then shot forth flames and stones full 1,000 feet in height, at intervals of from 1 to 5 seconds, according to the watch of one of the party. These tremendous convulsions were repeated, and then came the descending shower, composed of stones of various sizes, some certainly half a ton in weight, judging by the bulk. We could mark their course by the eye as long as they retained their red heat, but on approaching the earth they blackened, and then the ear alone could tell what was pitting the earth around.

The eruption has continued to the present time (Jan., 1868), and promises to be one of the grandest, and, it is feared, one of the most destructive, known in the history of this volcano.

BIOLOGY;

OR, PHYSIOLOGY, ZOÖLOGY, AND BOTANY.

CHEMICAL THEORY OF CELL FORMATION.

DR. C. MONTGOMERY has written a very remarkable paper, read before the Royal Society, December 20, 1866, on the above subject. The whole paper has a very particular interest, and his facts are well worth verifying by all who have an opportunity of doing so. From preliminary observations rationally treated, the above gentleman made the following experiments: A viscid substance was required, and myeline, after a long search, was found to be the one. When to myeline in its dry amorphous state water was added, slender tubes were seen to shoot forth from all free margins, "being sometimes wonderfully like nerve tubes in appearance, flexible and plastic." From this crystallization was inferred, and this extension was prevented by an intimate admixture with the white of an egg; clear globules resulted from imbibition by a viscid substance. By further extensions of this observation and similar ones, globules with lively molecular movement were found. A typical cell with nucleus, and even nucleolus, and "the white margin so often mistaken for a cell wall, was always present." This latter fact will be a decisive answer to Mohl's theories. Mother-cells were formed. Lastly, globules were obtained with another inclosed smaller globule, and this was sometimes multiple, like the typical pus-cell. If, instead of water, serum be added to the thinly-spread myeline, bi-concave discs will form, only generally much larger than blood corpuscles. The changes in theory effected by these precise facts will, of course, be very great. The author observes that "'cells' being thus merely the physical result of chemical changes, they can no longer afford a last retreat to those specific forces called vital. Physiology must aim at being something more than the study of the functions of a variety of ultimate organic units." — *Chemical News.*

BLANCHING OF THE HAIR.

Physiologists have been at a loss to account for the sudden whitening of the hair, which is known to be produced by intense and sudden terror or profound grief. Mr. Erasmus Wilson, in a paper recently read at the Royal Society, threw considerable light upon the question. The paper was founded on a case apparently unique, in which every hair of the head was colored alternately brown and white from end to end. The white segments were about half the length of the brown, the two together measuring about one-third of a line. Mr. Wilson suggested the possibility of the brown portion representing the day growth of the hair, and the white portion the night growth, and this opinion was corroborated by the remarks of Dr. Sharpey and others of the Fellows who took part in the discussion which followed the reading. Under the microscope the colors of the hair were reversed, — the brown became light and transparent, the white opaque and dark; and it was further obvious that the opacity of the white portion was due to a vast accumulation of air-globules packed closely together in the fibrous structure of the hair, as well as in the medulla. There was no absence of pigment, but the accumulation of air-globules veiled and obscured the normal color and structure. Mr. Wilson observed that, as the alteration in structure, which gave rise to the altered color, evidently arose in a very short period, probably less than a day, the occurrence of a similar change throughout the entire length of the shaft would explain those remarkable instances, of which so many are on record. of sudden blanching of the hair; and he ventured to suggest that during the prevalence of a violent nervous shock the normal fluids of the hair might be drawn inward toward the body, in unison with the generally contracted and collapsed state of the surface, and that the vacuities left by this process of exhaustion might be suddenly filled with atmospheric air. Dr. Sharpey mentioned a recent example of sudden blanching of the hair, which had been observed by Dr. Landois, of Greifswalde, as reported in Virchow's Archiv, and which was ascertained to be due to accumulation of air-globules in the fibrous substance of the hair. — *Lancet.*

MIND AND CORRELATION OF FORCE.

In a lecture delivered at the Royal Institution, on the "Doctrine of the Correlation of Force in its bearing on Mind," Prof. Alexander Bain shows that the extension of that correlation to mind must be made through the nerve-force. According as the mind is exerted, force is drawn away from the proper corporeal functions, which are to that extent weakened. We all know by common experience that great mental exertion is rarely combined with great physical robustness; neither do we find many examples of a combination of different modes of mental excellence. Leonardo da Vinci was a great artist and a great man of science; but how few have there been like him! Great sensibility is seldom associated with great activity of temperament, nor intellectual originality with emotional exuberance.

NEAR AND FAR-SIGHTEDNESS.

Until recently "near-sightedness" and "long-sightedness" have been explained by assuming in the first case that in consequence of the too great convexity of the cornea and crystalline lens, one or both, the focus is formed in front of the retina, while in the second the rays of light are concentrated behind the retina, because the convexity of the parts just mentioned is too small. The correction of these imperfections by the use of concave glasses in the first instance, and of convex ones in the second, seemed to be all that was needed to show that the explanation was true. It certainly had the merit of meeting the facts, and so has been almost universally accepted by physiologists, and has found its way into every text-book touching upon the optical structure of the eye. That these conditions, if they existed, would produce the effects indicated, no one will doubt; but it should not be lost sight of that the alleged conditions of the cornea and lens were never satisfactorily shown to be attendants of the two abnormal states of the eye of which we are speaking. Recent investigations have proved that both near and long-sightedness may be, and in most cases are, the result of wholly other causes.

A moment's reflection will make it apparent to any one that, the refracting media being quite normal, if, in consequence of the axis of the eye being too long, the retina is too far behind the lens, the rays will meet in front of this, and thus short-sightedness will of necessity follow. The average length of the axis of the eye is a little less than an inch, namely, 24.25 millimetres, or about 0.95 inch. Donders has shown that in near-sighted persons it exceeds an inch, and may amount to 1.2 inch, and even more, the other diameters being unchanged. In this case the ball of the eye becomes more or less oval or egg-shaped, and when turned strongly toward the nose will fill the orbit more than usual at the outer angle. Concave glasses will, of course, be required to disperse the light sufficiently to bring the rays to a focus on the retina. In proof that too great convexity of the cornea does not produce near-sightedness may be urged the fact that this convexity is greatest in children, but, as Volkmann observed, children are rarely near-sighted.

In regard to long-sightedness, if the alleged cause of it, namely, the flattening of the cornea and crystalline lens, existed, this would of necessity form the focus, other things being the same, behind the retina; but no proof was ever brought forward that this flattening actually did exist in the majority of cases. In adopting this explanation, its inconsistency with the fact that elderly persons still see far objects distinctly seems to have been overlooked by physiologists. The persistence of this faculty was of itself sufficient evidence to make it probable that no permanent change took place in the form of the lens, since this would impair the eye for seeing objects at a distance, as well as those near at hand. Kramer and Helmholz have shown that the accommodation of the eye for seeing near objects depends upon a temporary change in the form of the lens, this becoming more and more convex as the object approaches the nearest point of distinct vision. This is proved by watching the relative position of the three images of a candle as seen reflected, 1, from the front of the cornea; 2, from the foremost or convex surface of the capsule of the lens; and 3, from the hindmost or concave surface of this capsule. The image from this last is inverted, and that from the front of the capsule is in the middle of the three.

The attention of the person whose eye is observed being directed to a distant point, if it be suddenly changed to a near one in the same straight line with the first, so that no motion of the globe of the eye will be necessary, the central image will change its size, becoming smaller, showing that the reflecting surface has become more convex, and at the same time will change its place to one side, showing that the front of the lens has moved forward. The first and third images undergo little or no change. It is the loss of this power of changing the form of the lens,— a power necessary to the distinct vision of near objects,—that chiefly gives rise to long-sightedness in persons growing old. The inability to accommodate, according to Donders, depends upon the lens becoming harder, and therefore less compressive, and so offering greater resistance to the ciliary muscle, the chief agent in producing the compression required. When directed to distant objects, the accommodating power is at rest, so that the sense of effort is wholly absent. Most persons are, however, conscious of a distinct effort, and those who are becoming long-sighted, painfully so, when the eye is directed to a near object. It is commonly believed that near-sighted persons, as they grow old, acquire the power of seeing objects at ordinary distances, because their too convex refracting media become flattened with advancing age. This may and does happen to a slight degree in a few, but not in the majority of cases. For the most part, near-sighted persons, as they grow old, find that the near point of distinct vision recedes, while the far point undergoes but little change. This is an important fact in opposition to the theory of flattening, heretofore so generally accepted, and is fully explained by the loss of power to accommodate. — *The Nation.*

PERSISTENCE OF THE DIFFERENT COLORS ON THE RETINA.

Light has been hitherto considered as divisible only into the various colored rays by single, and into polarized rays by double refraction. A new distinction has been discovered, founded on the varied persistence of the impressions made by the different rays on the retina.

It has long been known that the impression made by light does not cease with the cause that produces it; and it has been found that luminous impressions repeated at intervals of time appear to the eye continuous. It is on account of such apparent continuity that a stick lighted at one end and made to revolve rapidly round the other as a centre seems to describe a circle of fire. The apparent continuity of sensations which are in reality intermitting is not confined to those connected with vision; sounds repeated at very short intervals appear to be uninterrupted. In fact, every sound, however sharp, is but a series of different vibrations.

The consideration of these facts leads to practical conclusions. If, in ornamentation and music, the sensation of a second color, or sound, may be produced before that of the first has disappeared, the coexistence of colors or sounds, which are primarily intended to act only in succession, must be kept in view; and the sound or the colors must be such as to produce in the one case musical, and in the other pictorial harmony.

M. Laborde has lately communicated to the Academy of Sciences researches on this subject in connection with colors, and the conclusions to which they lead are very curious. He has found that the retina decomposes the rays of light in a manner different from that either of the prism or the double-refracting crystal. These disperse the rays with reference to different points of space; the retina disperses them with reference to different points of time.

In the experiments which were made, the light of the sun was received on a mirror, which reflected it horizontally through a chink formed in the shutter of a darkened chamber. This chink was about the tenth of an inch wide, and the fifth of an inch high. Very near it, and within the chamber, was placed a metallic disk, around the edge of which were formed openings corresponding with, and of nearly the same dimensions as, that in the darkened chamber. These openings were at considerable intervals; the disk was made to revolve by clock-work, and a means by which the operator, though at a distance, could moderate, accelerate, or arrest the revolution of the disk was provided. Across the path of the luminous ray, and at the distance of about 3 feet, was fixed a plate of roughened glass, behind which the experimentalist observed the modifications of the light. The disk being set in motion, the luminous ray reappeared at certain known intervals. When it was made to reappear slowly, it seemed of a uniform white color; but when it reappeared at shorter intervals, the edges began to be colored, and as the velocity of rotation was increased, the image passed successively through the following tints: blue, green, rose-color, white, green, blue. After the latter blue no increase of velocity produced anything but white.

It thus appears that some of the colored rays cause a more lasting impression on the retina than others. — *The Scientific Review.*

TEACHING THE DUMB TO SPEAK.

It is well known that there is a school for teaching articulation to deaf-mutes, in successful operation at Chelmsford, Mass., under the instruction of Miss H. B. Rogers. At a meeting of the educational department of the "American Social Science Association," in Boston, in March, 1867, Mr. F. B. Sanborn presented a paper on this subject. The following are extracts from the "Proceedings" of this meeting: —

Why the Deaf are called Dumb. — The only impossibilities Miss Rogers has done are those which incredulity or ignorance first created. There is nothing miraculous about her art. She has simply applied common sense and patience, and a gift for teaching, to the unfortunate circumstances of these children.

The dumb taught to speak! But who are these dumb, these deaf-mutes, as they are called? They are simply persons who have lost the sense of hearing, and consequently have forgotten, or have never learned, the practice of speaking. That is the whole story. Let me state the case in the quaint language of a good old man, who has had some experience in teaching the deaf to speak. He says, "Here is a smart, intellectual child, having every facility for talking, but does not talk, and why? Because he cannot hear. This is the only reason, for he has sound lungs, a well-shaped mouth, tongue, teeth, palate, and every facility for talking, but cannot hear; he can laugh, and cry, and make the same noises in doing it that the hearing child does. Why happens this? Because this comes natural, it is spontaneous, it comes of itself. Not so with speech; this noise has to be shaped, gauged, and so fixed and manufactured, as when it presents itself it is language, and can be understood. Now, this deaf child lacks nothing but the knowledge of putting his talking-machine in operation. And as every good, plain talker's machine undergoes just the same operation, I would ask, is there no person in the land that has ingenuity and acuteness enough to assist this child in putting his machine in motion aright? I am ready to answer in the affirmative. I think it can and will be done."

How the School of Miss Rogers originated. — At a hearing before a legislative committee in Boston, in January, 1867, Miss Rogers said: —

"I knew nothing of it (articulation), except that it had been tried abroad; but I thought that what had been done abroad could be done here. I visited a lady in Providence who had taught articulation, got what information I could from her, and went home.

"I found, after my first pupil had been with me two months, that the finger-language was so much more definite than reading from the lips, that she was not satisfied unless it was used, and that the two systems could not be used together. I then took her and went to visit her parents, and told them they must decide which system they would choose. My preference was for articulation. They decided upon articulation. Then, just as soon as she could make any articulate sounds for the words she had learned, I obliged her to give up the finger language, and now she knows nothing of it."

This was why Miss Rogers gave up everything but articulation and reading on the lips. On the first of June last she received as a pupil a congenital mute, nearly 8 years old. Of him and his progress she said at the same hearing: —

"The congenital deaf-mute knew nothing of articulation; he had never articulated a word. I placed him before me; I held his hand and breathed upon it, and taught him to breathe upon it. When he could do that, he had the power of the letter *h*. The first day I gave him the power of five letters, but he could not articulate either of them aloud. The second day, I think it was, he articulated one or two of those letters aloud; and the third day I taught him his first word, 'pie.' He repeated it many times before he made an audible sound, but he did once or twice that day repeat the word in an audible voice. He knew four words when he came to me, as I have stated, when he saw them in a book, and he could also write his own name, and knew it when it was written. He did not know the letters contained in his name, but imitated it when it was set for a copy; and I do not know but he could write the names of two or three of his family at home.

"This congenital mute, who knew so little when he came, now writes home a letter to his parents every week without assistance; of course it is imperfect in sentences, but still it contains ideas. He can count to 100, and can add small numbers, like 9 and 8, or 27 and 10. He spells some 400 words, reads sentences, and forms sentences. He is 8 years of age now."

Says a correspondent of the "Boston Transcript": —

"The exhibitions of the 'School of Deaf-Mutes,' which have been held in the houses of several gentlemen in Boston and in its vicinity within a few weeks, have forever settled the question of the feasibility of teaching articulation to that class of human beings called deaf-mutes. The word ceases to have the signification that has hitherto been given it to those who have been so fortunate as to see the dumb speak. It is as long ago as the time of Philip I., of Spain, since a Spanish physician first discovered the fact that deaf-mutism is due to a defect of hearing only, and not to any deficiency in the organs of speech; but, strange as it may seem, it is not till the years since 1864 that an organized school for the purpose of instructing them has existed in America.

"The exhibition consisted in the spelling and speaking of half a dozen little children, who have not been under instruction quite two years, — some of them not one year. The result was shown in the easy conversation of a young lady of 15, who has been taught since 4 years old by her mother and aunt, with no other assistance than the report written by the Hon. Horace Mann after his return from Europe in 1843. In that report he described the instruction in articulation with sufficient minuteness to enable a lady to teach her child to speak so admirably, that at home she is scarcely thought of as a deaf child; and she now attends a school with other young ladies of her own age, and studies and recites in the classes with them."

The success which has attended the efforts of Miss Rogers, and others, in teaching deaf-mutes to speak, by imitating the position and action of the lips, teeth, tongue, and other organs concerned in articulation, is very satisfactory to those interested in the welfare and education of these unfortunate and hitherto almost isolated individuals.

ANIMAL ELECTRICITY.

Recent experiments have confirmed the theory that animal electricity does not owe its origin to the formerly imagined action of the nerves or muscles, but emanates directly from a purely chemical source, the exciting cause being generated by the contact of the air with the incipient decomposition of the freshly killed animal. Bearing in mind that a liquid, but very slightly saline, in contact with animal substance is an electrometer, it is easy to perceive that the so-called muscular current is nothing more than the current produced by their contact. To put beyond a doubt the question that a live muscle would generate electricity, which it could not produce when dead, contact has been made between the muscles of a live animal and the wires of a galvanometer, without the latter evincing the slightest sign of an electrical current. Moreover, if a portion of muscle be separated from the body of an animal freshly killed, and placed in communication with a galvanometer, a feeble degree of electricity is demonstrated. According to the opinion of M. Schultz Schultzenstein, as presented to the French Academy of Sciences, this is due to the influence of oxygen upon the flesh, — a cause always existing when the muscles retain their normal state of irritability. Assuming that animal electricity was due to the cause surmised by Galvani, the evidence of the current would cease so soon as the muscles become completely inert, or, so to speak, completely dead. But the reverse is the fact. The more decomposed the flesh becomes, the stronger are the advances of its electrical condition, and when it has acquired a state of almost total putridity it imparts the maximum deviation to the needle. That the presence of a saline liquid is necessary to these electrical effects is proved convincingly by several circumstances. One is that meat newly salted becomes electrical in proportion to the penetration of the solution; and the other, that cured meats, whether beef, pork, or fish, evince a high state of electrical development. The blood of a living animal is altogether destitute of electrical excitation, but becomes capable of affecting the galvanometer so soon as the animal is killed, and its power increases with the putrefaction of the body. A small addition of common salt to the blood immediately increases its electrical sensibility. If the epidermis of an animal be removed, the under layers of cuticle are highly electrical, as experiments upon frogs have demonstrated; and this condition is still further augmented by the addition of a saline solution. From these results we are justified in assuming that animal electricity, in its original symptoms, is a delusion, and that, without the intervention of some slightly saline liquid, the nerves and muscles are *per se* powerless to afford the smallest evidence of an electrical current. Unless a chemical action can be set up, there is nothing to indicate the presence of that vital muscular agency which the first experiments in connection with the subject led the older philosophers to insist upon and adhere to. The animal current, which they so fondly propounded and believed in, is simply an ordinary electrical current produced chemically by the contact of a saline solution with animal matter, in which combination the salt acts the part of the electrometer. Adopting this view of the question it is easy to perceive that the development of animal electricity, in invalids and diseased organs, instead of being due to the cause originally entertained, is solely the consequence of chemical decomposition. Thus, for instance, the mucous membrane of the mouth becomes electrical in patients suffering under disease of the stomach or digestive organs, and strong evidences of it are manifested in malignant, cancerous, and other ulcers of a dangerous and fatal type. All animal excretions are electrical, and urine possesses this property in so remarkable a degree as to cause the needle of the galvanometer to make a complete revolution of the dial. The electricity of fishes results from an alkaline solution in the cells of the electric organs, and manifests itself very powerfully. All the effects of animal electricity may there fore be regarded as closely resembling those of fermentation and putrefaction, and as depending not upon any muscular or nervous hypothesis, but solely upon an incipient chemical decomposition in combination with chemical electrometers. — *The Engineer.*

FOOD AS THE SOURCE OF MUSCULAR POWER.

Liebig assumed that oxidation is the immediate result of the disintegration of muscular tissue. He maintained that a portion of oxygen separated from its combination in the blood, and traversed the walls of the capillaries with the nutritive fluid, and that as fast as the new cells were built up by the one, the old ones were oxidized by the other; the oxidized and lifeless products being carried back to the blood, to be ultimately excreted from the body as useless. The force liberated in this oxidation was the force which contracted the muscle, and so did the work. He also assumed that inasmuch as the muscular tissue was formed from the flesh-formers of the food, and was almost identical in composition with them, the whole work of the body was derived from the flesh-formers, which were therefore a true measure of the amount of work which the body could accomplish, — the amount of urea excreted being taken as a measure of the amount of work effected by the organism.

Other physiologists have shown that the amount of work done could not be measured by the urea excreted; and Traube went so far as to maintain that the oxidation of muscle, far from being the sole cause of muscular work, contributed nothing whatever to it, but that the whole work was done by the combustion of fats and hydrates of carbon, as sugar, starch, etc. [For the experiments of Fick and Wislicenus, Frankland, etc., see "Annual of Scientific Discovery" for 1866–67, pp. 286–292; it is there shown that the oxidation of muscle will not account for one-half of the actual work done.]

Between these opposite views of the origin of muscular power is a third, by Mayer, founded upon consideration of the function which the blood fulfils in the matter. Muscular contraction is attended with a more rapid consumption of the oxygen of the corpuscles. Mayer makes the blood the seat of all oxidation, and therefore the originator of all force in the body. Some part of this force is evolved in the form of muscular work, the greater part of the remainder in that of heat. How it comes about that oxidation inside a capillary is converted into muscular movement outside, is not ascertained, though the conversion is probably effected under the control of the nervous system, some of the force set free taking the form of electric currents. If Mayer's hypotheses be true, the controversy between the followers of Liebig and of Traube would be meaningless; for as both fats and carbohydrates on the one side, and the products of muscle metamorphosis on the other, are oxidized in the blood, both may equally be supposed to be originators of muscular power. The establishment of this hypothesis would not help us much in the solution of the question, What kind of food is most suitable for the man who does hard work? Both flesh-formers and heat-givers are available for the purpose, and provided the former are sufficient to repair the daily waste of the tissues, it is possibly immaterial which is employed. — *Quarterly Journal of Science*, July, 1867.

ON THE COAGULATION OF THE BLOOD.

Dr. Richardson, of London, the originator of the so-called ammonia theory of the coagulation of the blood, gave, at the meeting of the British Association, 1867, the results of some recent experiments which he had made on the influence of the extremes of heat and cold on albuminous and fibrinous fluids, tending to show that the process of coagulation in these fluids is due to a communication of caloric force to them, and to a physical or molecular change, determined by the condition of their constituent water. Thus all substances which possess the power of holding blood in the fluid condition, through fixed alkalies, soluble salts, and volatile alkali, in every respect act after the manner of cold; they render latent so much heat, and in the absence of that heat the fibrin remains fluid. On the other hand, every substance which combines with water and produces condensation, with disengagement of heat, quickens coagulation. The direct effects of heat and cold illustrate the same truth, explaining the differences of coagulation in animals of different temperatures. He stated that, in the ordinary condition, there is a constant process similar to coagulation going on in the living body, in the formation of muscle, and a constant interchange of force from these parts, which are rendered solid by cold and fluid by heat, to those which are rendered solid by heat. The condition of *rigor mortis* belongs to the same order of phenomena.

LIEBIG'S ARTIFICIAL MILK.

This is an imitation, as close as chemistry can make, of the natural food of the human infant. Human milk of a person in good health contains, per cent., caseine, 3.1; sugar of milk, 4.3; butter, 3.1. Baron von Liebig concluded therefrom that woman's milk contains: Blood-forming principles, 1 part; heat-producing principles, 3.8 parts. By mixing flour and milk in certain proportions, it is easy to compose a food in which the two nutritive principles are in the same proportion as in human milk, namely, 1 to 3.8. Cows' milk contains, on an average, 4 per cent. of caseine, 4.5 of lactose, 2.5 of butter. If we take, then, 10 parts of milk, 1 part of wheat flour, and 1 part of ground malt, we have a mixture satisfying all the necessary conditions. For preparing this the author recommends the following method: A mixture is made of 15 grammes of wheaten flour, 15 grammes of ground malt, and 6 grammes of bicarbonate of potash; 30 grammes of water and 150 grammes of milk are then added. The whole is then heated and continually stirred until the mixture begins to thicken. It is then taken off the fire and stirred all the while. After 5 minutes it is boiled, and then strained through a wire or hair sieve. The ground malt necessary for this preparation is easily furnished by barley malt, obtained at any brewery. It can be ground in a common coffee-grinder, and then passed through a sieve. If this preparation is well made, it is as sweet as the natural milk; it is fluid enough, and keeps for 24 hours. In Germany the use of this food is very extensive, and its nutritive qualities are found to be excellent. It has a slight taste of flour or malt, to which children get accustomed, — in fact, they soon prefer it to any other food.

ARTIFICIAL DIGESTION.

A London physician, Dr. Marcet, has announced a process by which natural digestion is similated by artificial means, and solid food may thereby be prepared for invalids. He takes 58 grains of muriatic acid having a specific gravity of 1.1496; 15 grains of pepsine, —the organic principle procured from the stomach of a pig or other animal. Diluted in a pint of water and added to a pound of raw meat, the whole is allowed to simmer over a water bath at about the temperature of the body, 98° F. When the meat is thus sufficiently broken up, it is strained, and the acid neutralized by 81 grains of bicarbonate of soda. The product is of a most agreeable character, easily digested, and much more nutritious than beef tea. Where pepsine cannot be obtained, strips of calves' stomachs have been found to answer very well.

CHEESE AS FOOD.

We remarked not long since upon the superior nutritive qualities of this food, as proved by the experience of laborers in certain countries, where it forms the strongest staff of life. We have since observed certain researches of a French chemist, M. Charles Mene, of Lille, from which we learn that certain cheeses, specified as Dutch, Gruyère, and Roquefort, contain from 26 to 40 per cent. of nitrogenized matters, which are considered the most highly nutritive constituents of food. Consequently these cheeses are from 25 to a 100 per cent. more nutritive than bread or meat, which is set down at 22 per cent. of nitrogen. In the combustible or fatty elements for heating the body by respiration, cheese yields only to butter or other fats. Again, in point of mineral nutrition, cheese is found pre-eminent, containing 7 to 8 per cent. of ashes, whereas meat and bread contain only 1 per cent. The very richness of this article, however, prejudices its utility in delicate stomachs, where it is often found indigestible. The strongest food suits only the strongest digestion. The attention now given to an improved, economized, and increased manufacture of cheese is justified, and will naturally be stimulated by these facts. — *Scientific American.*

USES OF THEINE.

Theine, of which there is an average of 2 per cent. in good tea, though some green teas have as much as 6 per cent., has nothing to do with the taste of tea, but its presence is most important, on account of the unusually large amount of nitrogen (nearly 30 per cent.) which it contains. It is this substance that makes tea save food, by its action in preventing various wastes of the system, and renders it peculiarly acceptable to elderly persons, in whom these wastes go on very rapidly, while their stomach assimilates less and less of the nutritive portion of food. An ounce of good tea contains about 10 grains of theine, — an amount sufficient to produce a peculiar intoxication, and many unpleasant symptoms, if taken in one day. From 3 to 4 grains of theine is a healthy amount for a day, so that 3 ounces of really good tea is more than an ordinary person should take in a week.

Tannin, the astringent element in tea, is extracted by lengthened infusion, and any one who wishes to avoid the effects of its astringency should drink tea soon after the water is poured over it. The really nutritive element of tea, the gluten, is thrown away with the leaves. The use of soda tends to bring out a trifle more of this element; but the South American native custom of eating the spent leaves, after the liquor is consumed, appears to be the best way of making sure of the gluten.

EARTH EATEN IN BORNEO.

A few years ago the manager of the Orange-Nassau colliery, near Zandjermasin, in the Island of Borneo, found that many of his work-people (natives) consumed large quantities of a kind of clay. A sample of this material was forwarded to Batavia for analysis, and the following is the result in 100 parts: —

Pitcoal resin (organic matter volatile at red heat)	15.4
Pure carbon " " " " "	14.9
Silica " " " " "	38.3
Alumina " " " " "	27.7
Iron pyrites " " " " "	3.7
	100.0

The eating of clay is a custom to which savages — or, at least, human beings of a very low degree of development — are freely given in various parts of the world. No other analyses of any of the substances used as such have been made, or at least, if made, they have not been published. The resident military medical officer at the above-named colliery is strongly inclined to consider it the duty of the manager to eradicate and discountenance this habit of the workmen, as it appears to injure their health.

THE ABUSE OF PHYSICAL EXERCISE.

The "Westminster Gazette," in the course of a declamation against too much physical exercise, sensibly observes, "Those who have gone through the severest training become in the end dull, listless, and stupid, subject to numerous diseases, and in many instances the ultimate victims of gluttony and drunkenness. Their unnatural vigor seldom lasts more than 5 years. It was especially remarked by the Greeks that no one who in boyhood won the prize at the Olympic games ever distinguished himself afterward. The 3 years immediately preceding 17 are years of great mental development, and nature cannot at the same time endure any severe taxing of the physical constitution. Prudence, therefore, especially at this critical period of life, must ever go hand in hand with vigor, for the evils of excess outweigh by far the evils of deficiency."

DISINFECTANTS.

Dr. Letheby, Health Officer of the city of London, has recently made the following report.

The several disinfectants which I have largely tested are the following: —

1. Chlorine gas.
2. Chloride of lime.
3. Carbolate of lime.
4. Carbolic acid.
5. Chloride of zinc (Sir William Burnett's fluid).
6. Chloride of iron.
7. Permanganate of potash (Condy's liquid).
8. Animal charcoal.

Each of these disinfectants has its own particular value, and may be used on certain occasions in preference to any of the others. Thus: —

1. *Chlorine Gas*, being a very diffusive body, is best suited for the disinfection of places which cannot easily be reached by other disinfectants. I have used it largely for the disinfection of the vaults of churches, where the atmosphere has been so charged with offensive and dangerous organic vapors, let loose from the contents of the decaying coffins, that the workmen could not enter the vaults with safety. In this manner all the vaults of the city churches have been disinfected, and the contents of them put in order and covered with fresh mould. I have found also that chlorine is best suited for the disinfection of rooms where, as is the case with the poor generally, the occupant cannot be removed for a thorough cleansing; and I have employed it with great advantage in places where persons have been sick with fever, scarlet fever, small-pox, and cholera. The process which I adopt is the following: About a teaspoonful of the black oxide of manganese is put into a teacup, and there is poured over it, little by little, as occasion requires, about half a teacupful of strong muriatic acid (spirit of salt). In this manner the chlorine is gradually evolved, and the action is increased, when necessary, by stirring the mixture, or by putting the teacup upon a hot brick. As chlorine is heavier than atmospheric air, it is best diffused through the room by putting the mixture upon a high shelf. The quantity of chlorine thus diffused should never be sufficient to cause irritation to the lungs of those who occupy the room, and yet it should be sufficient to be distinctly recognizable by its odor. If it be properly managed, the chlorine may be thus diffused through the atmosphere of the room, even during its occupation by the sick.

2. *Chloride of Lime* has been very largely used in the city during the recent epidemic of cholera. The inspectors have sprinkled it upon the floors of the houses occupied by the poor, and have scattered it about the cellars and yards. In some cases it has been used with water for washing the paint-work and the floors of rooms. Altogether, indeed, with an average staff of 45 men, we have used rather more than 7 tons of chloride of lime in this manner in disinfecting every week about 2,000 of the worst class of houses in the city, and the results have been most satisfactory.

3. *Carbolate of Lime*, which is a mixture or rather a chemical compound of carbolic acid and lime, has been used in many cases where the smell of chloride of lime or its bleaching action has been objected to. It has been used by dusting it by means of a dredger over the floors of rooms and cellars: but as the disinfecting power of this substance is destroyed by chloride of lime, it is of great importance that they should not be used together. The carbolate of lime which we have employed contains 20 per cent. of carbolic acid. It is essential that this should be its minimum strength, or its power is not sufficiently efficacious. The strength of it may be ascertained by treating 100 grains of it with sufficient muriatic acid, diluted with its own bulk of water, to dissolve the lime, when the carbolic acid is set free, and floats upon the liquid; this, when collected, should weigh 20 grains at least. The advantage of carbolate of lime is its continuous action; for the carbonic acid of the air slowly lets loose the carbolic acid, which diffuses itself through the atmosphere in sufficient quantity to act as a disinfectant, and it does not destroy the color of clothing.

4. *Carbolic Acid* has been used as the sole agent of disinfection for privies, drains, and sinks, and for the sewers and the public roads. In the former case it has been used in its concentrated state by pouring it at once into the privy or drain, but in the latter case it has been diluted with about 2,000 times its bulk of water and sprinkled by means of the water-carts upon the public way. In this manner about 1,000 gallons of carbolic acid have been used in the city thoroughfares; and the acid getting into sewers, we have observed that the usual decomposition of sewage has been arrested, and instead of a putrefactive change with the evolution of very offensive gases, the sewers have been charged to a slight extent with carbonic acid and marsh gas. As there are many coal-tar acids now sold for carbolic acid, it is of importance that the adulteration should be recognized. This may be done by observing the strength of the soda solution which will dissolve the tar acid. All the inferior acids are insoluble in a weak solution of caustic soda.

5. *Chloride of Zinc* (Sir William Burnett's fluid, or, as it is sometimes called, Drew's disinfectant) is well suited for the disinfection of the discharges from sick persons, but it is hardly applicable to any other purpose. The liquid should be of a proper strength, as having a specific gravity of 1,594, water being 1,000, and it should contain about from 50 to 54 per cent. of solid chloride of zinc. A tablespoonful of this liquid is sufficient to disinfect each discharge from the body.

6. *Chloride of Iron* is applicable in exactly the same manner as chloride of zinc, and is only suited for the disinfection of the discharges from the body. It should have a specific gravity of 1,470, and should contain about 40 per cent. of metallic chloride.

7. *Permanganate of Potash* is only suited for the disinfection of drinking-water; for not being a volatile disinfectant, and being very slow in its action and requiring much of it for any practical purpose, it is not available as a common disinfectant; besides which it attacks all kinds of organic matter, and will therefore destroy clothing and be neutralized by every species of organic substance. As a disinfectant of water, however, in localities where good filters of animal charcoal cannot be obtained, it may be usefully employed to disinfect water by adding it thereto until the water retains a very pale but decidedly pink tint. The permanganate which is sold generally has a specific gravity of 1,055, and contains about 6 per cent. of permanganate of potash. It will take more than a pint of this liquid to disinfect a pint of the rice-water discharge from a cholera patient, and even then the disinfection is very uncertain.

8. *Animal Charcoal.* — I may state that, for the disinfection of water and the removal of dangerous organic impurity, I have ascertained by experiment that the best treatment is first to filter the water through animal charcoal, and then to boil it for a few minutes. It may then be safely drunk.

The disinfection of bedding and all articles of clothing is best effected by exposing them in an oven to a heat of from 260° to 300° Fahrenheit. The exposure should be sufficiently long to insure the thorough heating of every part of the material to that temperature. When such a process cannot be used, the clothing should be put into boiling water, and kept there until the water cools to the common temperature.

I refrain from entering into any explanation of the mode of action of these several disinfectants; for, whether the agent of disease is a living germ, capable of reproducing itself in the human body under certain conditions, — as most likely it is, — or whether it is an unorganized, or, even as Dr. Richardson supposes, a crystalline compound, the practical results are the same, and are unquestionable; and, in conclusion, I would say, by way of summary, that for the disinfection of sick-rooms, chlorine and chloride of lime are the best agents; for the disinfection of drains, middens, and sewers, carbolate of lime and carbolic acid are the best; for the discharges from the body, carbolic acid, chloride of zinc, or chloride of iron are the best; for clothing, the best disinfectant is heat, above 260°, if a dry heat, and 212°, if a wet heat; and for drinking-water, filtration through animal charcoal and a boiling temperature.

I may mention that the best disinfectant for stables and slaughter-houses is a mixed chloride and hypochlorite of zinc, and it has the advantage of mixing freely with the liquid matters of the slaughter-house, and not tainting the meat with any unpleasant odors. We have used it very largely for this purpose, and it is also applicable to the disinfection of houses in place of chloride of lime, which it much resembles in its chemical nature and mode of action.

Dr. Harris, registrar of the New York Board of Health, has written a circular on the subject of disinfectants, and the manner in which they should be used, from which the following are extracts: —

"In this memorandum the words infection and disinfection are employed just as they are commonly understood, as referring to the preventible causes that are concerned in repropagating specific kinds of disease. These causes are: —

"1. The specific infectious property or substance of any one of the pestilential disorders.

"2. The local impurities and moisture of the house and grounds where the outbreaks of disease have occurred, or are liable to occur.

"3. The foul exhalations and atmospheric impurities which injure health or help to propagate pestilential epidemics.

"Experience has proved that it is possible by certain chemical agencies wholly to destroy or prevent the operation of the specific infection or contagion of any disease; but, to do this, it is necessary that precise rules should be observed in applying the disinfectants, and, as regards cholera and typhoid fever, it is especially important that the infective discharges from the sick should be disinfected as soon as voided from the body, and that whatever clothing or surfaces may have been soiled by such discharges should be disinfected as soon as practicable. The fact should also be borne in mind, by all persons who have charge of infected things, that the infective property or virus of some diseases, and of cholera especially, is capable of rapid increase in filthy places, and in a foul, damp atmosphere. Therefore, the cleansing and disinfection of such places should, if possible, precede the arrival or outbreak of any such pestilential infection. Every unclean and damp place about dwelling-houses, warehouses, factories, places of assemblage, passenger vessels, railway depots, and hotels, should be made and kept perfectly clean and dry. All drains, privies, and water-closets should be kept as clean as possible, and should be thoroughly purified before cholera comes into the neighborhood. Such cleansing and disinfection give the surest protection against all epidemics.

"*Quicklime* — to absorb moisture and putrid fluids. — Use fresh stone lime, finely powdered; sprinkle it on the place to be dried, and in damp rooms place a number of plates or pans filled with the lime powder. Whitewash with pure lime.

"*Charcoal Powder* — to absorb putrid gases. — The coal must be dry and fresh, and should be combined with lime; this compound is the 'calx powder,' as sold in the shops.

"*Chloride of Lime* — to give off chlorine, to absorb putrid effluvia, and to stop putrefaction. — Use it as lime is used, and, if in cellars or close rooms the chlorine gas is wanted, pour strong vinegar or diluted sulphuric acid upon your plates of chloride of lime occasionally, and add more of the chloride.

"*Sulphate of Iron* (*Copperas*) *and Carbolic Acid* — to disinfect the discharges from cholera patients, and to purify privies and drains. — Dissolve 8 or 10 pounds of the copperas in a common pailful of water, and pour this strong solution into the privy, water-closet, or drain, every hour, if cholera discharges have been thrown in those places; but for ordinary use, to keep privies or water-closets from becoming offensive, pour a pint of this solution into every water-closet pan or privy seat every night and morning. If there is cholera in the house or in the district, let carbolic acid be added to this iron solution: one-half pint of the fluid acid to 5 gallons of the solution. Bed-pans and chamber-vessels are best disinfected with this mixed solution, using a gill at a time.

"*Permanganate of Potassa* — to be used in disinfecting clothing and towels from cholera and fever patients, during the night, or when such articles cannot be instantly boiled. — Throw the soiled articles immediately into a tub of water in which there has been dissolved an ounce of the permanganate salt to every 3 gallons of water. Boil the clothing as soon as it is removed from this colored solution.

"*Carbolic Acid (fluid)* — may be diluted at the rate of from 40 to 100 parts of water to 1 of the fluid acid. Use this solution for the same purposes as copperas is used; also to sprinkle upon any kind of garbage or decaying matter, and on foul surfaces, or in drains.

"When used to disinfect clothing, carbolic acid of good quality should be thoroughly mixed with its own quantity of strong vinegar, and next be dissolved in 200 times its own quantity of water, before the clothing is immersed in it. This mixture with vinegar insures such complete solution of the carbolic acid that the clothing will not be 'burned' by undissolved drops of acid when disinfected in the carbolic water. This weak solution (1 part to 200) will not injure common clothing. But to destroy clothing, as well as infection, instantly, use the acid diluted only 10 to 30 times its own quantity of water.

"The disinfecting and antiseptic power of good carbolic acid is so great that 1 part of it to 50 or 100 parts of water is sufficient for ordinary purposes.

"For drains, sewers, foul-heaps, stables, and privies, the cheap 'dead oil' of coal tar, or the crude carbolic acid, answers every purpose when freely applied. Coal tar itself is available as a disinfectant to paint upon the walls of stables, privy vaults, and drains. By mixing with sawdust or dry lime, coal tar or crude acid may be used on foul grounds or heaps of refuse.

"*Boiling or high-steam Heat.* — Whenever foul clothing and infected things can be boiled, or have a boiling heat steadily applied and kept up for an hour, this is one of the simplest and best modes of disinfection. But until such high heat is actually applied to the infected things, some one of the disinfecting solutions must be used. A common steam tub (in a laundry or elsewhere) with a tight cover is a good disinfecting vat."

CONDY'S FLUID AND CARBOLIC ACID.

Condy's fluid is a solution of some permanganate; for our present purpose let us say permanganate of potass. One equivalent of this salt=158 is calculated to lose one-fourth of its weight of oxygen in presence of oxidizable matter, and in so doing loses the pink transparency of its solution, and forms a brown precipitate. The quantity of oxidizable matter may either be estimated by giving the quantity of oxygen in the decolorized permanganate simply, or on Dr. Letheby's method, by multiplying the amount of oxygen by 8.

Let us suppose a water of a bad, or at least a suspicious marshy smell; the addition of one or more drops of "Condy," or of one of the finer solutions of permanganate, will speedily remove that smell and taste, and make the water fresher and nicer. The quicker the decolorization, the greater the need of it.

If water so treated, with a slight pink color remaining, be passed through a filter, it comes out perfectly clear and colorless, but without filtering may be used for cooking or making tea and coffee after the brown sediment has settled.

It seems generally agreed that the gases of decomposition are very quickly neutralized by this means, and that organic matter actually decomposing very quickly decolorizes the liquid also. But this is not the case with stable organic matter. Water colored with "Condy" so as not to be drinkable with pleasure, yet may contain animalcules in the most lively state. Nay, the amœba, paramœcium, colpods, and other disgusting broods are not in the least affected by water too reddened to be drinkable. The same with regard to minute plants. Give quantity enough and time enough, and all will be destroyed: first, the stinking gases; next, the decaying organic matter which evolves them; then the microscopic animalcules which feed on it, and which, if not destroyed by the "Condy," would die of starvation, and the plants last.

Animalcules of the kinds indicated may also live in water just containing carbolic acid enough to be smelt and tasted.

The conclusions we would draw from the above remarks are, that when we employ the carbolic acid for the disinfection of drains, sinks, etc., it ought to be employed in a state of pretty high concentration and large quantity, so as, above all things, to purify the aperture out of which the dangerous emanations would come. Likewise, in the use of Condy's fluid for purifying water-butts, enough should be used, but we should take care also that the butts themselves are cleansed and pitched or charred inside, for it is a waste of force to use the permanganate to do what might be done by a handful of lighted shavings and a brimstone match. — *Medical Times and Gazette.*

IODINE AND CARBOLIC ACID.

The "Journal des Connaissances Médicales" publishes a letter on Dr. Percy Boulton's late discovery of the action of carbolic acid on iodine. "The inconvenience," says the writer, "attending the external application of iodine and its preparations is so serious that physicians are often compelled to abandon a remedy the therapeutic efficacy of which is undoubted, nay, almost unequalled in *materia medica*. The great objection to the external use of this remedy is, that it leaves marks both on the linen and on the skin. This is a sufficient motive for seeking some means of getting rid of this drawback, especially in the case of ladies. Dr. Percy Boulton's method consists in adding a few drops of phenic (carbolic) acid to the iodine solution to be employed. This addition renders iodine perfectly colorless, so that it may be applied with impunity. But this combination has another advantage. It appears from that practitioner's observations, which I can confirm, that, so administered, carbolate of iodine, which is the new substance in question, is not only one of the most powerful antiseptics we possess, but is intrinsically a more efficacious agent than iodine alone. I have used this compound under the form of injections, gargles, and lotions, in all cases in which iodine is prescribed. In sore throat, ozæna, abscess in the ear, etc., this preparation is a sovereign remedy, since, besides its disinfecting qualities, it modifies the mucous membrane, causes all local sensibility to disappear, and cures the patient much sooner than if either of the two agents were employed separately. The formula I employ is as follows: Compound tincture of iodine, 3 gms.; pure liquid carbolic acid, 6 drops; glycerine, 30 gms.; distilled water, 150 gms."

ACTION OF POISONS.

The Poison of the Cobra-de-Capello. — The "Melbourne Argus," for April 26, contains an article by Dr. G. B. Halford, from which we extract the following: "The melancholy accident which so lately happened with the cobra-de-capello induced me to make some experiments and observations upon the action of the reptile's poison. When a person is mortally bitten by the cobra-de-capello, molecules of living 'germinal' matter are thrown into the blood, and speedily grow into cells, and as rapidly multiply; so that, in a few hours, millions upon millions are produced at the expense, as far as I can at present see, of the oxygen absorbed into the blood during inspiration; hence the gradual decrease and ultimate extinction of combustion and chemical change in every other part of the body, followed by coldness, sleepiness, insensibility, slow breathing, and death. The cells, which thus render in so short a time the blood unfit to support life, are circular, with a diameter on the average of one seventeen-hundredth of an inch. They contain a nearly round nucleus of one two-thousand-eight-hundredth of an inch in breadth, which, when further magnified, is seen to contain other still more minute spherules of living 'germinal' matter. In addition to this, the application of magenta reveals a minute colored spot at some part of the circumference of the cell. This, beside its size, distinguishes it from the white pus or lymph corpuscle. Thus, then, it would seem that, as the vegetable cell requires for its growth inorganic food and the liberation of oxygen, so the animal cell requires for its growth organic food and absorption of oxygen. Its food is present in the blood, and it meets the oxygen in the lungs; thus, the whole blood becomes disorganized, and nothing is found after death but dark fluid blood, the fluidity indicating its loss of fibrine, the dark color its want of oxygen, which it readily absorbs on exposure after death. It results, then, that a person dies slowly asphyxiated by deprivation of oxygen, in whatever other way the poison may also act; and so far as the ordinary examination of the blood goes, the *post-mortem* appearances are similar to those seen after drowning and suffocation.

The Boundou Poison. — At the meeting of the Academy of Sciences of Paris, MM. Pécholier and Saintpierre reported the results of their experiments on this substance, derived from a shrub of the *Apocynea*, and which is employed by the Africans on the Gaboon in an ordeal liquor. The Boundou contains a poisonous principle soluble in water and alcohol, and produces an action on the sensitive nervous system analogous to that of nux vomica. When administered by the stomach or by the endermic method, it produces at first an augmentation of the number of inspirations and cardiac pulsations, and afterward a considerable diminution of those movements. It causes an exaggeration of sensibility, next tetanic convulsions, and finally insensibility, paralysis, and death. Its action on the motor nervous system is only secondary, and it does not affect the contractility of the muscular system. It is not a poison of the heart, which, on the contrary, continues to beat for a long time after death. These results were obtained from administration of the poison to rabbits, a dog, and frogs. In some cases the animal slowly recovered. This may be the case sometimes with man, and the Africans regard those who escape from the deadly influence of the Boundou poison as recalled to life by the justice of God demonstrating their innocence. — *Med. Times and Gazette.*

Poisoning Whales. — M. Balard has been occupying himself with the problem how to poison whales rapidly. He combines a soluble salt of strychnia with a twentieth part of woorara. He loaded some explosive cartridges with two ounces each of this compound, and started off on a whaler. He gives particulars of the whales which he shot at and wounded. They all either died almost immediately or very rapidly (usually in less than ten minutes) after general convulsion. He concludes that whales are even more sensitive to poison than land mammals, and that, in future, it will be well to diminish the dose of poison, in order to determine a rather slower death. — *British Medical Journal.*

At a meeting of the New York Lyceum of Natural History, Dr. Amend made a communication on the Calabar bean and coca, as follows: —

Calabar Bean. — It is well known that certain poisonous substances have long been used among the negroes of Western Africa as a test of the innocence or guilt of an accused person. If a person recovered from the effects of the poison he was allowed to go free. One of these poisons is called the ordeal bean of Calabar. It was brought to the notice of the scientific world by Danieli in 1847. Considerable attention was attracted to the subject, and specimens of the bean were obtained from the Gold Coast. These were planted in the Botanical Garden of Edinburgh, and produced a plant which proved to be a perennial creeper, belonging to the family of *leguminosæ*, of an undescribed genus. The name of *phyrostigma*, suggested by the peculiar inflation of the stigma, was adopted.

The plant mounts on trees and shrubs near the banks of streams, into which the bean frequently drops, and the natives obtain their supply of the fruit from the borders of the rivers, where it lodges.

The seed is about the size of a large horse-bean, being somewhat more than an inch in length, by three-quarters of an inch in breadth, with a very firm, hard, brittle, shining integument, of a brownish-red or ash-gray color. The taste resembles that of ordinary leguminous seeds, without bitterness. The alkaloid principle can be extracted by alcohol, and is called phyrostigmine. It is an active poison, one grain being sufficient to produce death. It produces paralysis, loss of reflex action, contraction of the pupil. Immediately after death the pupils dilate. In cases where persons escaped from the poisonous effects, it was shown that they took such an over-dose as to produce vomiting. The most interesting practical application of the Calabar bean is that of contracting the pupil of the eye. A drop of the alcoholic solution affects only the eye which is operated upon. The eye becomes near-sighted under the influence of the alkaloid. It is sometimes applied in case of disease of the optic nerve.

Coca. — Erytroxylon Coca is a shrub which grows wild in South America, and is largely cultivated in Bolivia. The plant is propagated from the seed in nurseries, begins to yield in 18 months, and continues productive for half a century. The leaves are picked, and dried in the sun and transported in bags. They are known in South America by the name of *coca*, and have been used by the natives for centuries. A peculiar substance called *Cocaina* has been isolated by Dr. Nieman, of a white, inodorous, bitter taste, resembling the alkaloid of tea and coffee. Persons unused to it are liable to unpleasant effects, such as hallucination, delirium, and nervous excitement. The natives chew it for the same purpose that the Styrian peasants are said to employ arsenic, and the sale of the leaves is interdicted by the government. Instances of the dangerous effects of the leaves were cited by the members, one person having become deranged in consequence of the habit of chewing them.

Antidote to Strychnia. — M. J. Rosenthal ("Comptes Rendus," June 3, 1867) noticed that, by establishing artificial respiration in animals so as to suppress all the natural respiratory movements, a much larger dose of strychnia could be borne with impunity than in the normal condition of breathing; the convulsions manifested themselves when the animal breathed naturally, but ceased when artificial respiration was commenced, the animal appearing unaffected. This shows that a poison may exist in the blood without manifesting its effects, not powerless, but with suspended action; and that it is rendered thus inoperative by the special condition of the blood, namely, an abundance of oxygen in it. If the artificial respiration be kept up for three or four hours, a dose, otherwise fatal, will be recovered from, the greater part of the poison being transformed into a harmless substance; a very small portion only is eliminated by the kidneys. These experiments may lead to a rational treatment of tetanus, whether produced by poison or following wounds. The chief desideratum would be a method of keeping up artificial respiration for a long time.

Prussic Acid. — Mr. Ralph read a paper before the Medical Society of Victoria, "on the effects of prussic acid on the animal economy." He administered it to various animals, rabbits, flies, bees, maggots, etc., and in all cases found afterward concretions of Prussian blue or a cyanide of iron in the tissues, having failed to detect any such colored masses before his experiments commenced. In two cases of persons to whom prussic acid was given as a medicine, the films and concretions of Prussian blue were noticed in the blood with the microscope. From his observations he is satisfied that prussic acid causes a change in some of the constituents of the blood, that it attacks the iron when in some particular condition, and, with perhaps the aid of some alkaline base, the Prussian blue is formed, which may vary very much, as is well known, in its constitution. He also finds that at the same time as the ferrocyanide is formed, amylaceous particles are set free, and draws some valuable conclusions as to the formation of *corpora amylacea*, and suggests that the iron in the blood may not improbably have other functions beside that connected with oxygen, namely, that of being a vehicle or medium for holding carbon and hydrogen together, and for their more ready distribution to the tissues. Dr. Hassall some years since pointed out the formation of *indigo* in the urine and tissues of the body; Mr. Ralph's experiments show that the blue particles are not indigo, but Prussian blue or a cyanide of iron. — *Quarterly Journal of Science*, 1867.

NEW ANÆSTHETIC.

"We are glad to announce the introduction of a new anæsthetic, which, if further experience confirms the results hitherto obtained, promises to be of remarkable value. Dr. Protheroe Smith has been making some observations on the administration by inhalation of the tetrachloride of carbon (CCl_4), of which we wait for a fuller account. In the mean time, from our own observation, we may state, in favor of this agent, that it has a pleasant odor, somewhat resembling that of the quince. We understand that anæsthesia is rapidly produced by it (in some cases in the space of half a minute); that the condition appears to be easily sustained with or without entire loss of consciousness; and that the effects pass off very quickly. There is not usually, we learn, any excitement or struggling before anæsthesia supervenes, and its use is not followed by the sickness which is sometimes so troublesome a feature from the administration of chloroform. A point of great interest in relation to the tetrachloride of carbon is the property which we are told it possesses of immediately allaying pain arising from any cause. In a large number of instances it has been successfully employed for the relief of headache. Dr. Smith has found it of great value in inducing quiet and refreshing sleep. — *London Lancet.*

INOCULATION OF TUBERCLE.

Dr. Lebert, Professor at Breslau, has been trying the experiment of introducing tubercle into the system by subcutaneous injection. The amount introduced varied from 50 centigrammes to a gramme, diluted and triturated with distilled water. The nape of the neck was the spot chosen for injection. The experiments were made with Guinea pigs and rabbits, and both gray and yellow tuberculous matter was employed, as well as liquid from a cavity. The result of his experiments was the finding of tubercles not only in the lungs, but in the liver, the spleen, the pleuræ, the pericardium, and the whole lymphatic system. Microscopic examination demonstrates the identity of these tubercles with those of man. — *Boston Med. and Surg. Journal.*

BAYONET WOUNDS.

Our knowledge of bayonet wounds has been so limited that their effects have been, until a recent period, involved in considerable doubt and even mystery. Experience, however, teaches that we have exaggerated the nature of these injuries, and attributed to them formidable qualities which they happily do not possess.

Why is it that soldiers have such terrible fear of the bayonet? Why is it that the determined approach of a line of glistening steel makes the cheek blanch and causes the bravest hearts to waver? Why do we in many battles witness the rout of lines that have unflinchingly withstood a continued galling fire of musketry and artillery, as soon as the opposing line approaches closely with fixed bayonets? This dread of "cold steel" is, in my opinion, mainly attributable to ignorance of the nature of the injuries inflicted by it. There appears to exist in the minds of men a vague dread of transfixion by the bayonet. But this would probably not be so, were it generally known that bayonet wounds are almost harmless, when compared to the ploughed tracks which the terrible Minié bores through the tissues. The bayonet, on account of its less velocity, is easily diverted from a straight course by bony, cartilaginous, and tendinous tissues, and forms a smooth track, whilst the Minié is relentless in its course, whirling with unimpeded force through all opposing structures, crushing, tearing, maiming all. A bayonet wound almost invariably heals by first intention under auspicious circumstances, and leaves no deformity behind, whilst the simplest ball wound requires weeks for a complete recovery, and then perhaps leaves the sufferer with a contracted and useless limb. — *Dr. Baruch.*

THE CAUSE OF INTERMITTENT FEVER.

The question has been asked, granting that the cryptogamous plants which Dr. Salisbury regards as the cause of intermittent fever are found growing in districts confessedly malarial, do not malarial diseases occur in regions where these algoids are not found? To this inquiry Dr. Salisbury replies:—

"I have not found the Ague Palmella growing to any extent in any locality that is not malarial; and I never have found a malarial district or locality that did not produce one or more species of the plants described in my monograph.

"The Ague plants develop on and just beneath the surface of soils, in certain localities, where the soil and hygrometric conditions are suited for their development. They grow as prolifically upon a sand bed as upon boggy soils, providing the proper conditions are present. They begin to develop in profusion in this climate (Cleveland, Ohio) early in July, and continue to grow luxuriantly until the early frosts.

"As the plants mature they burst and discharge their spores, which accumulate in vast multitudes on the surface of the soil, presenting the appearance often of an incrustation of flour, lime, or brick dust, thinly or thickly scattered."

In answer to an inquiry whether he finds these plants in the blood,—as the impossibility of such a thing without very grave if not fatal results has been urged as one of the points of criticism of his theory, and in objection to his statement that he had found them growing in the urine,—Dr. Salisbury informs us that he does, and accompanies his statement with a drawing, representing them as they are found in the circulation. They differ in no respect from the plants in their natural habitat, except in the want of color. They appear as large cells, with "double walls, with a narrow intervening space. This is not always evident, but generally is. There is no nucleus. The plants are filled with spores. They are from 2 to 4 times the diameter of colorless corpuscles, and stand out with a strong outline like the *ova of entozoa.*

"One very interesting fact I have noticed,—which explains the use of quinine in ague,—and that is, where patients have taken it for some time and in considerable doses, the plants in the blood seem almost entirely empty of spores. It seems to destroy their power to produce the reproductive elements."—*Boston Med. and Surg. Journal.*

NEW PROCESS FOR PREPARING ANATOMICAL SPECIMENS.

Dr. Brunetti, of Padua, who received a gold medal at the Paris Exhibition, has communicated to the International Medical Congress particulars of his valuable invention. The process comprises 4 operations, namely, 1, the washing of the piece to be preserved; 2, the eating away of the fatty matter; 3, the tanning; and, 4, the desiccation.

1. To wash the piece, M. Brunetti passes a current of pure

water through the blood-vessels and the excretory canals, and then washes the water out by a current of alcohol.

2. For destroying the fat he follows the alcohol with ether, which he pushes through the same blood-vessels and excretory ducts. This part of the operation lasts some hours. The ether penetrates the interstices of the flesh, and dissolves all the fat. The piece, at this point of the process, may be preserved any length of time desired, plunged in ether, before proceeding to the final operations.

3. For the tanning process he dissolves tannin in boiling distilled water, and then, after washing the ether out of the vessels with distilled water, he throws this solution in.

4. For the drying process he places the piece in a vase with a double bottom filled with boiling water, and fills the places of the preceding liquors with warm, dry air. By the aid of a reservoir, in which air is compressed to about 2 atmospheres, and which communicates, by a stopcock and a system of tubes, first to a vase containing chloride of calcium, then with another heated, then with the vessels and excretory ducts of the anatomical piece in course of preparation, he establishes a gaseous current which expels in a very little time all the fluids. The operation is now finished.

The piece remains supple, light, preserves its size, its normal relations, its solid elements, for there are no longer any fluids in it. It may be handled without fear, and will last indefinitely. The discovery is important, and will enable the medical schools to provide themselves with full cabinets of natural and pathological specimens.

MUTABILITY OF SPECIES.

In a recent communication to the Geological Society of Paris, M. A. Gaudry pointed to some striking facts favorable to the theory of the mutability of species. The sand pits in the environs of Paris, and indeed all drift deposits in general, are very rich in remains of the mammoth or primitive elephant, and of the *elephas antiquus*. These remains chiefly consist of molar or back teeth, in which characteristic differences may be easily recognized. They consequently pertain to two different species, and, in order to ascertain whether there exists any close parentage between them, M. Gaudry goes back to the pleistocene period, which lies between the upper tertiary or pliocene and the drift strata. Now the pleistocene forest-bed of Norfolk contains a quantity of molars of each of the above species, but it also comprises others slightly differing from both, and also intermediate between those of *elephas antiquus* and *elephas meridionalis*, the latter ceasing to exist when the former and the mammoth begin. These again disappear after the drift, and are followed by other species. Here, then, we perceive a succession of species, each of which has sprung from the preceding one. During the tertiary period there existed a breed of horses to which paleontologists have given the name of *hipparion*. They had small, lateral fingers, thus forming a link between pachydermata and solipedes, which latter were considered perfectly distinct so long as the genus *equus* was characterized by a single finger at each foot. Now, Mr. Owen, on examining the horses' teeth found in the cavern of Oreston, discovered that the *equus plicidens* to which they belonged was intermediate between the hipparion and the present horse. In the *equus plicidens* the enamel of the teeth presents more folds than in the living breed; but in the molars found in our gravel pits, M. Gaudry has perceived gradations between those presenting many and those presenting fewer folds, whence he concludes that our horse is a descendant of the *equus plicidens*. A hippopotamus, the remains of which were discovered at Grenelle a few years ago, appears not to differ materially from the race that now inhabits the rivers of Africa; and yet at the time this animal was disporting himself in the Seine, the climate was much colder here than it is now; so that M. Gaudry concludes with great plausibility that, if we had the whole skeleton, some differences would probably appear. — *Scientific American.*

DARWIN'S THEORY.

Bischoff, in a recent work on the comparative anatomy of the quadrumana, appends a note on the Darwinian theory, some of the points of which are as follows: —

The assertion that the anthropoid apes are the direct ancestors of man, even if it were supported by any evidence, is contrary to the Darwinian theory rightly understood, for the extinction of the parent form is the direct consequence of the development of an improved form. The problem of organic nature is twofold: 1. The origin of the simplest original forms. 2. The causes and the mode of their operation, by which more perfect forms were developed. A great defect of Darwin's theory is, that he leaves the first question unanswered. Admitting that certain organisms must have been created, what right has he to say that other organisms may not have been created at intervals, even to the present time? Another defect of the Darwinian theory is, that no cause is assigned for the commencement of variation. To say that organisms have at once the power of transmitting peculiarities by inheritance, and of spontaneously originating varieties, is a contradiction in terms. Darwin's treatment of the second half of the second question is more successful. Natural selection and the struggle for life must henceforth be fundamental principles in any theory of development. Since no general cause is assigned either for the origin of life or for the commencement of variation, all that can be considered as proved is, that certain forms have been produced by variation from certain other forms. The facts warrant no general deduction. — *American Journal of Science, July*, 1867.

THEORY OF THE SKULL.

Mr. H. Seeley thus concludes a paper on this subject: "The skull is the terminal segment of the body; and, just as the adjacent segments consist of the pharynx, the larynx, and a vertebra enclosing part of the neural column, so also the skull, which is the termination of these three organs, and where their outlets are visible, must consist of them also. The brain-case, therefore (the termination of the neural system), is a modified vertebra, the bronchial circle of nasal and palatine bones a modification of the trachea, and the lower jaw a modified rib developed by the mouth. The respiratory circle of bones is the key to the skull."

HOMOLOGIES OF SOME OF THE MUSCLES IN FISHES.

M. Baudelot ("Comptes Rendus," June 10, 1867) communicates an interesting paper on the homology of the slender muscles in fishes, situated, above and below, in the interval between the two great systems of muscles which extend from the tail as far as the scapular arch. He points out the relation between these muscles and the median line fins, dorsals and anal. When there is a continuous dorsal fin from the head to near the tail, there is on the upper region only a single pair of these slender muscles, extending between the end of the single dorsal and the first rays of the caudal. When the dorsal is very short, as in the pike and carp, there are two pairs of these muscles, one in front of, and the other behind the dorsal. When there are two dorsals, as in the trout, there are three pairs of these muscles, one in front of each dorsal, and the third behind the second dorsal. In the flounder, where the dorsal extends the whole length of the back, these slender muscles are not found. The same variations are observed in the abdominal region in regard to the anal fin.

He shows that these slender muscles are only the motor muscles of the fin rays, whose fasciculi become consolidated into a single longitudinal bundle when the rays which serve to support them are absent or rudimentary. There can be seen a gradual passage from the ray muscles to the slender muscles.

He lays down the following formula in philosophical anatomy: given on one hand a series of homologous bones, and on the other a corresponding series of muscular bundles inserted into them, if a certain number of the bones are absent, the corresponding muscles are not at the same time wanting, but are united so as to form a complex muscle. He illustrates this by the costal system of mammals. In these the ribs cease at the beginning of the abdominal region, but the muscles which would be attached to them do not disappear, but are united to form the muscles called the external and internal oblique and transversalis of the abdomen. The external oblique is the union of all the external abdominal intercostal muscles; the internal oblique of the internal abdominal intercostals; and the transversalis of the muscles corresponding to the triangularis sterni. The recti muscles of the abdomen he regards as the homologues of the inferior slender muscles, which in fishes extend from the pelvis to the scapular arch. The different muscles of the neck may also be considered as representatives of costal muscles.

EXPERIMENTS ON LIVING ORGANISMS IN HEATED WATER.

Prof. Jeffries Wyman, in the "American Journal of Science," for Sept., 1867, has communicated the results of his experiments on the formation of infusoria in boiled solutions of organic matter. All living beings found under the above circumstances have been attributed either, 1, to organisms, or their germs, supposed to be contained in the fluid experimented with, or the air included in the flasks; or, 2, to the direct transformation of organic matter into new living beings, independently of any germs or living organisms whatever, — or, in other words, to spontaneous generation. The absolute proof of spontaneous generation, in view of the abundant existence of the very minute spores or germs of infusoria in the air, and the difficulty of being sure that all such have been destroyed by high temperature or kept out during the experiments, must come from the formation of living organisms out of inorganic matter. The evidence adduced is derived, 1, from the phenomena of hot springs; 2, from the appearance or non-appearance of infusoria in solutions boiled for different periods of time, and exposed only to pure air; 3, from the observed action of heat on the living organisms which the solution experimented with was known to contain.

The following are the conclusions which appear to him to be justified by the observations and experiments recorded in the paper: —

1. In thermal waters plants belonging to the lower kinds of algæ live in water the temperature of which, in some instances, rises as high as 208° F.

2. Solutions of organic matter boiled for 25 minutes, and exposed only to air which had passed through iron tubes heated to redness, became the seat of infusorial life.

3. Similar solutions contained in flasks hermetically sealed, and then immersed in boiling water for periods varying from a few minutes to 4 hours, also became the seat of infusorial life. The infusoria were chiefly vibrios, bacteriums, and monads.

4. No ciliated infusoria, unless monads are such, appeared in the experiments referred to in the above conclusions.

5. No infusoria of any kind appeared if the boiling was prolonged beyond a period of 5 hours.

6. Infusoria having the faculty of locomotion, lost this when exposed in water to a temperature of from 120° to 134° F.

7. If vibrios, bacteriums, and monads are added to a clear and limpid organic solution, this becomes turbid from their multiplication in from 1 to 2 days. If, however, they have been previously boiled, the solution does not become turbid until from 1 to 2 days later, and in some of the experiments not sooner than does the same solution to which no infusoria have been added.

THE RELATION OF PLUMAGE TO MODE OF NIDIFICATION IN BIRDS.

Mr. Wallace made a communication on this subject to the British Association, in 1867, of which the following is an abstract: —

Birds' nests may be divided into two classes: the first, comprising those in which the nest is either fully exposed or imperfectly concealed; the second, in which the nest is either roofed in or placed in a dark hole, so that the eggs and young, as well as the sitting bird, are effectually hidden. The thrushes, warblers, finches, pigeons, and birds of prey of temperate regions, and the tanagers and chatterers of the tropics, furnish examples of the first kind of nest; while the kingfishers (which build under ground), the parrots and woodpeckers (which build in holes in trees), the *Icteridæ* (with hanging nests), and the common wren (with a domed nest), afford instances of the second class.

From the point of view of color and markings, birds may also be divided into two classes, according to the difference or identity of color in the two sexes. In some groups, as in the toucans, the varied and brilliant colors are found in both sexes; but in the majority of birds the female is far less brilliant than the male. With very few exceptions, Mr. Wallace finds that whenever both sexes are of bright or conspicuous colors, the nest is of the second class, or such as to conceal the sitting bird; while, whenever there is a striking contrast of colors between the sexes, the female being dull and obscure, the nest is open and the bird exposed to view. The bright-colored kingfishers, motmots, barbets, toucans, plantain-eaters, hoopoes, todies, trogons, woodpeckers, parrots, metallic starlings of the East, ground-cuckoos, nuthatches, American hangnests, some titmice, etc., in which the females are almost, if not quite, as brilliant as the males, build their nests either in the ground or in holes of trees, or make them in a roofed form, or carefully concealed in dense foliage, or by various external devices. On the other hand, the birds of showy plumage, which build open nests, almost all have the females of a dull color, as in the brilliant chatterers, tanagers, manakins, tropical fly-catchers, shrikes, thrushes, and warblers. The females in these are deficient in the bright patches of color on the head and upper parts, which would render them visible when sitting on their open nests, and, moreover, have the earthy brown or olive green tints best adapted for concealment.

These facts, taken in connection with innumerable others in the insect world, show the remarkable provisions in nature for the protection of the female from carnivorous enemies while rearing the young. The absence of color, when the structure and situation of the nest are insufficient, protects the female bird during the important process of incubation. This view is confirmed by certain anomalous facts in the natural history of birds. There are some instances in which the males perform a part or even the whole of the duties of incubation. In these cases, when the bird is so defenceless as toneed protection, the usual colors of the sexes are reversed, the female becoming the larger and brighter bird, — as in the sooty phalarope, the dotterel plover, and the small Indian quails of the genus *turnix*. He thinks that this curious and unexpected connection between the manner of a bird's nesting and the color of the female plumage, is best explained by the action of the laws of variation and hereditary transmission, and the cumulative effect of natural selection or survival of the strongest; and that the views of Darwin well illustrate how large a part the need of protection has played in producing many of the most striking peculiarities in the animal kingdom. The few exceptions to the above law can in most cases be explained by the peculiar habits of the species.

[The same law holds good in the N. American birds.] — *Editor.*

ON THE LUMINOSITY OF THE SEA.

Mr. Collingwood, in the "Quarterly Journal of Science," October, 1867, classes all the cases of luminosity which came under his observation, during a voyage of eighteen months' duration in temperate and tropical seas of both hemispheres, under the following five heads: —

1. Sparks or points of light, very common, often very brilliant, varying in size from a pin's head to a pea, apparently caused by minute entomostracous crustaceans.

2. A soft, usually greenish, phosphorescent effulgence, seen only in calm weather, when a smooth sea is disturbed by a keel or oars; due to the presence of innumerable *Noctilucæ* and to minute *Entomostraca.*

3. Moon-shaped patches of steady white light, several inches in diameter, generally seen in the wake of the ship, such as might be given out by the umbrellas of *Medusæ*, but in his opinion not produced by *Acalephæ*, but by Ascidians of the genus *Pyrosoma.*

4. Instantaneous recurrent flashes of light, very common, seen when the night is dark and the sea smooth, occurring at a distance from the path of the ship and at a considerable depth in the water. These may be produced by Ascidians (when undisturbed), by small *Medusæ*, and by *Noctilucæ.*

5. Milky sea, of rare occurrence, considered by him as owing rather to ill-understood atmospheric or climatic influences, than to any extraordinary number of luminous animals. It may sometimes be due to the general diffusion in the water of the slimy substance in which the luminous property in many marine animals seems to reside.

The luminosity is most frequent and brightest in warm seas. Fish swimming rapidly in water abounding in minute luminous animals would produce an effect depending on the disturbance of the luminous points in their passage. This luminosity has sometimes erroneously been supposed to proceed from the fish.

CRUSTACEAN PARASITISM.

Prof. Verrill states ("American Journal Science," July, 1867), that in a collection of about 90 specimens of a small sea-urchin (*Euryechinus imbecilis*, Verrill) from the coast of Peru, not one could be found in which the anal area and surrounding parts of the upper side of the shell were not more or less irregularly distorted or imperfect. An examination of the interior showed that in each specimen a crab (*Fabia Chilensis*, Dana), allied to the common crab of the oyster (*Pinnotheres*), had effected a lodgment in the upper part of the intestine, which had thereby been greatly distended in the form of a membranous cyst, attached to one side of the shell, and extending around to the lower surface near the mouth. The shell is usually swollen on the side over the cyst, and the anal area is depressed and distorted, with a large orifice passing obliquely into the cyst, out of which the crab may thrust its legs at pleasure; but it is apparently unable, when full grown, to come entirely out. All the specimens examined in the cyst were females carrying eggs, but a very small crab found clinging among the spines appears to be the male. The crab probably effects an entrance into the intestine through the anus while quite young, and, by its presence and growth in that position, causes the gradual distortion of the shell and formation of the cyst.

Another peculiar mode of parasitism was observed by him in a singular crustacean (*Hapalocarcinus marsupialis*, Stimpson) from the Sandwich Islands. This creature lodges itself among the slender branches of a coral (*Pœcillipora cæspitosa*, Dana), and causes, probably by its incessant motions, the branches to grow up and surround it on both sides by flat expansions of coral, terminating in digitations, which often interlock above, leaving openings between them suitable for the uses of the parasite, but usually too small to allow of egress. Most specimens of the corals of this species sustain one or more, and often numerous, examples of these curious enlarged bulbs among the branches.

AXOLOTL A LARVAL SALAMANDER.

According to M. Aug. Dumeril ("Comptes Rendus," Aug. 5, 1867), the Mexican axolotls, born in the Museum at Paris, underwent a series of transformations, becoming yellowish-white in spots, and losing entirely their branchial apparatus and the membranous crest of the back and tail; the internal organs experience changes comparable to those observed in the tailed batrachians when they pass from the larval state. Three of the arches supporting the external branchiæ disappear, while the most external remains as the posterior articulation of the thyroid cornu; the anterior face of the vertebral bodies becomes less hollow; and the teeth on the vomer form beyond the internal orifices of the nasal fossæ an almost transverse row, which, with the absence of the posterior palate teeth, is found only in the North American tritons of the genus *Ambystoma*, of which the axolotl seems to be the tadpole or larval state. This confirms the opinion of Cuvier that this animal, considered as a perennibranchiate batrachian, must be a larva. He also found that the gradual, and even the sudden and total excision of all the external branchiæ in the axolotl, obliging them to respire through the pulmonary organs and the skin, did not seem to cause any inconvenience to them, and many thus mutilated underwent the above metamorphoses.

NATIVES OF MADAGASCAR.

Mr. Thomas Wilkinson, in the "Anthropological Review" for

1867, maintains the existence of two distinct races of men in this island, one inhabiting the coast, the other the interior. "The former," he says, "have woolly hair, brown or black skins, strong white teeth, and, in fact, all the characteristics of a superior order of negroes. Within the last few years this race has been conquered by the people inhabiting the interior of the island, who are called *Hovas*, and are generally slender, often small, with, in many cases, long, straggling, unsound, and ugly teeth, straight, coarse hair, and light brown skins, with faces resembling those of the Chinese or of other Mongolian races."

THE POLYNESIANS AND THEIR MIGRATIONS.

M. Quatrefages has attempted to show that the Polynesians are Malays, who migrated at a comparatively recent period from some island of the Malayan archipelago (probably the Moluccas), and who have more or less intermingled with the races of Melanesia and Micronesia. Mr. A. R. Wallace, in the "Quarterly Journal of Science," April, 1867, controverts this opinion, showing that the direct evidence of migration having been generally from the west is not so clear as M. Quatrefages appears to believe; and that the undoubted Malay element in the Polynesian language has all the character of a recent introduction, since the words are hardly changed except by the phonetic character of the Polynesian language. The physical and mental characters of the Polynesians are very different from those of the Malays, in stature, hair, and beard, features, disposition, and manner of building houses and canoes, — indicating a radical diversity of race, not to be overcome by any mere similarity of color or some common words in language. The existence of numerous groups of coral islands, indicating sunken land, and the distribution of animals in the existing islands, prove a former much greater extent of land in the Polynesian area than now exists, and entitle us to believe that the subsidence of the land took place since man inhabited the earth, probably coincident with, perhaps caused by, the elevation of the existing volcanic islands. Many of the races of the eastern Malayan archipelago (Timorese and mountaineers of Ceram and Gilolo) are perhaps allied to the Polynesians, but they are certainly not Malays, who are essentially a Mongol race. The Papuans of New Guinea form the extreme type of another and a widely different race, and all the evidence goes to show that in every characteristic except color the Polynesians are nearer to the Papuans than they are to the Malays, although it is not improbable that they are equally distinct from both.

DIFFERENCES BETWEEN MAN AND THE APE.

On the occasion of a paper on this subject by M. Schaafhausen, of Bonn, read before the Paris Anthropological Society, M. Gratiolet thus expressed the result of his researches. He thought that there existed no reason for establishing an anatomical similitude between man and the gorilla. "As regards the brain, the gorilla's is the lowest of the anthropoid apes, since the brain does not cover the cerebellum, by which he approaches the cynocephali. It is not in his size and strength that we must look for human characters, but in the conformation of the hands; and just in this he differs considerably from man. The thumb is very short in the gorilla, and its muscles much reduced. The long flexor is replaced by a tendinous tract, the origin of which is lost in the tendinous sheaths of the flexors of the other fingers. It follows that the thumb has no independent movement of opposition. In the orang, though the thumb is shortened, it is still capable of an independent flexion; but this depends on a peculiar disposition which he had lately verified with M. Alix. In point of fact, the proper flexor of the thumb is entirely absent in the orang; there is not even found that tendinous tract existing in the gorilla; but, by a singular contrivance, the marginal fibres of the abductor muscle of the thumb terminate in a tendon which is placed in the axis of the first terminal axis." "The fact which establishes a great relation between man and apes is, that in them the optic nerves open directly in the cerebral hemispheres, whilst in the other vertebrates these nerves reach the brain only by the intermediation of the tubercula quadrigemina. This peculiarity may explain the existence of a certain conformity in the manner in which man and ape perceive their sensations. But it does not follow that there is an identity in the nature of their intelligence; for though the senses are subservient to the operations of the intellect, it cannot be said that they produce it. Man must be placed by the side of the ape, but only as an animal. Man is a being apart, just as all other vertebrata must be separated, as they cannot be considered as having originated from each other." M. Gratiolet added that, as a pupil of Blainville, with whom originated the idea of a series in natural history, he felt bound to state how much the ideas of his master had become modified. Where Blainville formerly recognized transitions from group to group, he, in the latter period of his life, only saw maxima and minima of realization for each group. He acknowledged an ideal series between types, but not a lineal series between all beings. It is thus impossible to invoke the opinions of Blainville for the support of theories tending to reduce to a single stock the numerous species composing the animal kingdom. —*Medical Times and Gazette.*

CHALK AS A FERMENT.

M. A. Béchamp has been engaged in investigating the action of the chalk which is generally used in butyric and lactic acid fermentations. Chalk is commonly added to a liquid undergoing this change for the purpose of neutralizing the acids formed, and thereby augmenting the quantity producible. Although this, no doubt, is its general method of action, yet M. Béchamp now shows that native chalk is of itself capable of acting as a ferment, and, when added to a solution of starch or of sugar, will establish the alcoholic, lactic, and butyric fermentations without the intervention of any other substance.

It is well known that the chalk formation consists almost entirely of the fossil remains of minute organized beings, which are readily detected by the microscope. But independently of these fossils, which represent life which is gone, we are assured by M. Béchamp, that white chalk still contains quite a generation of living organisms, much smaller than any we know, and less than all the infusoria and microphytes which have been studied in fermentations. These living organisms, which M. Béchamp names *microzyma cretæ*, are, the author states, the most powerful ferments known. Taking a sample from the very centre of a large block of native chalk, mixing it with pure water, and examining it by the microscope, there will be seen in the field some bright points, often very numerous, endowed with a very lively trepidating movement. These are the microzymæ of M. Béchamp,—the smallest living beings to be seen. In further support of his view, M. Béchamp shows that such chalk is capable of acting as a ferment, and also that it contains the elements necessary to organic beings, — carbon, hydrogen, and nitrogen.

420 grams of starch paste, and 30 grams of chalk, with 4 drops of creosote, were intimately mixed. At the same time, a similar mixture was made, but the chalk was replaced by pure carbonate of lime. In 3 days the chalk had liquefied the starch, while the carbonate of lime had effected no change whatever. On the 14th November, 1864, 100 grams of starch, 1,500 c.c. of water, and 100 grams of chalk, with 10 drops of creosote, were mixed. On the 30th March, 1866, the mixture was analyzed. It yielded 4 c.c. of absolute alcohol, 8 grams butyric acid, and 5.2 grams of crystallized acetate of soda. On the 25th April, 1865, 80 grams of cane sugar, 1,400 grams of chalk, and 1,500 c.c. of creosotic water were put together. On the 14th June, the product of the action yielded 2.6 c.c. absolute alcohol, 4.5 grams butyric acid, 6.8 grams acetate of soda, and 9 grains of lactate of lime.

When proper precautions are taken, no other ferment can be found in the liquid after fermentation, besides those which are found in the chalk, but these have become considerably augmented. To prevent chalk from acting as a ferment, it is sufficient to raise it, moist, to a temperature of 300° C.

The organic matter in chalk amounts to 7 per cent., and contains carbon, hydrogen, and nitrogen. — *Chemical Gazette.*

THE BORING OF LIMESTONE BY ANNELIDS.

Mr. E. Ray Lankester stated, at the meeting of the British Association at Dundee, in 1867, that, in the discussions concerning the boring of molluscs, no reference has been made to the boring of annelids, — indeed, they seemed to be quite unknown, — and brought forward two cases, very abundant on some shores, where boulders and pebbles may be found worm-eaten, and riddled by them. Only stones composed of carbonate of lime are bored by them. On coasts where such stones are rare, they are selected, and all others left. The worms are quite soft, and armed only with horny bristles. How, then, do they bore? Mr. Lankester maintained that it was by the carbonic acid and other acid excretions of their bodies, aided by the mechanical action of the bristles. The selection of a material soluble in these acids is most noticeable, since the softest chalk and the hardest limestone are bored with the same facility. This can only be by chemical action. If, then, we have a case of chemical boring in these worms, is it not probable that many molluscs are similarly assisted in their excavations? Mr. Lankester did not deny the mechanical action in the pholas and other shells, but maintained that in many cases the coöperation of acid excreta was probable. The truth was to be found in a theory which combined the chemical and mechanical view.

THE WOODPECKER'S FORESIGHT.

The woodpecker in California is a storer of acorns. The tree he selects is invariably of the pine tribe. He bores several holes, differing slightly in size, at the fall of the year, and then flies away, in many instances to a long distance, and returns with an acorn, which he immediately sets about adjusting to one of the holes prepared for its reception, which will hold it tightly in its position. But he does not eat the acorn, for, as a rule, he is not a vegetarian. His object in storing away the acorn exhibits foresight, and knowledge of results more akin to reason than to instinct. The succeeding winter the acorn remains intact, but becoming saturated with rain, is predisposed to decay, when it is attacked by maggots, who seem to delight in this special food. It is then that the woodpecker reaps the harvest his wisdom has provided, at a time when, the ground being covered with snow, he would experience a difficulty, otherwise, in obtaining suitable or palatable food. It is a subject of speculation why the red-wood cedar or the sugar-pine is invariably selected. It is not probable that the insect, the most dainty to the woodpecker's taste, frequents only the outside of two trees; but so it is, that in Calaveras, Mariposa, and other districts of California, trees of this kind may be frequently seen covered all over their trunks with acorns, when there is not an oak-tree within several miles. — *A. B. Barton.*

SILUROID FISHES.

At a recent meeting of the Boston Society of Natural History, Professor Agassiz stated that he had recently been reviewing the siluroid fishes, for the sake of illustrating the definitions he had long since presented for the different categories of structure among animals. The siluroids had always been considered a natural group; placed, at first, in a single genus, which was subsequently divided into two, they were next considered a family including several genera, and finally an order, embracing several groups termed families. Was there, then, no meaning in the terms genus, family, order?

He urged strongly that the application of these terms should be uniform, since a genus really remains a genus, no matter how numerous its subdivisions. He believed that orders were founded upon degrees of complication of structure, and families upon the forms of animals. Gill, finding that Bleeker had divided the group into several families, raised it one grade higher and called it the order of Nematognathi, — a name implying a structural feature of no ordinal value whatever.

He claimed that the group was an order of ganoid fishes which should be placed between the sturgeons and garpikes. They had one striking feature in the structure of the jaws, not only reptilian, but bird-like; this was the power of sliding the palatine bone forward upon the sphenoid, and thus thrusting the barbel forward. The brain greatly resembled that of a sturgeon. Four families were mentioned belonging to the order.

EOZOÖN IN BAVARIA.

Prof. Gümbel has described the *Eozoön Bavaricum* in the primary series of eastern Bavaria, in a rock consisting of a granular aggregation of calcite, serpentine, and a white hornblendic mineral, supposed to be of Huronian or Cambrian age. Beside the general characters of *E. Canadense*, the serpentine bands pass into an adjoining portion of one-half the width, or less, made up of very much twisted lamellæ, consisting of serpentine or a whitish mineral, and possessing highly-vaulted and deeply-channelled outlines. From the last character he gives it the name of *E. Bavaricum*. He makes out the occurrence of Eozoön in the pargasite of Finland, the coccolite limestone of New York, at Tunaberg, Boden in Saxony, and Hodrisch in Hungary. — *Journal Geological Society*, xxii. 23.

Eozoön Canadense. — Messrs. Dawson and Carpenter, in the "American Journal of Science," Nov., 1867, give the results of an examination of this fossil, furnishing a conclusive answer to the objections to the organic nature of *Eozoön*, which have been founded on comparisons of its structures with the forms of fibrous, dendritic, or concretionary minerals. They also give the summary and conclusion of Messrs. King and Rowney, who maintain that this fossil is solely of crystalline origin and inorganic substance.

AFFINITIES OF TELERPETON.

Prof. T. H. Huxley, in describing the remains of *Telerpeton Elginense*, discussed especially the biconcave character of the vertebræ, the mode of implantation of the teeth, which he believed to be acrodont and not thecodont; and the anomalous structure of the fifth digit of the hind foot, which presents only two phalanges, — a proximal and a terminal; a structure differing from that of all known lacertian reptiles, living or fossil. He concludes that the animal is one of the reptilia, and has no indication of affinity with the amphibia. In all its characters it is decidedly saurian, and agrees with the suborder *Kionocrania* of the true Lacertilia.

The possession of biconcave vertebræ is not opposed to this view, as, although most living Lacertilia have concave-convex vertebræ, biconcave vertebræ, much more deeply excavated than in this animal, are found in the existing geckos.

It presents not a single character approximating it toward the type of the Permian Protorosauria, or the Triassic Rhynchosaurus and other allies of that genus, or to the mesozoic Dinosauria. Whether the age of the deposit in which it occurs be Triassic or Devonian, it is a striking example of a *persistent* type of animal organization. — *Geological Magazine.*

GROWTH OF LYCOPERDON.

The observations of M. Baudrimont on the growth of *Lycoperdon giganteum* lead to very interesting conclusions. In 14 days after appearing at the surface of the ground it had acquired a considerable size. When plucked it had begun to decrease visibly, but its circumference was 1 m. 4 c. on its greatest diameter, and its weight 3 kilo. 500 grams. After having been completely dried in an oven it weighed 305 grams, showing that before desiccation it contained 91.28 per cent. of water. Analysis has proved that nitrogen represented 8.96 per cent. of the weight of it in the dried, or .78 per cent. in its normal state. If we suppose all this nitrogen to have been in the state of albumen, which contains 17.70 per cent. of nitrogen and 53 per cent. of carbon, the 305 grams of lycoperdon contained about 174 grams of carbon. We have even 142 grams by adding the carbon contained in the non-nitrogenized substances, its cellulose, etc. The 142 grams of carbon represent 520.66 grams or 265 litres of carbonic acid, and hence 530.000 litres of air. It is from this enormous volume of air, equal to a cube of 8 metres linear edge each way, that the fungus must have drawn the 142 grams of carbon necessary for its development of 14 days, — this is at the rate per day of 10.15 grams of carbon, 18.9 litres of carbonic acid, and 37.800 litres of air, — it is upon nearly half a litre of air that the plant must have operated per second to effect the total extraction of the carbonic acid which was in it. By what means can we estimate the prodigious activity that this inferior plant could develop to be able to take in 14 days all the carbonic acid belonging to 530.000 litres of air? How astonishing must be the delicacy of the absorptive organs which seize on its flight an elastic fluid disseminated in such an enormous mass, continually moving with great rapidity! But this is not all. The mean circumference of the fungus was .990 m.; its volume more than 16,-000,000 of cubic millimetres; and its mass formed of cellules 1 millimetre long at most, and one three-hundredth of a millimetre in thickness, between which are placed the reproductive spores. The total number of the cellules exceeds 14,000,000,000; and, since the development lasts 14 days, a million of cellules had to be produced every 4 hours, — 12,000 cellules per second! Just let one stroke of the pendulum, and then another, be heard, and conceive, if you can, that in that space of time the fungus constructed 12,000 cellules, besides 1,200,000 spores, without any sensible shock or any hurried interior derangement capable of disturbing the mysterious equilibrium that reigns through all the parts of this living body. How great, then, is the prodigious energy which animates the material substance, and which can accommodate itself instantaneously to the exigencies of life! —*American Journal of Science, from Chemical News, April*, 1867.

HOMOLOGIES OF THE FLOWERS OF CONIFERÆ.

According to Mr. Andrew Murray, the male flowers are monopetalous and diandrous in the firs and pines, monopetalous and polyandrous in the cypresses and their allies; the female flower is also monopetalous. The envelopes are supposed to have the following homologies: 1. Outermost envelope or its appendage corresponds in ordinary dicotyledons to the petal; in conifers, to the bract. 2. Next envelope corresponds ordinarily to the disk; in conifers, to the scale. 3. First covering of the fruit, ordinarily to the pericarp; in conifers, the wing of the seed. 4. Second covering of the fruit, ordinarily mesocarp; in conifers, cellular substance between 3 and 5. 5. Third covering of fruit, ordinarily endocarp; in conifers, the testa.

SPONTANEOUS MOVEMENTS IN PLANTS.

In the "Comptes Rendus" M. Lecoq describes some extraordinary vibrations which occurred regularly in the leaves of *Colocasia esculenta*, so violent as to set small bells ringing which had been attached to them; the vibrations were from 100 to 120 a minute. The plant was in a hot-house, and free from currents of air which could produce the movements. M. C. Musset, in his observations on this plant, did not notice the movements of the leaves, but noted that during prefoliation the sap was projected from the leaves to a distance of several centimetres through two orifices, in the form of stomata, at the apex of the leaf; 85 drops were projected per minute. Most likely the movements noticed by M. Lecoq depended on the inactivity of the terminal orifices, as he did not notice any projection of sap, the projecting force having thus been converted into a vibrating force.

THE FUNCTION OF CHLOROPHYLL.

According to Dr. F. Cohn, of Breslau, the coloring matter in all algæ — red, blue, green, yellow, or brown — contains chlorophyll, or a closely allied substance. He also maintains that it is contained in all growing plants, as the principal agent in the process of assimilation, acting perhaps in a manner analogous to that which the oxygen-carrying constituents of blood exhibit in animals. The presence of chlorophyll in the lowest forms of plants has an important bearing on the direction of their motion; they always move toward the light, and, if variously colored light be used, toward the highly refractive actinic rays in preference to the thermal red ones. He believes that the decomposition of carbonic acid and the evolution of oxygen through the chlorophyll, under the influence of light, explain some of the movements of these minute colored organisms.

TALL TREES IN AUSTRALIA.

From Dr. F. Müller's pamphlet upon "Australian vegetation," it appears that the great trees of California are surpassed in height by the *Eucalyptus* of Victoria Colony, Australia. From actual measurements these trees attain a height of 480 feet, higher than the spire of Strasburg cathedral, and as high as the great pyramid of Cheops. They are not, however, so thick as the California trees, — a tree 400 feet high, having a circumference of only 40 to 50 feet, — though they have been found with a circumference of 81 feet at a distance of 4 feet from the ground. The enormous height of vast masses of timber trees in the rich diluvial deposits and sheltered depressions in the Victoria ranges is attributable to the richness of soil, humidity of climate, and moderate temperature of the region. The absence of living gigantic forms of animal life amid this colossal vegetation is very striking. These trees are also remarkable for their rapid growth, even on dry and exposed spots, and for their fitness to resist drought.

He says that "in Australian vegetation we probably possess the means of obliterating the rainless zones of the globe, to spread at last woods over our deserts, and thereby to mitigate the distressing drought, and to annihilate, perhaps, even that occasionally excessive dry heat evolved by the sun's rays from the naked ground throughout extensive regions of the interior. . . . How much lasting good could not be effected, then, by mere scattering of seed of our drought-resisting acacias and eucalypts and casuarinas, at the termination of the hot season, along any water-course, or even along the crevices of rocks, or over bare sands or hard clays, after refreshing showers? Even the rugged escarpments of the desolate regions of Tunis, Algiers, and Morocco might become wooded; even the Sahara itself might have its oases vastly augmented; fertility might be secured again to the Holy Land, and rain to the Asiatic plateau, or the desert of Atacama, or timber and fuel be furnished to Natal and La Plata."

SKELETON LEAVES.

The following method has been communicated to the Botanical Society of Edinburgh: "A solution of caustic soda is made by dissolving 3 oz. of washing soda in 2 pints of boiling water, and adding 1½ oz. of quicklime, previously slacked; boil for 10 minutes, decant the clear solution, and bring it to the boil. During ebullition add the leaves; boil briskly for some time, — say an hour, — occasionally adding hot water to supply the place of that lost by evaporation. Take out a leaf and put it into a vessel of water; rub it between the fingers under the water. If the epidermis and parenchyma separate easily, the rest of the leaves may be removed from the solution, and treated in the same way; but if not, then the boiling must be continued for some time longer. To bleach the skeletons, mix about a drachm of chloride of lime with a pint of water, adding sufficient acetic acid to liberate the chlorine. Steep the leaves in this till they are whitened (about 10 minutes), taking care not to let them stay in too long; otherwise they are apt to become brittle. Put them into clean water, and float them out on pieces of paper. Lastly, remove them from the paper before they are quite dry, and place them in a book or botanical press." — *Hardwicke's Science-Gossip.*

GEOGRAPHY OF PLANTS.

In an article on this subject by M. T. Lippincott, of New Jersey, the following rules were given for determining the fitness of districts in the United States for the growth of certain varieties of wines: —

Those places which have a summer temperature of 65.6°, a hot month of 70°, and a September of 60°, will ripen Delaware, Clinton, Perkins, Iona, Logan, Israella, with other hardy varieties. The temperature of their growing season corresponds to a mean of 65° and upward, and an aggregate of heat of about 8,000° F.

Those places which have a summer of 70°, a hot month of 72°, and a September of 63°, will ripen Concord, Hartford Prolific, Diana, Creveling, etc. Their season of growth corresponds to a mean of 67°, and an aggregate of 8,500°.

The Isabella requires a summer of 72°, a hot month of 73°, and a September of 65°, and a mean during its growing season of 70°, and an aggregate of 10,000° of heat, etc., etc.

OZONE PRODUCED BY PLANTS.

Professor Daubeny, of Oxford, has contributed to the "Journal of the Chemical Society," for January last. an interesting article, giving the details of a series of careful experiments, which go to prove that green foliage, in assimilating carbonic acid, water, etc., liberates a part of the oxygen in the form of ozone. After his experiments were made, Dr. Daubeny found that Kosmann, of Strasburg, had reached the same conclusion, but through less refined experiments. Referring to the first paper he ever communicated to a scientific society, — that published in the "Philosophical Transactions" for 1834, on the evolution of oxygen gas by plants in the day-time, — Dr. Daubeny concludes: "Should I now have established, to the satisfaction of the scientific world, that these same green parts of plants, at the very time they are emitting oxygen, convert a portion of it into ozone, I might hope that these researches of my later years will serve appropriately to wind up those undertaken in my younger ones, by showing that vegetable life acts as the appointed instrument for counteracting the injurious effects of the animal creation upon the air we breathe, not merely by restoring to it the oxygen which the latter had consumed, but also by removing, through the agency of the ozone it generates, those noxious effluvia which are engendered by the various processes of putrefaction and decay," engendered, we may add, as much by decaying vegetables as by animal matter. — *American Journal of Science and Arts.*

THE CINCHONA TREE IN INDIA.

Finding that chemists could not produce quinine nor a substitute, and that, owing to the wasteful manner in which cinchona bark was collected, this valuable drug was getting very scarce, it was determined to introduce the plant into India. It has been found that the change of habitat does not prevent the development of quinine, and the valuable discovery has been made that covering the bark during its growth with moss increases the percentage of alkaloids. The cinchona plantations in India are now so flourishing that there need be no apprehension of the supply of quinine ever failing.

BIOLOGICAL SUMMARY.

Microscopic Examination of Nerves. — Prof. Max Schultze, in his recent observations on the structure of the retina, has used with great advantage a solution of hyperosmic acid, OsO_4, which colors nerve tissue black, without producing much effect on connective and fibrous tissue. This will prove of great importance to microscopists.

Sugar in Muscle. — Dr. Rancke, of Munich, has by recent experiments confirmed the discovery made by Meissner, that a true, fermentable sugar exists in the muscle, which is increased by muscular action (tetanization caused by strychnine or electricity), and further that the liver has no effect in causing this increase, for the sugar is proved to arise in the muscle itself, and not from muscular substance. — *Medical and Surgical Reporter.*

Electricity and the Blood Corpuscles. — Professor Newmann, of Königsberg, who has been working upon the subject of the action of electricity on white blood-corpuscles, has pointed out some very remarkable facts. He finds that under the influence of strong induced currents the white corpuscles of the frog swell out, their walls become quite smooth, and a clear space is left between the wall and the granular nucleus in the interior. The molecules in the cell commence, too, to exhibit rapid movements.

The Nutrition of Teeth. — Henry S. Chase writes, in a communication to the "Dental Cosmos," that he has ascertained, from much observation, that one great cause of the early decay of teeth is the insufficiency of phosphate of lime in the fine or bolted flour upon which children are fed. The most nutritious and wholesome part of the grain exists in the bran that is rejected.

Fish Biscuit. — Professor Rosing, of Asa, France, has invented a process of making flour from a species of sea-fish, which he forms into biscuit, thereby providing a very nutritious and compact article of food. These biscuit are 4 times as rich in albuminoid substances as beef, 4½ times as fresh codfish, and 16 times as fresh milk.

A New Gland in the Human Body. — Von Luschka, of Tubingen, has pointed out a hitherto undescribed gland at the end of the spine of man, which he calls the coccygeal gland, comparing it with the pineal gland. The same body, more largely developed, has been since found in the macaque (*Macacus cynomolgus*), and a similar structure in the cat; the tails of the dog, rat, and mouse do not exhibit it. Meyer regards it as similar to the caudal hearts or retia mirabilia, appendages of the arterial system in many animals.

Cervical Ribs in Man. — Dr. Stieda, of Dorpat, records the case of a woman, in whom a pair of cervical ribs sprang from the seventh cervical vertebra; they appeared fully-formed and well-marked pleurapophyses, and were attached to the sternum by cartilage. The other vertebræ were normal.

Distribution of the Feathers in Birds. — According to Nitzsch, there are definite regions marked out on the bodies of birds, which carry different sorts of feathers, and these regions or pterylæ (feather forests) may be compared and identified in different genera and species, furnishing a very natural means of classification. The "Pterylography" of Nitzsch has recently been published by the Ray Society of London.

Regulation of the Heat of the Body. — Bergmann and Donders made the skin the moderator of animal heat, and found that the self-regulation takes place in its vaso-motor nerves. Particular parts of the skin act as moderators in different animals: in the dog, the nose, paws, and tongue; in the ape, parts of the face; in cocks and turkeys, the vascular combs and gills, which, though usually having a low temperature, under certain circumstances become very warm. The ears of the rabbit are the most remarkable of these organs, being provided, according to Jacobson and Laudré, with means of alternate contraction and dilatation of the blood-vessels, depending wholly on the sympathetic system of nerves.

Reproduction of Limbs. — According to M. Philipeaux, "Comptes Rendus," June, 1867, the limbs of salamanders are not reproduced unless the basilar portion, scapula or ilium, be left in place; neither is the spleen in mammals reproduced unless a portion of the organ is left with its normal connections.

On Pendency of the Epiglottis. — Sir Duncan Gibb read a paper before the British Association, in 1867, on this subject. He found that about 11 per cent. of Europeans had the epiglottis hanging down over the windpipe, instead of erect, producing, in his opinion, sluggishness of disposition in consequence of retardation of respiration, and preventing clearness in speaking and singing. Of 280 Asiatics (male and female) examined by him, all had a more or less pendent epiglottis, — a startling fact, and probably connected with their incapacity for fine singing.

Cause of Cholera. — Of all materials likely to determine an attack of cholera, the most conclusive evidence shows that sewage, introduced in water into the stomach, is the best adapted to develop the cholera germ. Whether sewage, by affording a congenial soil, introduces the living spores into the stomach, or whether it simply supplies the material for their growth in the intestines, the fact that sewage is the most effective material for the production of cholera, cannot be disputed; and it possesses this property, when largely diluted in water. If water thus contaminated be supplied to a family simply, we have sporadic cholera; if to a large community, the disease becomes an epidemic.

Cholerine. — Dr. Frankland has been investigating some of the physical properties of cholera matter, *cholerine.* He shows that it passes through filtering paper, and water containing one five-hundredth of the matter is not entirely purified by transmission through animal charcoal.

Selachians. — At the 1867 meeting of the National Academy of Sciences, at Hartford, Conn., Prof. Agassiz claimed that the order of selachians (sharks and rays) constitutes a type of a special mode of vertebral structure. They have a tail of certain dimensions as compared to the body, and they are the only fishes in which the head, chest, abdominal, and caudal regions are to be found. They are also remarkable for the structure of their brains. It may also be added that, like some reptiles, they are viviparous in their mode of reproduction.

Moulting in Fishes. — It is well known to ichthyologists that the skin in many fishes, especially the *Cyprinidæ*, becomes the seat of a more or less confluent eruption of small, hard, whitish tubercles, during the period of reproduction. These tubercles have led to the establishment of species, and even of genera. These tubercles are temporary; they vary in size and prominence, and are most conspicuous on the upper surface and sides of the head, adherent to the subjacent skin. They consist of superposed layers of epithelial cells, flattened and united, and consequently belong to the epidermic structures. After the reproductive season these tubercles fall with the epidermis to which they are attached, constituting a veritable moult, as in batrachians and reptiles.

Infusoria in Whooping Cough. — According to M. Poulet, in the vapors resulting from the respiration in this disease, microscopic examination detects great numbers of small infusoria. The most abundant, as well as the smallest, he refers to the species described as *Monas* (*Bacterium*) *termo;* others, less numerous, slightly spindle-shaped, two or three-hundredths of a millimetre long, and about one-fifth as wide, belong to *Monas* (*Bodo*) *punctum* or *Bacterium bacillus* of the micrographers. Thus, whooping cough, in the alterations of the expired air, ranges itself in the class of infectious diseases, with small pox, scarlet fever, and typhoid fever.

Egg of Epiornis Maximus. — This bird, attaining a height of about 4 metres, had an egg whose volume equalled that of six eggs of the ostrich. In a specimen recently received at Toulouse from Madagascar, the dimensions were as follows: thickness of shell, m. 0035; large diameter, m. 310; small diameter, m. 255; greater circumference, m. 87; lesser, m. 76; capacity, 8 1-10 litres; color yellowish white, with a few streaks of dendritic form and brownish-red color.

Form of the Trunk of Trees.—According to M. Musset, "Comptes Rendus," Sept. 2 and 16, 1867, all trees have an elliptical trunk, the greater axis directed sensibly from east to west. As the centrifugal force developed by the rotation of the earth, according to

M. Babinet, inclines the water-courses to the right, M. Musset thinks that this continuous, long-enduring, though feeble action exerts the same influence upon trees; it is best seen in trees with smooth bark.

Muscular Force of Insects. — According to M. Felix Plateau, in the same group of insects, the force varies inversely to the weight; that is, of two insects belonging to the same group the smaller presents the greatest strength. The phytophagous families appear to exceed all the others in traction force, their muscular strength being explained partly by the large size of the posterior femora and partly by their small weight. As regards flight, the mean forces of insects are also in inverse proportion to the weights, but not to the same extent as in traction or pushing force.

Structure and Affinities of Lepidodendron and Calamites. — Mr. Carruthers, in the "Journal of Botany," gives his reasons for regarding these plants as cryptogams, more highly organized than any existing members of the class, and for considering merely analogical the arrangement of their tissues as in certain *Cactaceæ* and *Cycadeæ.* He cautions geologists not to take it for granted that the known conditions of the living species of a genus are true also of the fossil members of the same genus, citing the case of *Elephas primigenius* in illustration. This may well cause suspicion of the numerous speculations on the climate and conditions of the coal-measure period.

Sucking Disc of the Remora. — In "Comptes Rendus" (March 18, 1867) M. Baudelot confirms the opinion of philosophical anatomists that this disc is the equivalent of a dorsal fin. He shows that each lamina of the disc on the head is supported by a ray sustained by an interspinous bone, and that the movements are effected by small muscles, corresponding to the elevators and depressors of fin-rays. When the laminæ of the disc are raised the space between them is increased; the air consequently is rarefied, and, as all communication is cut off from the external air by the raised edges of the disc, the animal thereby attaches itself by a strong power of suction.

Eggs of Corixa Mercenaria. — The eggs of this kind of bot-fly are deposited on reeds in fresh-water lakes of Mexico; they are ground by the natives and used as food. They are chemically composed, according to Dr. Phipson, of chitine, which he considers a glucoside, and a little phosphate and carbonate of lime. The eggs are supposed to contribute to the formation of a new oolitic limestone at the bottom of the lakes.

Period of Incubation of Sharks. — According to M. Coste, in the *Squalus catulus*, Linn., there are laid 18 eggs in the course of the month of April, on the coast of France; these are hatched early in December, incubation being a period of 9 months.

Insect Fabricators of Iron. — It is well known that some insects are skilful spinners, but it was not known that some of them fabricated iron. A Swedish naturalist, M. de Sjogreen, has published a curious memoir on this subject. The insects in question are almost microscopic; they live beneath certain trees, especially in the province of Smaland, and they spin, like silk-worms, a kind of ferruginous cocoons, which constitute the mineral known under the name of "lake ore," and which is composed of from 20 to 60 per cent. of oxide of iron mixed with oxide of manganese, 10 per cent. of chloric, and some centimetres of phosphoric acid. The deposits of this mineral may be 200 metres long, from 5 to 10 metres wide, and from 8 to 30 inches thick. — *Rev. de Thérap. Méd.-Chirurg.*

A Monster Fish. — Dr. Newberry exhibited to the Lyceum of Natural History of New York some fossil fish from Delaware, Ohio. A large number of these had been collected during the summer. In this country the fish begin with the Devonian and corniferous limestone. Above the limestone comes the black slate or Hamilton group. The fishes exhibited were from the black slate of Ohio. One of these, a portion of which was exhibited, must have been more than 25 feet in length, and endowed with a power beyond that possessed by any fish of the present age. Dr. Newberry has given the name of *Deinichthys* to this monster. This discovery is in ichthyology what the exhuming of the mammoth was in zoölogy, and it is to be hoped that other specimens will be found, now that their occurrence in the black slates has been pointed out.

Fossil Insects. — At a meeting of the Boston Society of Natural History, Mr. S. H. Scudder exhibited specimens of the fossil larvæ from the Connecticut River sandstone which Prof. Hitchcock had referred to the lace-winged flies, but which Mr. Scudder was inclined to consider larvæ of beetles. He also showed a collection of fossil insects recently brought from the tertiary strata of the Rocky Mountains by Prof. Wm. Denton, of this city, — the only large collection yet made in this country. They were found abundantly in two localities in Colorado, about midway between Great Salt Lake and Pike's Peak, and the species from the two localities differed so much in character as to awaken a suspicion that the rocks of one locality might be older than those of the other. The insects consisted mostly of flies and their larvæ, belonging to groups which live in moist localities; small beetles, one or two ants, a moth, and a species of thrips, allied to the one which attacks our grain, but belonging to a new genus. This last is of especial interest, because it is the first insect of this group which has been found fossil. It is rather remarkable that none of the numerous larvæ belong to the perfect insects found in the same rocks.

Snow Animalcules. — A distinction is observable between the taste of snow-water and that of rain-water, and the use of the former in parts of Switzerland is thought to be the cause of peculiar affections of the throat, including *goitre.* The discovery of numerous shrimp-like animalcules in snow-water, by a distinguished chemist, has suggested a possible connection between them and the unwholesomeness of snow-water. They prove at least that life is not restricted to the conditions of temperature with which we usually associate it. The fluids which give mobility within these organisms must be such as, unlike those of animals, and like alcohol, resist extremes of cold.

Silk from Fishes' Eggs. — M. Joly, as we learn from the "Chemical News," has discovered in the eggs of fishes of the family of the Selachians (the ray), that their external envelope is formed of a very close tissue, composed of an infinite number of delicate filaments, which are easily removed and separated. Once drawn out, they possess the appearance, color, and finish of cocoon silk, serving without trouble for tissue of ordinary silk or silk wad. The interior of the egg contains an albuminous, white substance, which can serve usefully in competition with the white of hens' eggs for printing on tissues. They contain a considerable quantity, as each one weighs on an average 240 grams, — about 7½ ounces.

Antiquity of Organic Life. — Mr. Nordenskiold, the distinguished Swedish geologist, announces a discovery of bituminous gneiss, a real organic substance formed of the remains of plants or animals, imbedded in layers of gneiss and mica schist. He considered infiltration impossible in the case, and the inference is that organic life existed on the earth far back in what has hitherto been considered the azoic age.

Bos Longifrons. — According to Mr. Boyd Dawkins, the existence of this species, though found abundantly in the bone caves and alluvia of the pre-historic age, has not yet been proved in earlier epochs. He considers it the progenitor of the small Highland and Welsh cattle, and of more interest to the archæologist than the geologist.

Mesotherium. — According to M. Serres, this fossil animal, from the pampas in the neighborhood of Buenos Ayres, is intermediate between the rodents and the pachyderms. It was a little larger than the cabiai, and forms one of the connecting links between these two orders. It was called *Typotherium* by Bravard, who gave the first positive information concerning it.

Silica in Grain Stalks. — Pierri, the French chemist, has re-examined the grasses, and has apparently thrown some further light on the agency of silica, which was once erroneously supposed to give the stalk its rigidity. He finds, on the contrary, that in the wheat plant the silica accumulates chiefly in the leaves, and least of all in the hard knobs or joints of the stalk; the latter containing less than one-seventh as much as the leaves, and the stalk between the joints less than one-fourth. Hence, the more silica the more leaf, the more shade, the less hardness in the stalk, and the greater liability to break down or "lodge."

Colocasia. — This is the name given to a plant which is now attracting notice, from the curious observations which M. Lecoq has communicated to the Paris Academy concerning it. Without any apparent cause, the plant often exhibits a trembling motion, sometimes as many as 100 to 120 vibrations being noticed per minute. These undulations are strong enough to effect the neighboring plants, and even, it is asserted, have caused a similar motion in the flower-pots. The only explanation offered, is that this is a remarkable instance of the direct transmission of solar heat and light into motion.

Curious Plant. — One of the strangest members of the vegetable kingdom, now not unfrequent in hot-houses, is the *Myrmecodia tuberosa*, first sent to England from Malacca by Dr. Collingwood. Its stem is tuberous, and everywhere covered with thorns. It is constantly inhabited by thousands of ants, that have pierced galleries through it in every direction. These galleries are coated with an animal cement of such tenacity that, when a tubercle dies and wastes away, the galleries remain, presenting the appearance of certain ramified algæ.

Vitality of Seeds. — M. Pouchet, the advocate of spontaneous generation, has observed that a certain proportion of the seeds of *Medicago Americana* (lucern) will withstand an uninterrupted boiling for 4 hours without losing their vitality. In the greater proportion of the seeds thus treated the contents had swollen and broken the integument, and the water became therefore mucilaginous; but others successfully resisted the high temperature, the outer integument remaining unbroken, so that when sown they sprang up in from 10 to 20 days.

Action of Electricity on Seeds. — M. Ch. Blondeau, "Comptes Rendus," Nov., 1867, states that by subjecting fruits, as apples, pears, and peaches, to the action of an induced electric current, he can hasten their maturity. Having also rendered seeds good conductors by moistening them, he affirms that the effect of the induced currents is to cause a germination earlier than in seeds not subjected to this action.

LIBRARY

ASTRONOMY AND METEOROLOGY.

METHOD OF LOCAL CORRECTION FOR REFRACTING TELESPOPES. — BY MR. ALVAN CLARK.

At a meeting of the American Academy of Arts and Sciences, in 1867, the Rumford Medal, awarded to Mr. Alvan Clark for his improvement in telescopes, was formally presented. The presentation was prefaced by an address by the president, Prof. Asa Gray, from which the following are extracts: —

"Three-quarters of a year have passed since, by unanimous vote, the Rumford premium was awarded to Mr. Alvan Clark. It will be very proper, therefore, briefly to rehearse the grounds upon which the Rumford committee recommended, and the Academy decided, to mark by these *insignia* their appreciation of the service which Mr. Clark has rendered to astronomical science in the perfecting of its most important instrument of research, the lens of the refracting telescope.

"The two great classes of telescopes, reflectors and refractors, labor under difficulties of construction peculiar to each; and one class or the other has enjoyed the preference of astronomers, according to the degree in which these difficulties have respectively been overcome.

"In the refracting telescope the obstacles are: 1, the want of homogeneousness in the glass; 2, the dispersion of the substance; and, 3, imperfection in the figure of the lens. If the first of these difficulties has been reduced to a minimum by the selection of the best materials, then the artist has to contend with the other two. He must give to the four surfaces of his compound achromatic lens such shapes as will produce the maximum of distinctness and the minimum of discoloration in the image of the object seen through it. After all has been accomplished which can be expected from a faithful adherence to general formulæ, the last degree of perfection will depend on the skill of the artist.

"Now, just where most artists have supposed that their work was done, our associate has thought that his had only begun. Selecting either a real star, or for greater convenience substituting a fictitious one, he now enters upon an examination of his lens, ring by ring, ascertaining by an ingenious test which annuli have too long and which too short foci. The lens is then dismounted and retouched at the defective places, — is examined and retouched again and again, until his simple test assures him that every portion will converge the rays to the same focus. The long underground tunnel which Mr. Clark has excavated on his grounds, communicating with his workshop, is an original contrivance for providing a fictitious star, — for converting day into night, so that he may examine and repolish at any hour; it also provides a sufficient space filled with homogeneous air, much better adapted for nice observations than the external atmosphere. All this is what is meant by Mr. Clark's *method of local correction*, for which the Rumford premium was awarded. The late Mr. Fitz, of New York, also used a method of local correction. But he retouched only one surface of his compound lens, and was therefore obliged to leave it with such irregularities as must result from the local working; as it could not be returned to the tool upon which it was originally polished without rapidly losing all the advantage gained by the local treatment.

"Whenever Mr. Clark dismounts his lens and retouches it, he separates the component parts, and applies his local correction to each of the four surfaces. These will tend to fall back to the primitive figure; but, while the elasticity of the tools and the lens together suffice to prevent a very rapid change, under Mr. Clark's skilful and delicate handling, he allows for and guards against this by a slight excess of local working. It is therefore to this nice, artistic handling that our associate's lenses owe, in no small degree, their pre-eminence.

"The justification of the Academy's award is found in the importance and the originality of this method of local correction.

"Its importance is assured and measured by the fact that by it a lens of 18 to 20, or even 24 inches aperture is as manageable under construction now, as 9 to 12 or 15 inch lenses lately were without it. Through this invention, and the consummate skill by which it is turned to account, supremacy in this high art, which lingered long in London under the influence of the Dollands, and then deserted its ancient home for Munich, has now confessedly taken up its abode with us, in Mr. Clark's unpretending but most efficient establishment at Cambridge.

"The originality of the invention will hardly be questioned when it is known that Foucault, as recently as 1858, tried something of the same kind on the single surface of a reflector, with fine results, and then suggested its application to lenses, in honest ignorance that this was what Mr. Clark had been doing for 10 years, and in the most delicate and refined way.

"In the administration of Count Rumford's trust, the Academy could take notice only of such work as comes within its specific terms, and could adjudge his premium solely in regard to the absolute merit of some particular invention. It could take no account of the difficulties and disadvantages under which Mr. Clark has struggled on, — without early scientific training, — without access to any of the gathered experience which is handed down in optical workshops, — without having seen before any, even the commonest, process which he had to execute, — with little means of knowing what had already been done, much less how it had been done, — without even encouragement, until after success achieved made encouragement superfluous, — earning by daily toil in one fine art the means and opportunity of developing his genius in an equally refined, and, to us, more important one, — we must allow that where moderate success were highly praiseworthy, the exquisite and unprecedented results which our associate has reached are worthy of double honor.

"Nor could the Academy in its award take cognizance of the well-known fact that Mr. Clark's skill and success, not to say genius, in using his telescope are rivalled only by that displayed in perfecting it. Yet this might fairly have been introduced as testimony. For the prompt and brilliant discovery of the before invisible companion of Sirius, and the detection of more than a score of new double stars in the quarter of the heavens which had been most diligently searched for them, having been made by our associate with his own glasses, and mostly in testing their power, — these should be received as direct witnesses to the importance of his inventions; showing, as an experienced astronomer has remarked, 'that objects of great difficulty and delicacy may be detected with *very perfect telescopes* of smaller size, which have escaped the most diligent scrutiny with far larger instruments;' showing, also, perhaps, as the same astronomer suggests, — in reference to stars which, after withstanding the Pulkowa 15-inch refractor, Mr. Clark proved to be double with his object-glass of only half that diameter, — 'that his eye as well as his telescope must possess an extraordinary power of definition.'"

The following are extracts from Mr. Clark's response: —

"I know not how I can better express my gratitude for these honors, than by giving some brief account of the manner in which my efforts as a working optician were commenced and have been carried on.

"Up to 1844, and when more than 40 years of age, I had never witnessed or attempted the grinding of a lens of any description. My elder son, George B. Clark, then a youth of 17, during a school vacation, sought amusement in casting and grinding small reflectors for telescopes; and, without any thought or design beyond assisting him to find interest and instruction in his pastime, I joined in.

"After working and talking with astronomical friends, and consulting books, until we found that reflectors, even when wrought with utmost skill, were little sought for, I proposed to the youth to try a refractor; but he objected by saying, 'The books represent it as a very difficult thing.'

"Materials were, however, procured, and the attempt made, with such results as to induce a repetition, and finally another, until it became a settled occupation for us both. Thus it began as boys' play, and, so far as my own spirits and feelings have been affected by it, it has been boys' play all through.

"There exists among the double stars such a variety, in distances and magnitudes, that tests for the excellence of telescopes of different dimensions are always at hand; and through them the value of a glass can be made known, pretty accurately, to a distant correspondent, who has had experience, and is well versed in such matters.

"The evidence must, of course, have more weight if the stars selected had never found a place in Struve's or any other catalogues, and were of a character making very sharp defining necessary to exhibit them.

"It was in this way the attention of Rev. W. R. Dawes, of England, was first called to my seemingly incipient, obscure, and humble labors. I have since sold him 5 object-glasses, of from $7\frac{1}{4}$ to $8\frac{1}{4}$ inches aperture, and his published reports upon their qualities have brought orders enough, for a number of years past, to secure for me, in making proficiency, the full benefit of an abundant practice.

"In April, 1860, an order came from the University of Mississippi for an object-glass of unusual dimensions. In undertaking this it became necessary for me to remove to some more commodious place than the one I had previously occupied. In the same month a site was selected, and dwellings and a workshop erected in the course of the ensuing summer. The material was ordered from Chance & Co., of Birmingham, and preparations made for the work.

"This lens was completed in the autumn of 1862, when all communication with Mississippi was cut off. Fortunately they had paid nothing upon it, and I felt at liberty to put it in the market.

"George P. Bond manifested much interest in it, visiting me repeatedly while my rough proving tube was in such a position that he could deliberately examine the great nebula in Orion through it; and he placed his opinion of it on record, at the next meeting of the visiting committee, by recommending its purchase for the Cambridge Observatory, and measures were soon on foot for raising the money. When the sum of $4,500 had been reached, and my expectations were centred in that direction, I was suddenly and most unexpectedly called upon by a purchaser from Chicago, with a tender of the full price I was to have received from Mississippi. With the assistance of my sons, I have since made a mounting for it, and put the instrument up at the University at Chicago, where Professor Safford has it in charge.

"It was with this glass that my younger son, Alvan G. Clark, discovered the companion of Sirius, on the first occasion of its being looked for, and before the star had been in the field three seconds."

NEW DOUBLE STAR.

We are informed that a new double star, supposed to be below the defining power of more than two or three telescopes in the world, has been observed by means of the fine instrument in the possession of Jacob Campbell, Esq., of Brooklyn. It is almost in a line between Procyon and the companion star by which the defining power of first-class telescopes is frequently tested. But although it is a common practice of astronomers to try their glasses by first observing Procyon and then waiting a few minutes for the companion star to come into the field, this new companion, which enters the field before the other, had never been revealed by any of the instruments so often crossed by it. Professor Winlock, the astronomer at Cambridge, was informed of the discovery, and after some search with the fine Munich telescope of that observatory, detected the new star, although at first as elongated, not double. The success of European instruments with the new test is yet to be heard from. The remarkable quality of Mr. Campbell's telescope (a 12-inch lens, 3 inches smaller, if we mistake not, than that of the Munich instrument at Cambridge) is due to the well-known skill of Mr. Clark, of Cambridgeport, who has been engaged for months in correcting and perfecting it. — *Scientific American.*

DISTANCE OF THE SUN.

At the 1867 meeting of the "American Association for the Advancement of Science," Prof. Newcomb read a paper on a "New Determination of the Distance of the Sun," the calculations having been made at the Washington Observatory. Ten years since astronomers began to suspect that the value of the sun's distance found by Encke from the transits of Venus observed in 1761 and 1769, was largely in error. This distance, 95,300,000 miles, had long been received as the standard. But all the modern tests which could be applied to it indicated that it was about 3,000,000 of miles too great. In the year 1862 circulars were issued independently from the observatories of Washington and Pulkowa (the Russian national observatory situated near St. Petersburg), inviting the co-operation of astronomers everywhere in a general attempt to determine the parallax of Mars at apposition of that year. The plan was generally adopted, and nearly every active observatory in the world engaged in the observations, which occupied 10 weeks. It was the most extended co-operate effort on the part of astronomers which had been made during the century.

It is now complete, and the sun's distance is determined to be 92,340,000 miles, and the velocity of light is thus reduced to 185,500 miles per second.

THE TRANSIT OF VENUS.

This important astronomical phenomenon, which is to take place on the 8th of December, 1874, and again on the 6th of December, 1882, already begins to engage the thoughts of astronomers, as those of the last century, which occurred on the 5th of June, 1761, and on the 3d of June, 1769, engrossed the attention of the past generation. The transit of Venus over the sun's disc affords a direct observation of the planet's node, or point, where its orbit cuts the ecliptic, — an element which is of great value for the correction of astronomical tables; but it is chiefly important for the determination of the sun's parallax (or angle) under which an observer, situated in the centre of the sun, might see the earth's radius. One side and two more elements of the six constituting a triangle are requisite in order to determine the other three; hence, considering a right-angled triangle, having the vertex of its right angle in the centre of the earth, one of the sides forming that angle being the terrestrial radius, and the other a line that joins the centre of the earth with that of the sun, it follows that, as we know the radius and right angle, the third element we want in order to determine the distance of the two centres is precisely the angle made by the latter and the hypothenuse drawn from the centre of the sun to the extremity of the earth's radius; and that is precisely the parallax.

Without knowing that we cannot, therefore, know our own distance from the sun, and consequently, by Kepler's third law, the distances of the planets either. Such is the importance of that element that Encke, in 1835, recalculated it from the transit of Venus in 1769, and found it to be 8.58 sec. M. Leverrier finds this value too small on theoretic grounds, and states it at 8.95 sec. By the aid of the apposition of the planet Mars, which occurred in 1862 under remarkably favorable circumstances, a combination of observations simultaneously made at the Cape of Good Hope and at Pulkowa, the parallax was found to be 8.964 sec. M. Pauwalki, of Berlin, finds it only 8.86 sec. From these various results it is clear that there is an uncertainty as to the value of the parallax amounting to nearly three-tenths of a second, — a considerable figure in such an enormous distance as that existing between the sun and the earth; and it is hoped that the coming transits of Venus will be attended with circumstances favorable enough to determine the exact value sought.

THE SUN'S SPOTS.

The astronomers of Kew Observatory have been engaged in observing and comparing, from time to time, the spots on the sun, with a view of discovering some cause with which their changes may be connected. They have found that the expansion and contraction of the spots proceed at a regular rate according to their varying position in the apparent disc; the spots increasing invariably from left to right, and attaining their maximum at intervals of about 19 or 20 months. The revolutions of the planet Venus, which proceed in like manner from left to right, and occupy also about 20 months, were next compared with the changes in the spots, and were found to correspond. The area of spots exposed to view toward the earth was found to be uniformly greatest when Venus was on the opposite side of the sun, and least when the observed side was exposed most directly to her influence. Jupiter also, from its great mass, exercises an influence upon the spots, although from its distance it is not predominating. When Jupiter and Venus were both in opposition to the earth, the spots were much more enlarged than when Venus was in opposition and Jupiter in conjunction with the earth. The nature of the influence evidently exerted is thought to be suggested in an opinion expressed by Prof. Tate, "that the properties of a body, especially those with respect to heat and light, may be influenced by the neighborhood of a large body;" and an influence of this kind would naturally be most powerful upon a body possessed of a very high temperature, like the sun; a very small increment of heat causing a mass of liquid to assume a gaseous form, and *vice versa*. So that the heat withdrawn by Jupiter and Venus from the side exposed toward them might be sufficient to cause a copious condensation of gases, which might have a visible effect directly, or produce mechanical changes by means of altered reflection varying the distribution of a great amount of heat.

Mr. Balfour Stewart, in a lecture before the Royal Institution, London, on the sun as a variable star, expressed the opinion that the spots on the sun's surface are produced by downward currents of the surrounding atmosphere, the depth of which had been estimated at not less than 72,000 miles. A downward-rush of atmosphere occasioned an exposure of the body of the sun, and produced an appearance of a dark spot; an upward rush of the atmosphere produced the bright faculæ that surround the dark spots, and are seen more conspicuously on the borders of the sun's disc. This atmosphere, he thought, was very sensitive to the approach of the planets, especially of Venus, in consequence of its comparatively short distance, and of Jupiter, in consequence of its size. When Venus is opposite to the earth, the spots attain their maximum, which is sometimes as much as 15,000 miles in diameter. From these spots we estimate that the sun rotates on its axis once in about 25 days; but there is reason to believe that the spots rotate faster than the body of the sun, owing to the more rapid rotation of the upper portions of the atmosphere, which, on being carried nearer to the centre by a downward current, retains the velocity it before possessed, in the same manner as the trade winds on the earth are supposed to be caused by the different velocities of the air near the poles and in the equatorial regions. In addition to the influencing causes attributable to the movements of the planets, there are periodical variations of the spots occurring about every 10 years, which cannot thus be accounted for. The lecturer spoke of the corona observed during the last total eclipse of the sun, which he attributed to its atmosphere, and it was on calculations founded on those appearances that the height of the sun's atmosphere had been conjectured.

M. Hock, taking the mass of a planet and the inverse cube of its distance as the measure of the planet's influence in raising waves of disturbance on the sun, assigns to Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, effects proportional to the numbers 12, 24, 10, 0, 23, and 7, respectively.

According to M. Faye, the interior of the sun is a "nebulous, gaseous mass, of feeble radiating power at a temperature of dissociation," a sun spot being caused by the heating effects of an "up-rush" from the interior breaking through the less intensely heated photosphere. English observers refer the sun spots to the cooling effects of a "down-rush" from the exterior. Mr. J. N. Lockyer's spectroscopic observations confirm the latter view. In the spectrum of light from the spot the absorption bands were visible, as in the spectrum given by the photosphere, and apparently even thicker; further, no bright lines were visible. This, if confirmed by the observation of larger spots, would establish the presence of descending currents, without deciding the question of heat in the interior and neighborhood of spots. An apparent descent of a large portion of the photosphere into the interior of a spot, with diminishing brightness, has been repeatedly observed; but whether the change indicates a process of cooling, or one corresponding to the transformation of clouds into invisible vapor, is yet undecided.

VARIABLE STARS.

M. Faye, in the "Comptes Rendus," gives the following as the results of his observations on variable stars: —

So-called new stars are not really so, their sudden appearance being only an exaggeration of the ordinary phenomena of periodic variables, corresponding to simple oscillations, more or less sensible, in the production and maintenance of the photospheres of all stars. These phenomena, considered successive when the history of a star is examined in part, characterize the progress of the cooling of the star and the decline of its solar or photospheric phase; when they occur thus in an irregular, intermittent manner, with very long and gradually increasing intervals, they are the precursors of the star's extinction, or of the formation of a first more or less consistent crust. Hence phenomena of this kind occur only in stars already very faint, and never result in the formation of a fine new star.

MASS OF JUPITER.

Herr Krüger, from careful investigations of Themis, one of the minor planets, gives the mass of Jupiter as $\frac{1}{1047.16}$ of the sun's mass. The mean of this and the values as given by Airy, Bessel, and Jacob, is $\frac{1}{1047.34}$ as the mass of the largest planetof the solar system.

NEW SOLAR EYE-PIECE.

Messrs. Merz, of Munich, place in their solar eye-piece two pairs of plane unsilvered glass mirrors in such a way that, by rotating one pair, any part of the sun's light may be intercepted. By this arrangement no false color is introduced, as with blue or neutral-tint glasses. In it films are seen with a frosty tint, the color of the protuberances seen in solar eclipses, which appeared blue in the common oculars.

ECLIPSE OF JUPITER'S MOONS.

On the 21st of August, 1867, occurred the rare astronomical phenomenon of Jupiter appearing without his satellites. To astronomers this is a phenomenon of great interest, having only been observed on four different occasions. It occurred in 1681, and was observed by Molyneaux. Sir William Herschel saw it in 1802, and Wallis in 1826. It was last seen by Dawes and Griesbach in 1843.

An eclipse of one of these satellites appears, by calculation, to take place 16 minutes sooner, when the earth is in that part of its orbit nearest to Jupiter, than it does when the earth is in that part of its orbit most distant from Jupiter. These four moons are of progressional sizes. The magnitude of the nearest is about a quarter greater than that of our own; that of the second is equal to ours; the diameter of the third, however, is nearly double that of our moon, and it is nearly equal to the planet Mercury; the diameter of the fourth satellite is about one-half greater than that of our moon. When these satellites get into the shadow of Jupiter they become invisible to us, and hence we know they are opaque bodies, which shine, like the moon, by the reflected light of the sun. All the circumstances connected with their eclipse are visible to us. We see them enter the shadow and leave it, and we can estimate the duration of each eclipse, and observe exactly its beginning and ending. These eclipses have been instrumental, not only to useful purposes in art, but also to great discoveries in science. It is by them, among other means, that the longitude of places on the surface of the earth is determined; but by far the most important discovery connected with these bodies is that of the motion and velocity of light, it having been shown, by their means, that the velocity of reflected light is the same as that of direct light.

The planet was unaccompanied by any visible satellites for a period of 1¾ hours. The disappearance and reappearance, as seen in England and America, were as follows: at 8h. 14m. G. M. T. (soon after sunset), the third satellite entered on Jupiter's face; at 9h. 9m. the second was eclipsed in Jupiter's shadow; at 9h. 28m. the fourth, and at 10h. 4m. the first entered on Jupiter's face. All four satellites were then invisible, — three on account of their passing simultaneously over the planet's disc, and the fourth from being immersed in the planet's shadow. At 11h. 49m. the third satellite passed from Jupiter's face; at 12h. 13m. the second reappeared from behind the body of the planet; at 12h. 23m. the first, and at 13h. 54m. the fourth satellite passed off the disc.

The shadow of the fourth satellite appeared larger than that of the third, though the latter is the larger body. This observation, if confirmed, would show that the apparent dimensions of the shadow depend rather on the extent of the penumbra than of the true shadow.

THE PLANET MARS.

According to Mr. Huggins' observations during the late opposition of Mars, Jan. 10, 1867, in this planet's spectrum groups of lines were seen in the blue and indigo, but they could not be measured so as to determine whether they are solar or due to the planet's atmosphere. Many marked lines were also seen in the red. On Feb. 14 faint lines were seen near D, and were thought by him to be due to absorption by the planet's atmosphere, as, although similar to lines seen in the solar spectrum when the sun is low, Mars was not low enough for the production of the lines, which were not seen in the moon's spectrum, though she was lower than Mars. The spectrum of the darker portions of the disc was less brilliant than that from the lighter part, indicating equality of absorption, and that the color of the darker parts is nearly, if not quite, neutral.

He concludes that the ruddy color of Mars is not due to its atmosphere, but to the materials of the planet's body; and he remarks that the polar regions show no color, though the light from them traverses a greater depth of atmosphere than that from the central parts of the disc. He quotes, as additional evidence, the views of Dr. Zöllner respecting peculiarities in the rate at which the brightness of Mars varies with varying phase, and the greater brightness of the disc near the limb. According to Mr. Joynson, there is a permanent dark band extending all around the planet, with only one narrow break in it. — *Quarterly Journal of Science*, July, 1867.

LUNAR CRATER LINNÆUS.

There seems to be a difference of opinion among astronomers as to the change which has taken place in the crater in the moon, called Linnæus or Linné.

In May, 1867, at a meeting of the French Academy of Sciences, M. Delaunay presented, in the name of M. Camille Flammarion, a note on a change remarked on the surface of the moon in the crater of Linnæus. It is well known that this crater has recently been subjected to an essential modification. The attention of astronomers having been called to this fact by M. Jules Schmidt, of Athens, M. Flammarion chose the moment when the sun rises at the meridian of Linnæus to study this spot. The sun, being only yet elevated a few degrees above the horizon of the crater in question, lit it up very obliquely. The slightest irregularities in the conformation of the surface were most distinctly visible. An attentive observer would remark at once that Linnæus is no more a crater; there is no exterior shadow, no shade in the centre. In its place there is only a cloudy white, circular spot, or rather a white stain on the ground. Far from being elevated as a crater, it has a greenish color, like the Sea of Serenity, and seems to be neither in relief nor sunken, but resembles a lake of lighter color than the neighboring plain.

This crater has therefore descended to the level of the plain, — fallen in, — or else the plain has been raised to about the level of the crater. The interior appears also filled up, for no shadow is distinguishable, whilst smaller craters, such as A and B of Bessel, A and B of Linnæus, and those in the neighborhood of Posidonius, show the dark shadow very perceptibly. If Linnæus had this aspect at the time when Beer and Maedler laid down their selenographic map, it would have been impossible to have indicated it as a crater. In the map constructed eight years ago by Lecouturier the height is not marked. It appears that it was very deep, 10 kilometres in diameter, and that it served as a fixed point for Lorkmann and Maedler.

On May 11, the sun being more elevated, Linnæus presented the same aspect as on the evening before. The evening of the

12th was rainy; the 13th the atmosphere, being very pure, permitted the author to distinguish in the Sea of Serenity a multitude of small disseminated craters. The plain was brilliant, and Linnæus had the same relative brightness.

M. Chacornac, who observed the same things at Lyons, arrived at similar conclusions. Father Secchi, of Rome, has already presented to the Academy his own observations. It is, then, proved for a certainty that a movement has recently taken place in this region of the lunar world. The magnifying power used was 230 to 300 times.

In the centre of the bright spot which covers the former crater "Linnæus," there appears a minute black point, indicating a crater of about 600 yards diameter. The original crater appears to have been a deep one, and about 10,000 yards in diameter. This small crater was so plainly visible as to have been noticed by Dr. Schmidt, at Athens, by Secchi, at Rome, and by Prof. Lyman, at New Haven, Ct. It was detected at the latter place three days after the sun had risen over the horizon of "Linnæus," and when the sun was therefore 30° or 35° high upon it. These observations show that any change which has taken place is not in the nature of a development of a cloud, but imply rather that the old crater has been filled up by an eruption from the small one now visible.

According to Prof. Respighi, of Rome, the western margin of the small crater in "Linnæus" is higher than the eastern, and was even visible as a bright point just before the sun rose upon the crater. He thinks that the historical evidence is not sufficient to prove beyond doubt that a change has taken place.

Dr. Schmidt states that numerous and careful observations made during the four lunations, both in the waxing and the waning moon, prove that "Linnæus," under no direction of the sun's light, can now be seen as a normal crater.

After a careful review of the evidence, Dr. Schmidt concludes that the change which has taken place in this lunar crater corresponds, on a greatly magnified scale, to the changes produced by mud volcanoes on the earth. He believes that all the internal part of the crater has been filled up by eruptive material, which, by overflowing, has obliterated under gentle slopes the former steep outer walls of the crater. A minute depression, nearly in the middle of the light spot which now marks the place of the crater, has been attributed to the subsequent cooling of the matter within the crater.

M. Leverrier announced, in June, 1867, that the lunar crater Linnæus, the disappearance of which had lately caused so much speculation, was in its old place, as had been ascertained by M. Wolff, at the Imperial Observatory.

Mr. Rutherford has lately examined his photographs of the moon, surpassing in size and minuteness of detail any taken in Europe, with special reference to the supposed lunar volcano, and he states that he cannot detect any change in the brightness of the locality in question.

COMETS OF 1867.

Comet I. — M. Stephan, director of the observatory at Marseilles, discovered on the 22d of January a new comet, of considerable brilliancy, generally round, and with a well-defined nucleus. The train is supposed to be in line with the nucleus and the earth, and therefore concealed. The nucleus appears denser on one side than the other, leading to the supposition that the train is fan-shaped. On Jan. 25th, at 8h. 53m. 35s. P. M., the right ascension was 2h. 33m. 53.5s.; north polar distance 74° 26′; hourly movement in right ascension + 5.17s. and in polar distance — 1.29′. It is said by Silloujelt to be periodical, and to be the same as Messier's comet of April, 1771.

Comet II. — A faint comet was discovered by Mr. Tempel at Marseilles, on the 3d of April, 1867.

The comet appeared to consist of a slightly oval coma, surrounding a minute, not very bright, nucleus, which was not central, but nearer to the following edge of the coma. The light of the coma, as observed by Mr. Huggins, formed a continuous spectrum; but he was unable to distinguish with certainty the spectrum of the light of the faint nucleus from the broad spectrum of the coma on which it appeared projected; he was not certain of the presence of 2 or 3 bright lines. He considers it similar in physical structure to Comet I., 1866.

DIAMETERS OF THE ASTEROIDS.

Mr. Stone has calculated the probable diameters of 71 asteroids, determining their relative dimensions from their apparent brilliancy, assuming that their surfaces have equal reflective powers. Adopting the diameters of Ceres and Pallas, as determined by Herschel and Lamont, he converts their diameters into miles. The following are the diameters of the 5 largest and the 5 smallest asteroids: —

Vesta . . .	214 miles.	Themis . .	24 miles.
Ceres . . .	196 "	Asia	22 "
Pallas . . .	171 "	Maia . . .	18 "
Juno . . .	124 "	Atalanta . .	18 "
Hygeia . . .	103 "	Echo . . .	17 "

NEW PLANETS IN 1867.

Prof. Peters, at the Hamilton College Observatory, Clinton, New York, discovered on the morning of July 7th, planet No. 92, or the one hundredth primary member of the series. Its position was in 21 hours and 21 minutes of right ascension, and 21 degrees and 31 minutes of southern declination. On the morning of the 8th it was found to have moved, in 24 hours, about 25 seconds to the west and 6 minutes to the south. Being of the eleventh magnitude and about one month before opposition with the sun, the planet promises to be a bright one. This, the sixth discovered by Prof. Peters, and at very nearly the same time by Prof. Tietjen, of Berlin, has received the name of Undina.

Planet 93 was discovered by Prof. J. C. Watson, at Ann Arbor, Michigan, Aug. 24, 1867. Its position in mean time at Ann Arbor, Sept. 8, 1867, 9h. 22m. 28.8s. was, right ascension 23h. 55m. 4.81s.; declination, — 3° 42′ 30.1″. 11th magnitude.

Planet 94 was also discovered by Prof. J. C. Watson, at Ann Arbor, Michigan, Sept. 6, 1867. Mean time on that day 16h. 15m. 37.45s.; right ascension, 0h. 56m. 31.34s.; declination + 6° 11′ 14.5″. As bright as a star of the 11th magnitude.

METEORIC SHOWER OF NOVEMBER, 1867.

The ideas of scientific men have been much enlarged of late in regard to the nature of the showers of falling bodies, known as meteors or shooting stars. An accumulated mass of observations, made both in Europe and this country, during the past 30 years, and a collection of historical data reaching back into earliest periods of history, bring us to the following conclusions: That the meteors are a constant phenomenon; that every hour of the day or night they are striking the earth's atmosphere; that they shine by self-emitted radiance; that they are ignited by force of impact upon the atmosphere; that they are of all sizes, from the smallest conceivable dust to masses weighing several tons; that they appear in the atmosphere at heights varying from 40 to 70 miles; that they are struck by the earth in its passage through space, but have also a motion of their own, the combined effect of the two reaching in some instances the extraordinary velocity of 36 miles in a second.

The researches of Schiaparelli and others lead to the conclusion that these bodies, like some of the comets, come from the outer and extreme regions of space, being gradually drawn in spiral movements about the sun and planets, as they in drawing near feel the increasing influence of mutual gravitation. It is considered certain that they do not belong to what is called the solar system, but, coming from every quarter of the starry heavens, arrange themselves in many eccentric bands and groups, forming a vast nebula of dark bodies, which is denser as we draw nearer to the sun.

A part of this foreign system appears to be gaseous; a part fine dust; a part bodies of visible size called meteors, some of which are compelled by atmospheric resistance to fall to the surface of the earth.

The zodiacal light, seen after the setting of the sun, is believed now to be an atmosphere composed of solid and gaseous meteorites of all sizes, gathered about the sun, and reflecting the light of that luminary.

At the 1867 meeting of the British Association, Prof. Alexander Herschel remarked that the connection between comets and meteors had this year been established without doubt, and that connection gave wide scope for speculation as to the origin and character of meteoric bodies. Mr. Huggins had made an observation of the light of a comet, and although that observation was not perfect, still it was sufficient to identify the light of the nucleus of the comet with that of the meteoric bodies. There were two theories as to these meteors. Leverrier had shown that their orbit extended from that of Uranus to that of the earth, while Schiaparelli believed that they came from the utmost fields of space.

Prof. Herschel said it was too bold to say that every shooting star was a comet. They were more likely the dissipated parts of comets, — probably comets torn into shreds by the sun's attraction drawing them into space.

M. Schiaparelli, Director of the Brera Observatory at Milan, has announced the elliptic elements of the orbit of the meteoric shower of last November, in a comparative view with those of the orbits of two late comets, — that of 1862 and the first of 1866, — pointing out the important coincidence of all their details, to a fraction of a degree in most cases. Thus, the revolution of the comet of 1866 is calculated as 33.18 years, corresponding closely to that of the swarm of shooting stars. Comparing with the great comet of 1862, Schiaparelli gives for the orbits of the shower and the comet respectively the following elements, the coincidence of which will be found very striking: longitude of perihelion, 343° 28′ and 344° 41′; longitude of ascending node, 138° 16′ and 137° 27′; inclination of orbit, 64° 3′ and 66° 25′; perihelion distance, 0.9643 and 0.9626; perihelion passage, August, 10.75 and 22.9.

Leverrier has done M. Schiaparelli's discovery the honor of adopting it as his own, and reproduced it with some elucidation in a letter at the Academy of Sciences, January 21st. Schiaparelli had published his comparative calculation in the observatory bulletin for Dec. 31st, and a complete mathematical theory of the phenomena in "Les Mondes" of January 25th.

M. Leverrier is quoted to the effect that the tricennial shower is a swarm of asteroids coming toward us from the depths of space, at regular intervals, and returning toward the superior planets. A body coming from a distance, with great velocity at the moment when it attains the minimum distance of the earth from the sun, could not be fixed in an orbit of one or two years by the feeble action of the inferior planets. This truth finds a physical proof in the fact that the shower of falling stars which repasses the earth every 33 years is not deranged in the configuration of its orbit, but returns at regular intervals. M. Leverrier also assumes that the mass of shooting stars could not have been introduced and thrown into its actual orbit but by some energetic disturbance; and, remarking that its orbit crosses that of Uranus, concludes that all the phenomena may be explained by the collision of a globular cluster with Uranus at about the year 126 of our era. The latter suggestion meets with doubt, and it is remarked, as to the period, that passages quoted by M. Schiaparelli in his article, from the ancient Indian poems, seem to show that the November meteoric shower had been observed long before A. D. 126.

The expected meteoric display came off early in the morning of the 14th Nov., and, so far as numbers are concerned, Prof.

Loomis, of Yale College, pronounced the exhibition more remarkable than the one our European neighbors were favored with one year ago, and but little inferior to that seen in the United States in 1833. Reasoning from analogy in the case of the shower 34 years ago, astronomers confidently predicted this meteoric exhibition, and arrangements were made in most of our observatories for making systematic records of the shower. During the greater part of the night the task of mapping down on star charts the course and exact time of appearance of solitary meteors was an easy one; but toward morning their appearance became so frequent that the observers ceased their efforts to time and map them, and only counted. The authority above quoted states that at New Haven the shower reached its greatest magnitude at 4.30 A.M., over 500 being then counted by one observer in an hour. And as one individual can watch but about one-sixth of the hemisphere, according to the usual method of computation, 3,000, at least, were at this time visible in the whole heavens, and, without doubt, twice that number actually came within the field of vision, but were eclipsed by the superior light of the full moon. From all parts of the country have come reports of the beauty and brilliancy of the shower. Even the inhabitants of our Pacific States witnessed it, although, of course, it reached its full grandeur at an hour much earlier than with us. The display was not visible in England or on the continent.

The time when the shower attained its greatest brilliancy was, in this section, two hours later than that given by European observers of last year.

Beside the above report from Prof. Loomis, several were published in the New York Tribune, as follows: —

Dudley Observatory, Albany, Nov. 14, 7 A. M. — The grand meteoric shower was observed with complete success at the Dudley Observatory. Between 4 and 5 o'clock, A. M., was visible the grandest display of shooting stars in the United States since 1833. From 11.30 P. M., until 3.45 A. M., it was more or less cloudy and but few meteors were seen; but about 4 o'clock they began to fall with great frequency, and their numbers continued to increase until 4.30 A. M., after which they gradually decreased in frequency until rendered invisible by sunrise. The greatest number fell at 4.31 A. M., when 47 were counted in a single minute. During the maximum of frequency sometimes 6 or 8 would burst out simultaneously, making one of the grandest sights we have ever witnessed. From 4 o'clock to 5 o'clock 1,200 had been noted, but it is presumed a large number escaped observation. The total number counted up to 6 A. M. was 1,301. From that time until sunrise only a few brilliant ones were observed. Many were seen surpassing Sirius in splendor, and giving off trains of light from 10 to 15 degrees in length. One curious phenomenon was the continuance of the train after the meteor itself had disappeared.

In one case the trains remained visible for 65 seconds, and in quite a number of cases the time exceeded 30 seconds, — the radiant point was in the constellation Leo, right ascension about 10 hours and declination 25 degrees north. Although the number seen was not as great, yet the maximum and the frequency were nearly equal to the shower observed in England.

Washington, Nov. 14. — A report from the Superintendent of the Washington Observatory to the Secretary of the Navy says the display of meteors this morning was the most brilliant seen in this country since 1833. Very few were seen until 1 o'clock. 125 meteor tracks were marked down before 6.30 A. M., when the meteors flew so thick that identification became hopeless and simple counting was resorted to. 1,000 were counted in 21 minutes previous to 4.35 A. M. Many were remarkable for their brilliancy and for a brilliant train, which usually vanished in a few seconds, but in one or two cases lasted several minutes. The most brillant and thickest display came from the direction of Leo, which is about 60 degrees above the horizon. The course of the meteors was principally north and east, though there were scattering ones from other directions.

Vassar College, Poughkeepsie, Nov. 14. — 13 brilliant meteors were seen during the night, mostly near the Great Bear.

Wilmington, Del., Nov. 14. — The meteoric display from 2.30 to 4 A. M. was very fine; 500 were counted in 20 minutes after 4 o'clock, and it is estimated that there were altogether between 2,000 and 3,000.

New York, Nov. 14. — At the Central Park Observatory 334 meteors were observed; the first at 7.35 P. M., and the last at 5.38 A. M. 54 left luminous trains behind them, and many were splendid. With few exceptions, all took a northerly course.

Richmond, Va., Nov. 14. — Meteors fell at the rate of 1,500 per hour this morning at 4 o'clock.

Charleston, S. C., Nov. 14. — The meteoric display this morning was very brilliant, lasting several hours.

ON THE DISTRIBUTION OF HEAT OVER THE EARTH.

The following are extracts from a paper by Pliny E. Chase, in the July number of the "American Journal of Science": —

The principal elements of general thermometric variation are: 1. The heat imparted by the sun. 2. Terrestrial absorption and radiation. 3. Atmospheric currents. Of these three agencies the first is, in one sense at least, the chief, since it is the one on which the others depend; the second is mainly instrumental in modifying the other two, and especially in retarding the daily and yearly changes; the third is a subject of hourly experience, and its meteorological importance is now generally recognized.

The amount of heat which is received directly from the sun evidently varies as the cosine of the zenith distance, or the sine of the sun's altitude. In the daily distribution of temperature this is the most important element. Absorption and radiation proceed at nearly uniform rates; therefore, it may be assumed that their effects are approximately proportional to the time during which they operate. The average general variation which is due to the influence of the winds is a difficult point to determine; but the present investigation has led me to believe that it may be measured by the difference of *arc*, instead of the *sine*-difference, of the sun's meridian altitude. My reasons for this inference are the following: 1. The general average temperature of the year often appears to vary very nearly as the arc in question. 2. It seems unreasonable to suppose that a variation of this character can be attributable either to the heat communicated by the sun or to terrestrial absorption and radiation. 3. The tendency of the air, so far as it is determined by the direct heat of the sun, is at all times toward that point of the earth's surface at which the sun is vertical, and we may readily believe that that tendency should be proportional to the distance, measured on a great circle of the earth, through which the air would be obliged to move in order to reach the sub-solar point. This distance evidently varies as the *arc* of the sun's zenith distance.

From extensive comparisons, the following inferences seem to be warranted, all of them being confirmed by other considerations: —

1. Taking into view the entire land surface of the globe and the entire range of the year, the direct heat of the sun and the induced aerial currents appear to be about equally instrumental in determining fluctuations of temperature.

2. The influence of the winds is most marked in the northern and western hemispheres; that of solar obliquity in the southern and eastern hemispheres.

3. Where the sun's rays are least intense, as in the polar regions, and where the winds are most variable, the ratios exhibit the nearest parallelism to the increments of arc; but where the winds are most uniform, in or near the region of monsoons, they correspond more closely with the sinal increments.

4. The general changes of temperature at midwinter, and at the equinoctial seasons, when the sun's declination is changing most rapidly, are most dependent upon the local solar heat; the midsummer changes are more subject to the influence of the winds.

5. The greatest conflict of opposing forces occurs during the sun's passage between the comparatively wind-governed northern hemisphere and the sun-governed southern hemisphere. This conflict is manifested in the spring and autumn rains.

6. The closest and most general approximation of ratios is shown in the monthly temperature change at midsummer, which corresponds almost precisely with the change of arc.

INFLUENCE OF TREES ON TEMPERATURE.

According to M. Becquerel, as stated before the French Academy, "Comptes Rendus," April 29, 1867, in summer the mean temperature in free air is slightly in excess of that under trees; the contrary is the case in winter. The trees, notwithstanding their inferior conductibility, very slowly assume a temperature in equilibrium with that of the air. The diurnal maximum takes place toward midnight under the trees, but toward 3 P. M. in free air. A little more rain falls three kilometres from the woods than at the edge or in the interior. The climate under the trees, therefore, is a sort of sea climate in its thermometric and hygrometric characters.

INDIAN SUMMER.

Prof. J. E. Willet (in the "American Journal of Science," Nov. 1867) gives the following facts in regard to the period of several weeks in autumn, characterized by a smoky atmosphere, equable temperature, and cloudless sky, known in America as Indian Summer: —

1. Indian Summer is not confined to North America, but occurs in both hemispheres. 2. The indications are that it is a phenomenon of the temperate zone. 3. The season of its appearance and its period of continuance seem to be slightly different in different countries. 4. There are individual days of smoky weather, distributed through the whole year, and undistinguishable from Indian Summer in any particular except the time of duration.

He suggests the following theory on the subject: —

1. The smokiness is produced by real smoke, proceeding from the ordinary fires employed in preparing food, etc., or from extraordinary fires in the burning of grass, brushwood, etc. 2. Atmospheric currents, subsiding from higher to lower regions, would produce smokiness by depressing the smoke, and, by coming under greater pressure, would become relatively dry, and would thus produce relative dryness and equableness of temperature during their continuance. 3. The subsiding of atmospheric currents will be most apparent when a conjunction of circumstances renders them continuous through a series of days, as in the autumn. 4. Descending currents of air are supposed to occur most in the temperate zones, to which Indian Summer seems to be peculiar.

OZONIFEROUS CURRENTS OF THE OCEAN.

Dr. Moffatt read a paper at the Dundee (1867) meeting of the British Association, embracing the results of observations made between lat. 53° N. and 39° S., and long. 83° E. and 25° W. It was found that as the wind veered with increasing readings of the barometer from south points of the compass through W. to N., ozone disappeared, and continued absent while the wind was in points between N. and E., and that it reappeared as the wind veered with decreasing readings of the barometer to S. points. The disappearance and reappearance of ozone with those conditions were so regular, that the changes appeared to be the result of an invariable atmospheric law, and the examination of the law of rotation of the wind led him to believe that the polar current is the non-ozoniferous or that of minimum of ozone, and that the equatorial is the ozoniferous or that of the maximum of ozone. According to the rotation theory, the north polar current forms the north-east "trade," and the south polar the south-east "trade," while the equatorials form the northern and southern hemispheres to upper or returning "trades;" if this be true, the north-east and south-east "trades" ought to be the minimum of ozone currents, the one in the northern hemisphere forming the south-west wind, and the other in the southern hemisphere a north-west wind.

TRANSPORTING POWER OF THE FOG-VESICLE.

That fogs and mists possess the power of transporting vapors, gases, odors, and the like, or even minute solid particles, as in smoke, is a fact well known to the observant. Many persons dwelling far to the leeward of certain manufacturing establishments are well aware that offensive or irritating gases may be caught upon the lap of a fog, as they issue from the chimneys of the factory, and carried away for miles. The same thing is apparent when the sea-fog sweeps inland, bearing the "smell of the sea," as the landsman calls it, or when the land-mists drift out on to the ocean, carrying to the incoming mariner the "smell of the land," — the odors in question, both that "of the land" and that "of the sea," being, in reality, one and the same, namely, the odor of the strand.

A somewhat analogous instance of the transporting power of the mist is seen in the long-persisting and all-pervading smoke-fogs which arise from burning forests and peat-bogs toward the close of our northern summers. These autumnal smokes are really of the nature of mists, as will appear from a moment's reflection upon the manner of their formation, and upon the chemical composition of the products of the combustion of a forest. A very large proportion of these products is nothing but aqueous vapor, which, under the peculiar circumstances of the case, immediately assumes the vesicular condition which we see in fogs and clouds.

In defiance, then, of all the ordinary laws which control the diffusion of gases, fogs can buoy up, hold for a long time, and carry to great distances, odors and vapors which, under ordinary conditions, are but slightly volatile; and in the same way, though in a lesser degree, they can transport solid substances. Beside the soot above mentioned, another familiar instance of this transporting power, as regards solids, is that of the boracic acid brought up by steam jets which issue from the earth in the volcanic districts of Tuscany; and there is another striking example of the same thing in the salt which is carried inland by fogs from the ocean. As an evidence of the extent to which this process goes on in some localities, we may cite the experience of the farmers upon our eastern seaboard, where fogs are frequent. It is there found, even at distances of 10 or 15 miles from the salt water, that animals have none of that craving for salt which is so strong in the cattle of the inland districts; and the farmer consequently pays no heed to a matter which is so important elsewhere. He takes no pains to "salt his cattle," for he knows from long experience that they will obtain a sufficient quantity in and upon the grass which they daily eat.

As bearing upon these well-known facts, the system of applying medicaments and perfumes by the so-called method of atomization, which has come into vogue within the last few years, would appear to be worthy of the careful study of meteorologists; the phenomena of transportation exhibited by the "atomizer" being evidently akin to those manifested by the fogs and clouds which occur in nature. In order to atomize a substance, it is first dissolved in water, and this aqueous solution is then, by means of suitably disposed jets of air or steam, driven out of minute orifices in the form of a finely divided spray or mist. This spray is inhaled by the patient, and the physician is thus enabled to apply his therapeutic agents, such as the various astringents and alteratives, directly to the diseased part of the throat or bronchial tubes.

Apart from its intrinsic scientific interest, this system of transporting drugs by atomization was undoubtedly a very important addition to the methods employed in the art of healing. But, as now appears, it has led to a discovery of still greater consequence, namely, to the production of local anæsthesia by freezing through the agency of certain volatile liquids.

ROSY AURORA.

Among the latest explanations of the red glow and splendor of sunrise and sunset which has been given, is that of Dr. E. Lommel, in Poggendorff's "Annalen," in which he shows it to be an effect of diffraction of light, as viewed through a series of dark or partially dark screens. He lays it down as an axiom that a point of white light, viewed through a sufficient number of groups of screens, appears not merely reddish itself, but also is surrounded by a still more strongly red-colored aureole of diffracted light. The lower stratum of the atmosphere is full of minute corpuscular bodies — dust, organic and inorganic, carbon or watery particles — which serve as dark screens, and when the sun is low, the rays, traversing a long range of atmosphere, undergo diffraction, and by superposition of adjacent points of light the effect of redness is deepened. A mere red glow, without brilliance, is occasioned by solid particles, as we see the sun red when viewing it through smoke; aqueous vapor, when present in the air, makes a diffused reddish light.

VARIATIONS OF CLIMATE.

We know little of the weather anterior to the historic period, except what may be inferred from geological traces, and incidental notices bearing on the subject which have casually floated down to us. But enough is known in these ways to decide that the climate of particular regions has undergone great changes since the creation, and even within the historical period. There is evidence of a marked amelioration of climate, both in North America and Europe, since the discovery of the western continent. While the spread of agriculture and civilization undoubtedly has its effect in this direction, there are also astronomical changes constantly in progress, which control, slowly but irresistibly, the climatic conditions of the earth. The elliptical form of the earth's orbit brings us about 3,000,000 miles, or nearly 3 per cent., nearer to the sun, at about the season of "January thaw." This is the case at present; but a regular change is going on in the proportions of the ellipse marked by the earth's annual revolution, which would in process of time so much flatten and elongate it as to increase the difference between the greatest and least radius to as much as 14,000,000 miles. At the same time, the month of January is gradually rotating from the nearest to the remotest and coldest position. At the suggestion of Sir Charles Lyell, a calculation was undertaken some time ago by Mr. Stone, chief assistant at the Royal Observatory, England, to determine the period of the extreme difference. The calculation was too vast to be completed at the time, but it was carried far enough to show that 210,000 years before A. D. 1800, the difference amounted to as much as 10,500,000 miles. Again, there is a small but constant change going on in the direction of the axis of the earth, which runs through all its variations in about 26,000 years; so that the position of a given latitude, relatively to the sun, would vary from the aspect or exposure of minimum warmth to that of maximum warmth in about 13,000 years. The importance of these points of contact between astronomical and geological researches can not fail to be developed by the devotees of science. — *Scientific American*.

THE INFLUENCE OF THE MOON UPON THE WEATHER.

Prof. Marcet, of Geneva, who has worked upon the meteorological tables from 1800 to 1860 in the "Bibliothèque de Genève," has given the results in tables in the same journal. During the last 60 years (21,915 days, 742 lunar months) there have occurred 2,630 changes of weather — that is, from rainy to fine weather, or fine weather to rainy. Of these 2,630 changes, 93 happened at new moon, and 90 at full moon; 109 occurred on the day following the full moon, and 107 on that following the new moon. It is hence calculated that the probability of a change of weather occurring on the day of the full moon is 0.121; at new moon, 0.125; the day after full moon, 0.143; the day after new moon, 0.148. The influence of the moon upon the number of days of rain, and the quantity of water which falls, the professor regards as negative. With reference to the barometer, he states that, of the 2,630 changes of weather, the barometer prophesied 1,960 times correctly. This approaches nearly to the proportion of three times out of four.

ON THE PERIODICAL VARIATIONS OF TEMPERATURE.

M. Ch. Sainte-Claire Deville has established, in a former memoir, that there exists a certain depending connection in the movement of the mean temperature of four days, placed on the ecliptic at an angle of 90° one from the other, for the four months, opposed two by two, of February, May, August, and November, which contain the critical days, known by the ancients under the name of the *three saints of ice* (May 11, 12, 13), and the *summer of Saint Martin* (November 11). In a new work with the above title, presented to the French Academy, May, 1867, he shows that the fact is general, and that this connection or mutual dependence of the four opposite days exists during the whole of the year; whether we take into consideration a considerable cycle, —110 years at Berlin, 90 years at Vienna, 50 at London, 40 at Prague and Edinburgh, 30 at Brussels, 24 at Toulouse, 21 at Paris, — or whether we take in this point of view an isolated year (1864) on several European stations.

The former, depending upon the same data, establishes, in fine, that this connection is evident also when we combine 12 by 12 the days separated one from the other by 30° of the ecliptic.

The latter phenomenon constitutes the *meteorological month*, as the *season* was established by the consideration of the quadruple days.

METEOROLOGICAL SUMMARY.

Transparency of the Air.—According to M. De la Rive, of Geneva, the great transparency of the air before rain is owing to the presence of a quantity of invisible vapor, which renders transparent the numerous germs floating in the air, to whose presence light mists are attributed.

Solar Radiation.—From a series of observations made by M. Soret, with the actinometer, it appears that the moisture of the atmosphere influences the intensity of direct solar radiation; and in general, other circumstances being the same, the more aqueous vapor the air contains, the less intensity there is in the radiation of solar light. Radiation increases with altitude; but its increase is less rapid than the fall of the barometer. The density of the atmosphere being the same, the radiation observed at a great altitude is undoubtedly stronger than at a lower one, and the diminution of radiation as the sun inclines toward the horizon is much less at a high altitude than in the plains.

Temperature of the Lower Strata of the Air. — It appears from the latest observations on temperatures of the air at different altitudes, that at a distance of 24 feet above the ground it is generally higher than at other elevations. Great differences are observed, especially previous to thunder storms.

Temperature of the last Winter. — Prof. Loomis, of Yale, states that the average temperature in the month of February was 7 degrees' higher than the average for this month for the last 88 years, and that it counterbalances the excessive cold of the 2 preceding months; so that on the whole the past winter must be ranked as an ordinary one.

Changes of Temperature during Solar Eclipses. — According to M. Bérigny, "Comptes Rendus," March 18, 1867, when the sky is free from clouds during an eclipse of the sun, the temperature is lowered, and increased when the sun is obscured by clouds.

GEOGRAPHY, ANTIQUITIES, AND STATISTICS.

FATE OF DR. LIVINGSTONE.

MUCH anxiety has been felt concerning the fate of this eminent African explorer. Apparently truthful and minute details concerning the manner of his death had convinced most persons of his melancholy fate; but recently intelligence has been received which leads to the belief that he may yet be living and prosecuting his scientific explorations.

From a report communicated to the Department of State by the U. S. Consul at Zanzibar, derived from Dr. Kirk, formerly a member of Dr. Livingstone's Zambesi expedition, and dated Dec. 9, 1866, it appears that Dr. Livingstone left Zanzibar on the 9th of March, 1866, for exploration of the river Rovuma and the great lake country of Central Africa. His expedition may be briefly stated to have been an attempt to unite the magnificent discoveries of late years, and determine the limits and connections of the three great lakes which reach from 14° south to 2° north latitude, flowing to the sea by the Zambesi and Nile at the two extremities, but with an intermediate space, as yet unknown. Such was the geographical problem. But he had in view also to affect the present enormous East African slave-trade, through pioneering the way which might lead to lawful commerce.

To have consolidated in one the successive discoveries achieved by himself on the Nyassa; by Burton, on the Sanganyika; by Speke and Grant, on the Victoria; and by Baker, on the Albert Nyanza, would have been a fitting triumph for one who was the first to cross the African continent within the tropical zone; but these hopes have been wrecked by his supposed untimely death.

The last heard of him was at "N'doude," at the confluence of the Rovuma and Niende. Here he met with kindness, but found the land desolated by the slave-traders supplying the market of Zanzibar. We have information that he proceeded further west to "Mataka," a Miao chief, who gave presents of cattle and food. At this point the Indian sepoys remained behind, and have since returned to Zanzibar. From Mataka to Alake was eight days' march. On crossing a wide water in Canves, they followed the border of the lake for several days, and then struck inland. They were suddenly attacked in a bush country, about 9 A. M., by a band of Mavite, a wandering people, by whom Dr. Livingstone and many of his party are said to have been killed. This happened about October 25th, 1866, and in a locality which cannot be precisely determined.

The scientific world await with anxiety the confirmation of the last welcome news of his safety.

THE GULF STREAM AND THE CUBA TELEGRAPH.

A special survey has been made under the direction of Mr. J. E. Hilgard, of the U. S. Coast Survey, at the instance of the International Ocean Telegraph Company, with a view to determine the conditions to be encountered in locating the cable between Florida and Cuba, through the Gulf Stream. The examination reveals a very irregular and precipitous descent from the Cuban coast, reaching the maximum depth of the channel, 840 fathoms, 37 miles from the Moro. From the northward, the bottom falls away in terraces without abrupt slopes. It is in the deep cañons or gorges of the southern portion that the Gulf Stream and its counter currents find their channels, while the sea lies almost motionless above the terraces of the northern coast. About 21 miles from the coast of Cuba, a submarine mountain rises in the midst of the southern channel, with the extreme depths of 748 and 843 fathoms on either side of it. The summit of this mountain is 2,400 feet above the bed of the straits, and reaches to within 2,400 feet of the surface; the current running over it so strongly that soundings were made with great difficulty. It appears to be triangular in its general form, with precipitous sides, presenting at its west angle a bold prow to the stream.

RUSSIAN AMERICA.

The following information in regard to Russian America is derived from Prof. Baird, of the Smithsonian Institution.

Means of Information. — He has had two explorers in that field between one and two years, who returned last autumn, bringing a collection of specimens of natural history, extending from the British possessions to the shores of the Polar Sea.

Climate, Temperature. — The coast from Prince of Wales Island to the entrance of Behring's Straits, during the winter months, is about the same as at the city of Washington. Little snow, much rain. During summer months, very foggy.

Timber. — Whole country, well up to the northern coast, heavily timbered, chiefly hard pine forests; small trees up to the very shores. Some of the islands heavily timbered with pine forests and dense underbrush; some of them destitute of timber, and covered with grass of luxuriant growth. The soil on the west coast produces excellent barley and roots, such as radishes and turnips, and esculents, such as lettuce, cabbage, etc.

Animals. — Furred animals, such as sea otter, river otter, sable, furred seal, mink, foxes, black, silver, red, etc., in great numbers. Red deer in the south, reindeer in the north. In Behring's Sea and northward great whales are very numerous.

Fish. — Herring, salmon, halibut, and codfish abound in exhaustless numbers.

Minerals. — Surface washings of gold have been discovered on the head-waters of streams, on the east side of the coast range of mountains. Geological developments the same on the west slopes. Native copper has been discovered in various places on the coast, and in the vicinity of Copper River. Iron ore of excellent quality, now being smelted and worked by Russian artisans in repairing ships, etc. Coal is found in large quantities, used by the Russians for naval purposes, similar to New Brunswick coal, but not equal to Cumberland coal. Recent discoveries have been made of what is believed to be a better quality of coal, not yet tested.

Inhabitants. — 5 or 6,000 Russians, and 50 or 60,000 Indians and Esquimaux. The Esquimaux inhabit the coast on the Northern Sea; are industrious, peaceable, and tractable, and live by hunting and fishing. The Indians inhabit the interior, and live by hunting, fishing, and trapping.

THE ANTIQUITY OF MAN.

The following are extracts from a paper by Mr. J. Crawford, F. R. S., read in the Ethnological department of the British Association at the late meeting at Dundee: "Man, when he first appeared on earth, was not without articulate speech, and, like the lower animals, must have expressed himself by what was little better than mere interjection. He had, therefore, to frame a language, — a seemingly difficult achievement, yet one which every savage tribe had been able to achieve, and that not in one place only, but in several thousand separate and independent localities. It followed, then, that as every tongue was regularly constructed and perfect for its own purposes, many ages must have passed before language could have reached its present maturity. Even the languages of a people so low in the scale of humanity as the Australians, incapable of reckoning beyond duality, were found to be not only skilfully, but even completely constructed.

"I may conclude this paper with a recapitulation of the conclusions which may, I think, be legitimately deduced from the facts stated in it. Man, although the latest creation of the class of beings to which he is most nearly allied, is yet of vast antiquity, although that portion of his history which has transpired since he acquired the art of making a durable and authentic record of his own existence forms but a very small fraction of it. From the time in which he acquired the skill to frame this record, we have to trace him back over the many stages he had to pass through up to the discovery of his remains in caves, and those of his handiwork in the most recent geological formation, 'the drift.' We must, indeed, go beyond this, and up to his first appearance, when he was without speech, ignorant of every art, and, like the lower animals, chiefly guided by instinct. This is to be inferred from the fact that, where material evidence of man's presence exists, in caves or 'drifts,' he is already found in possession of implements of stone, implying a considerable step in advance. But the localities in which the physical geography of the land and the genius of its people combined to effect such an early social advancement as was necessary to the attainment of the skill indispensable to the production of a reliable and enduring record of human events, however rude and imperfect, have been few in number, and confined to such as I have endeavored briefly to enumerate. Over the greater part of the earth's surface, auspicious locality and genius of race were not so combined as to have enabled mankind to reach that point. The red man of America, the shepherds of Tartary, the black races of Africa, never even approached it. The most highly endowed and the most happily situated of the nations of Europe had reached it only in comparatively modern times, and might not, indeed, have reached it at all had they not borrowed largely from their more precocious neighbors of Asia. The physical geography of the wild regions of Tartary, independent of the quality of the race, has ever made it impossible that man should have advanced beyond the condition of migrating shepherds, who have now and then united in formidable hosts, and proved the scourges of civilized man. The peculiar privations, both as to locality and race, which characterize some regions of the earth have made all advance in arts beyond what was indispensable to a bare preservation of existence impossible, and of this we have examples in the land of the Esquimaux and of the Australians. In a few localities even this amount of skill had not been attained. Thus, Spitzbergen, Nova Zembla, and even Iceland, when first seen by civilized man, were uninhabited; and when we see the Esquimaux living and multiplying and spreading in equally rigorous or even more rigorous climates, it is hard to believe but that they must once have had an aboriginal population, seeing that at least animal food is abundant in them. If they had they must have perished for want of skill to maintain existence. New Zealand would seem to have had no native inhabitants until it came to be colonized by savages and cannibals from the tropical islands of the Pacific. It is difficult in this case, too, to believe that prolific nature should have left so large a country without aboriginal inhabitants, yet it is more probable that the aborigines were either extirpated or absorbed by the more powerful invaders, than that they perished from want of skill in the arts."

At a recent meeting of the "Boston Society of Natural History," Prof. Agassiz offered some remarks upon the antiquity of man. He said that 50 years ago both the learned and unlearned believed they possessed a trustworthy chronology of human history. Historians struck the first blow at this assumption by their researches into the successive dynasties which had ruled over Egypt. Their lead was quietly followed in the different departments of science, until now we are forced to cast aside the ancient beliefs and construct our chronology from a new and independent basis. Twelve years ago, Ferdinand Keller, of Zurich, by his examination of the lake deposits of Switzerland, brought to light proofs of the existence of races of men with new characters of civilization. These discoveries astonished the world, and have since given rise to a new science, new societies, and new museums. Humanity is now connected with geological phenomena.

Formerly the presence of such large mammals as the *Elephas primigenius*, *Rhinoceros tichorhinus*, *Bos primigenius*, and *Ursus spelæus*, was considered the dividing line between geological and human history, — now the extensive researches of such able naturalists as Lartet, Von Baer, Rütimeyer, and Brandt, have proved that these quadrupeds were once contemporaneous with man. The question before us is whether we can establish a successive chronology of events since the appearance of these animals upon the earth. Brandt has attempted to show that they were living within the historical period, and has argued therefrom that the native cattle of Europe were developed from the *Bos primigenius*. The argument for their recent extinction is drawn from documents hitherto partly unknown, because written in the Sclavonic tongue; these represent the existence of *Bos primigenius* in the forests of Lithuania and Poland up to the 11th and 13th centuries. The presence of *Cervus megaceros* in the marshes of Europe up to the 14th century is also made probable.

There is no doubt that the fauna of the diluvial deposits and of the European caves consisted of animals, some of which, at least, had a circumpolar geographical distribution, and that the southern limit of animals now living in the polar regions was once much greater than now; remains of the reindeer have been found all through France to the Pyrenees and in Southern Germany. We find that these mammals had intimate relations with the ice-period, and it becomes necessary for us to investigate the extent of the ice-fields at the time when the glacial period was at its height. He believed that the changes in extent which our ice-fields have undergone, during successive periods, would furnish us with data for our chronology. In America the ice-fields, at the time of their greatest extension within definite limits, reached the 32d degree of north latitude. In Europe they extended as far as the plains of Lombardy. Subsequent to this came a limited glacial period, in which the Southern and Middle States were freed from glaciers, but from Maine westerly the country was still ice-bound. During a third period, the ice retreated to the northern shores of Lake Superior and the slopes of Mt. Katahdin, while in a fourth period, the one before the present, the continent was clothed with vegetation up to the hilly parts of Canada.

In answer to the question whether we had any means of connecting chronology with these facts, it might be stated that none of the cave animals or the large mammals which have been mentioned have been proved to exist prior to the time of the greatest extent of the ice-fields, and, as it can no longer be doubted that man lived contemporaneously with these animals, he believed that with the waning of the ice-period began the era of primeval man. In the successive epochs of the ice, indicated by the retreating ice, we have a *relative* chronology; when we ask for more specific statements of age, we find ourselves at once at a loss for an answer. Some indications might be seen in the abrasions of rocks of unequal hardness, and instances were cited in illustration of this.

In the course of the discussion which followed these remarks, he said he hoped for great results from the investigations now undertaken in our own country, and believed that marks of the reindeer would yet be found in the Carolinas.

AN EXTINCT RACE.

One of the most remarkable races that ever inhabited the earth is now extinct. They were known as the Guanches, and were the aborigines of the Canary Islands. In the sixteenth century, pestilence, slavery, and the cruelty of the Spaniards succeeded in totally exterminating them. They are described as having been of large stature, but of a singularly mild and gentle nature. Their food consisted of barley, wheat, and goat's milk, and their agriculture was of the rudest kind. They had a religion which taught them of a future state of rewards and punishments after death, and of good and evil spirits. They regarded the volcano of Teneriffe as a punishment for the bad. The bodies of their dead were carefully embalmed and deposited in catacombs, which still continue to be an object of curiosity to those who visit the islands. Their marriage rites were very solemn, and before engaging in them the brides were fattened on milk. At the present day these strange people are totally extinct.

ASSYRIAN ANTIQUITIES.

Sir Henry Rawlinson has recently succeeded in uniting and thus completing two separate portions of an Assyrian record covering 243 years of the empire, one of which is the year of the computed eclipse of the sun, 763 B. C. This event is distinctly noted in a record at a date varying not over 40 years from Archbishop Usher's chronology. The genuineness and authenticity of the record, the accuracy of the reading and translation, and the correctness of the chronology computed from the Hebrew Scriptures, are all established by their coincidence with a fact demonstrated by modern astronomy. The record was upon two separate blocks in the British Museum, the one containing the names and the other the dates, and not hitherto supposed to have any connection with each other. We have now but few chapters in the history of ancient nations written out so authentically and accurately as that of Assyria at this period, from the time of Benhadad and Ahab nearly to Josiah.

CATS AND CIVILIZATION.

Dr. Rolleston, of Oxford, one of the most eminent physiologists of the day, tells us in the first number of the new series of the "Journal of Anatomy and Physiology," that the cat, though domesticated in Egypt, was never tamed by the Romans, who used the white-breasted marten (*Mustela foina*) for the same sort of purposes, mousing and rat-devouring, for which we use the cat. Egypt, indeed, had made the cat her own, and something more, for she mingled mysticism with her regard. But Rome, who extended her rule so far and wide over barbarians of Scythia and barbarians of Britain, who civilized so many races with her grave and patient justice, never civilized the cat. The cat remained to the Romans, says Dr. Rolleston, the thief of the poultry-yard, but never became the humble dependent of the house. In the ancient world it needed the more feline nature of orientals to appreciate fully its grace and its repose, its strictly limited ferocity of nature developed only toward inferiors, the complete union of its capacities for domestic quiet and useful carnivorous energy, its art of sleepily ignoring man and yet utterly depending on him, its utter want of restless anxiety concerning human affairs, its lazy vigilance for meals, and, finally, its Buddhist thirst for Nigban (or Nirvana) — absorption in absolute vacuity of mind — when not under the dominion of any appetite. This was not the kind of creature over whom Romans were likely to exercise sway. They could not rule the cat by any sense of justice. Indeed, it is something of a surprise to us to find that even the white-breasted marten or weasel was sufficiently open to the sense of law to have been in any degree domesticated by that national genius for military and judicial government. Perhaps it was the *invading* spirit of the white-breasted marten which succumbed to the Roman genius of conquest. Dr. Rolleston tells us that the marten was strictly troglodyte, and destroyed its enemies by following them into their holes, not by catching them when outside. This must have been the quality which endeared it to the Roman rule, and made the martens submit to the domestic yoke of a people so successful in piercing in similar operations the wildest retreats of its mountain enemies. The cat, though aggressive on its peculiar prey, does not possess the genius for territorial invasion, and would not therefore have been likely to have been drawn toward the Romans, like the weasel, by this peculiar genius of his. The cat lurks in ambush, where the weasel invades, and the former was never a favorite Roman manœuvre. It is not perhaps, then, so surprising that the cat had to wait its time for being taken up into the essence of European civilization, till the European genius became modified to some extent by the more subtle spirit of the East. It was in Constantinople, — the very nearest point to Asia, — if we understand Dr. Rolleston aright, that the cat first made her appearance as a domestic animal. She seems to have passed into the domestic life of Europe soon after the first General Council, and from Constantinople to have moved westward. Her approach was everywhere welcome, for, as she had gained apotheosis in Egypt by protecting the grain harvests of the Nile from the marauding rats and mice, so in Europe she has been able to keep down these hungry creatures quite as successfully as the weasel, and to adapt herself more completely to human habits and to local attachments as well. Dr. Rolleston points out that cats, besides being gentler and cleaner, are less "plastic" in their habits than weasels, — less disposed, that is, to run wild, and in many climates even incapable of supporting themselves by their own wits in the wilderness, in the absence of man; in other words, while the presence of man is not necessary to the weasel, but only the weasel (in the absence of the cat) to man, the tie between the cat and man is a double one, he being as important to her as she to him.

And this it is which determines the relation of cats to our domestic life. They are not allies and companions, like dogs. They make no attempt to take a part in human affairs, as dogs do. They undertake no responsibilities of guarding the houses, or protecting the persons, or joining in the sports of man. They will not disturb themselves if burglars break into the dwelling, or if violence assaults their protectors. They are not, like dogs, curious of suspicious characters, furious against uninvited strangers. Nor are they like dogs in the welcome they give to change, and the joy with which they transfer themselves to fresh fields and pastures. They are bound to men only as birds are bound to the forest, as affording the conditions under which they can most conveniently live; not as having sympathies with them, but as providing the warm nooks, the scraps of food, and the moral influence by which they are saved from want and protected from their natural enemies.

You will see dogs full of pride at the accomplishment of their little tasks, and looking up to men for recognition. But there is nothing of this about the cat. If she catches a mouse, she is excited, but not proud. She looks for no praise; her carnivorous instinct is its own reward. She will, indeed, often attach herself to individuals, and in that case greatly enjoys to be fondled; but this is rather due to the keen appreciation of protection and patronage, and the tokens thereof, than to purely personal preferences. This only specimen of a domestic beast of prey (or at least the only one domesticated exactly because it is a beast of prey), and yet always accounted more domestic, and indeed more closely associated locally with home than the dog, which is not a beast of prey, seems entirely unaware of what Dr. Rolleston calls her "functional" relation to man. She may dimly know that she needs him, but has no idea that he needs her, and hence, no doubt, the complete *abandon* and restfulness of her domestic character. The dog is always straining upward. He feels the electric power of human influence. His duties to mankind are duties of *moral* selection, of true loyalty, and of fierce antagonism. But the cat is a pure creature of natural selection. She is selected by man for encouragement, because the mice are selected by her for destruction.

One great interest of the cat, considered in relation to the philosophy of civilization, is the entire failure of Mr. Buckle's law to account for her semi-civilization. Mr. Buckle held, we know, that the accumulation of new knowledge was the "one sole" cause of civilization, — that civilization goes on *pari passu* with the accumulation of knowledge. And this theory might fairly be supposed to apply to the civilization of the dog, the horse, and even, perhaps, the parrot. There is no doubt that what these creatures *learn* from man is, in some measure, at least, the cause of their milder nature. A dog is always high or low in the scale of moral affections in some proportion — we will not say in exact proportion — to its intelligent curiosity and interest in affairs.

But none of the species are beasts of prey, as the cat in its wild state is. And she, we may fairly say, has intellectually learned absolutely nothing from man. She is a far keener and more acute being when out on the trail of a bird than when most domestic in her mood. She changes her whole mental attitude, when on an expedition, to one of superior alertness, as much as the wild Indian, who was sunk in plethoric sleep for days previous, does when he puts on his war-paint and stealthily returns to the trail of his enemy. The cat which you see with ears erect, stealing through the shrubbery, is quite a different being from the one attaining "Nigban" in her mistress's lap, or on the hearth-rug before the fire. And yet civilization does graft something upon her which is worth more than her savage acuteness, though it is not new knowledge. It is the *need* of a higher companionship of some sort, though she spends most of her time no more aware of that companionship than she can be in a dreamless sleep; for the cat never dreams as the dog does. However indigestible she may find her food, you never hear her growl, or start, or cry in her sleep, as the dog does when his dreams present imaginary enemies. And yet she is sensible of the pleasure of companionship even in sleep, and a civilized cat will usually prefer to slumber in the room with her personal friends to slumbering in loneliness. We know a cat which, confined for "functional" purposes to the stable and the loft over it, always comes to sleep on the back of the pony, which the pony evidently approves of, as giving him also a sense of the sublime feeling of protection; indeed, as directly inverting the feeling which he has with a rider on his back, and substituting for it one of positive patronage. There is no doubt that what civilizes the cat is not in the least any intellectual influence exercised over her by man, for, on the contrary, his presence half extinguishes the little intellect she has, but is, on the contrary, a dumb, pleasurable sense of companionship with a creature who is her superior. The place of her half-extinguished instincts as a beast of prey is supplied by a graft of an almost equally instinctive and entirely torpid pleasure in the protection of superiors. And yet it is not to the species man, but to the individuals, that she feels thus. There is no creature which less likes strangers than the cat. She objects, perhaps, to the disturbing magnetic influences they introduce with them. While the dog first barks at and then welcomes them, stretching out quite cordially the right hand of fellowship, as clearly understanding that his master approves, — and while the parrot falls into a silent fit, and studies, in order to reproduce them, — the cat simply absents herself.

The civilization of the cat is purely customary and habitual; the dog's in many respects one of activity, and even sharpened by competition. At the accustomed meal time she will rush in with a cry almost of nervous agony, lest the proper moment be gone by. She is importunate to the last degree till her customary claim has been satisfied, but then she never encroaches. She has claimed her tribute of popular privileges; she never goes on to exaggerate them into democratic rights. The dog, on the other hand, who is more radical and active, never fails to espy a new comer for possible encroachment, and, unless morally taught to restrain himself, never loses sight of an opportunity where he can practise upon the observed weakness of his protectors.

The interest of the cat's civilization is, then, the curiously pillowy inertness of her higher and engrafted nature. It is like her fur and velvet paws in relation to the carnivorous cravings and sharp claws which these conceal, — like the purr with which she announces her satisfaction in relation to the mew with which she proclaims her wants. The higher element in her is a mere receptivity for higher companionship, — an unconscious, inarticulate pleasure in the presence and protection of a higher creature, which, so far from educating her, only blunts the edge of her carnivorous acuteness. Civilization with her is not the eliciting of new ideas, but a certain sedative administered to old ones by the partial pacification of her savage characteristics, and the growth of a new and higher class of composing associations. It is enough, however, if the cat teaches us, as she certainly does, that civilization is by no means a process arising in the growth of knowledge and the accumulation of intellectual laws, — that it may be subserved up to a certain point, at least, by influences which operate chiefly as smothering and blunting the raw material of the original passions, rather than as educating and enlightening the nature which owns them. — *The Spectator.*

THE REINDEER PERIOD.

The following are some of Mr. Christy's observations on the Reindeer Period, as given in the "Reliquiæ Aquitanicæ," recently published by him and M. Lartet: —

"It would be easy to cite many circumstances illustrative of the resemblance between the condition and habits of the modern Esquimaux and the cave-dwellers of France at the Reindeer period. But now comes the question: 'When was the Reindeer period in southern France, and what is its antiquity?'

"It is far easier to indicate its place in the series of observed facts in relation to ancient man, than to assign to it any definite antiquity of years. Geologically, a wide gulf separates it from the drift-period, though perhaps wider in the geological than in the paleontological aspect; but, on the other hand, it will seem, both from the paleontological and archæological bearings, to be of higher antiquity than the Kjökkenmöddings of Denmark and the lacustrine dwellings of Switzerland, and very certainly than the whole group of so-called Celtic and Cromlech remains. Comparing its fauna with that of these various periods, the Reindeer period may be placed thus: —

"In the drift (valley-gravels) the mammoth, rhinoceros, horse, and ox are the predominant animals, and the reindeer appears but sparingly. In the Dordogne caves the reindeer predominates, associated largely with the horse and aurochs, and exceptionally with some remains of mammoth, hyena, etc.; but all traces of such domesticated animals as the sheep, the goat, and the dog are wanting.

"In the Kjökkenmöddings of Denmark, though so much nearer the subarctic regions, the reindeer is not found, and the fauna, though more ancient than that now existing, indicates the presence of domesticated animals (dog).

The same may be said of the Swiss lacustrine dwellings; domestic animals are present; and the reindeer is absent even from the most ancient of them, though that it was once in the neighborhood is manifested by the existence of its remains in caves (at l'Echelle) in the same district.

In none of the cromlechs or sepulchres is there a trace of the reindeer; and the fauna indicated by the remains found in them is cited as more recent than either the fauna of the Kjökkenmöddings or that of the most ancient lake-dwellings.

From the archæological or industrial point of view, it may be remarked that from the drift we have no example of man's industry except implements of flint; and of these only the larger and coarser have been detected, though there is no reason to doubt that he had also implements for finer work than the majority of those found are fitted for.

In the reindeer period, although man had attained to a great proficiency in chipping, we have a total absence of ground or polished axes; and though he had arrived at the art of sewing, there is no trace of his having known how to spin; and in many of these caves of Dordogne there are no traces of pottery.

In the Kjökkenmöddings pottery is not unfrequent, though ground axes are very few, but not wholly wanting, and spindle whorls are scarce.

In the very oldest of the lake-dwellings (those in which there is no trace of metal, as at Wangen) the majority of the axes are ground, and the grinding-beds are the same as those found in the surface-period of Denmark and England. Pottery is abundant; not only spinning but weaving is presented; and there are evidences that the cultivation of wheat and other cereals has been attained to. In the cromlechs and the sepulchres pottery is abundant; and the frequent occurrence of articles in bronze indicates a later time.

THE IRON AGE OF DENMARK.

The Iron age of Denmark has been divided by Prof. Worsaae into, 1. The Early Iron age, from about 250 to 450 A. C. 2. The Transition period, extending to the close of the 7th century. And, 3. The Late Iron age, terminating with the introduction of Christianity about the year 1,000.

According to M. Engelhardt, in his work "Denmark in the Early Iron Age," this age commences with the introduction of three very important elements of civilization, in advance of those which characterized the Bronze age immediately preceding it. These are, 1. The use of iron. 2. The employment of horses for riding and driving. And, 3. The possession of an alphabet of Runic letters.

On comparing the antiquities of the Bronze and Early Iron ages, some remarkable contrasts are exhibited. The weapons and cutting instruments of the Early Iron age were invariably of iron, with a high degree of finish, instead of the cast bronze swords of the previous period. Bronze or brass was in use, but zinc was mixed with the copper instead of tin. The use of gold is common to both periods, but silver, ivory, glass, agate, and porcelain beads appear first during the Iron age. The ornamentation in the Bronze age was geometrical, stiff, and monotonous. In the Iron age it consisted of heads and figures of animals, human figures, stars, and often of a religious device, known as the *fylfot* (believed to have originated in Eastern Asia).

Considering these characteristics of the two periods, the question arises whether they lead to the inference that the transition from one to the other was gradual, as a result of advancing civilization and peaceful intercourse with other nations, or whether they indicate that, at the termination of the Bronze period, Denmark was invaded by a more highly civilized people. M. Engelhardt accepts the latter solution. As to the question, Who were the invaders? beyond saying that the Romans never conquered Denmark, he comes to no conclusion. — *Quart. Journal of Science, April,* 1867.

ETHNOLOGICAL SUMMARY.

First Appearance of Man. — According to M. Le Hon, the first appearance of man on the earth was *after* the epoch of *Elephas meridionalis.* In Europe he believes that he first appeared after the diminution of the ice of the glacial period, and after the contemporaneous upheaval of that continent, migrating from Asia to the newly raised countries.

Uses of the Flint Implements. — These have been generally considered by antiquaries as used either in war or the chase, or for the peaceful occupations of agriculture. Prof. Steenstrup has recently compared them with certain stone objects used by the Esquimaux for the purpose of sinking their hooks in fishing, to which they bear a considerable resemblance in form and proportion.

Lake-Dwellings of Switzerland. — For an account of these, and the Rock-dwellers of France, the reader is referred to the "Quarterly Journal of Science," January, 1867, pp. 79–85.

THE COAL SUPPLY OF ENGLAND.

Among the various questions of great economical importance which have been before the public during the past year, there are two on which I will make a few comments. These are the contingency, at no remote date, of a considerable exhaustion of certain mineral resources in this country, and the altered position which England might consequently assume, and the present condition of what is familiarly called the money market. Attention has been called by an economist, who has exhibited great research and original thought on a number of subjects, to the relations subsisting between the consumption of British coal and its future supply. Should the consumption of coal in this country, it is argued, progress at the same rate as now, the supply will be exhausted at no distant date, and with such an exhaustion there must ensue a cessation of most of those industries which have hitherto characterized us. So energetically was this alarm seconded by one of our most distinguished economists, that a financial operation was proposed, with a view to palliate some of the evils which might be likely to ensue from such an event. Now, the real question is, it seems, when will the scarcity-price operate on consumption, and when it does so operate in what will the saving be effected? That the scarcity-price is not yet operative is manifest from the increase in the aggregate consumption of coal, and from the increased production of metals; for it is in the smelting of metals that the largest consumption occurs. Nor can it be doubted that when the saving becomes necessary from enhanced price the economy will be exercised in this direction. But the total value of all metals produced in this country in the year 1864 (the largest in value, though not the largest in amount, yet recorded) was worth little more than £16,000,000, — a great but not a dominant quantity in the annual aggregate of British industry. It would seem, then, that the alarm, if it be not premature, is certainly excessive. The material wealth of this country, it may be observed, greatly as it is related to its manufactures, one of the raw materials of which is locally limited, is far more fully derived from its geographical position, and thereupon its trade, the advantages and aids of which are permanent. Occupying, as Great Britain does, the most central position between the New and the Old World, it is, and will be, so long as the people are industrious and resolute, the highway and the mart of nations. Its commerce, by virtue of causes which cannot be reft from it, increases at a far more rapid rate than its manufactures; and if that commerce remain unfettered and unshackled, there seems no limit to the width which its markets may attain. — *Prof. Thorold Rogers.*

COAL MINES OF THE WORLD.

M. A. Burat, in a work entitled "Situation de l'Industrie Houillière," gives the following as the statistics of the extent of known coal-fields and their annnal productions: —

	Extent in hectares, 1 hectare being equal to 2.471 acres.	*Tons.*
British Isles	1,570,000	86,000,000
France	350,000	10,000,000
Belgium	150,000	10,000,000
Prussia and Saxony	300,000	12,000,000
Austria and Bohemia	120,000	2,500,000
Spain	150,000	400,000
North America	30,000,000	20,000,000

STATISTICS OF THE WAR.

The Washington correspondent of the "Chicago Tribune" furnishes that paper with an exhaustive compilation of the statistics of the war. The following tables are compiled from official documents: —

ENLISTMENTS BY STATES.

Maine	70,500	Missouri	119,364
New Hampshire	35,012	Kentucky	75,275
Vermont	34,054	Kansas	21,186
Massachusetts	158,380	Tennessee	31,092
Rhode Island	26,395	Arkansas	8,289
Connecticut	58,157	North Carolina	3,156
New York	468,521	California	15,725
New Jersey	79,207	Nevada	1,080
Pennsylvania	266,005	Oregon	1,810
Delaware	12,265	Washington	964
Maryland	47,350	Nebraska	3,157
West Virginia	32,903	Colorado	4,903
Dist. Columbia	18,693	Dakotah	206
Ohio	359,265	New Mexico	6,651
Indiana	207,969	Alabama	2,576
Illinois	279,006	Florida	1,290
Michigan	88,892	Louisiana	5,224
Wisconsin	93,972	Mississippi	545
Minnesota	24,932	Texas	1,965
Iowa	80,609	Indian Nation	3,530

When the war closed there were in the field, on the 30th day of April, 1865, 1,000,516 men, actually in service, and an enrolment of 2,245,063 men subject to draft. This would make the total fighting force of the free States, between the ages of 18 and 45, and in good physical health, and not including foreigners not naturalized, to be 3,245,579 men.

CASUALTIES.

Deaths from wounds	96,089	Dishonorably discharged	5,390
Deaths from disease	184,31	Resignations	22,281
Desertions	199,045	Missing, etc.	7,062
Honorbly discharged	174,577		
Discharged for disability	224,306	Total	913,081

COMMUTATION MONEY BY STATES.

Maine	$610,200	District of Columbia	96,900
New Hampshire	208,500	Kentucky	997,530
Vermont	593,400	Ohio	1,978,087
Massachusetts	1,610,400	Minnesota	316,800
Rhode Island	141,300	Illinois	15,900
Connecticut	457,500	Indiana	235,500
New York	5,485,799	Michigan	614,709
New Jersey	1,265,700	Wisconsin	1,533,600
Pennsylvania	8,634,300	Iowa	22,500
Delaware	416,100		
Maryland	1,131,900	Total	$26,366,616

BOUNTY BY STATES.

Maine paid	$7,837,643	Ohio	23,557,337
New Hampshire	9,636,313	Indiana	9,182,354
Vermont	4,528,744	Illinois	17,296,205
Massachusetts	22,965,550	Michigan	9,664,855
Rhode Island	820,768	Wisconsin	5,855,356
Connecticut	6,887,554	Iowa	1,615,171
New York	86,629,227	Minnesota	2,000,464
New Jersey	23,868,966	Missouri	1,282,148
Pennsylvania	43,155,986	Kansas	57,407
Delaware	1,136,599		
Maryland	6,271,992	Total.	285,939,000
District of Columbia	134,011	Paid by United States,	300,223,500
West Virginia	861,737		
Kentucky	692,577	Total bounty money,	585,162,500

AMERICAN WAR ENGINEERING.

In an abstract of the report of Brig. Gen. D. C. McCallum, Military Director and Superintendent of Railroads in the United States, by appointment of the War Department, are the following specifications of services rendered by his construction corps: —

"Some of the achievements of Gen. McCallum's department deserve to rank with the most remarkable engineering feats of modern times. The wonderful bridge over the Chattahoochee, 780 feet long and 92 feet high, was built by the construction corps in 4½ days; the bridge over the Potomac Creek, at Aquia, 414 feet long and 82 feet high, was built ready for trains to pass in 40 working hours. In their leisure time this corps rebuilt the Chattanooga rolling mills, which turned out in a few months nearly 4,000 tons of railroad iron for the government, and were sold at the end of the war for a 175,000 dollars. With justifiable pride Gen. McCallum classes the attempt to supply Sherman's army of 100,000 men and 60,000 horses and mules, from a base 360 miles distant, over a line of a single track, as one of the boldest ideas of the war. Whole corps, and even armies, were frequently transported hundreds of miles on the mere verbal orders of their commanders. In 1865 the Fourth Army Corps were transported from East Tennessee to Nashville, a distance of 360 miles, without delay or difficulty,— this herculean task requiring nearly 1,500 cars. In the first six months of 1865 one wrecking train picked up and brought into Nashville 16 wrecked locomotives and nearly 300 car-loads of wheels and bridge iron, the destructive handiwork of rebel raiders. In October, 1864, Hood, passing round Sherman's army, tore up 35 miles of track, and burned 450 feet of bridges between Chattanooga and Atlanta. The damage was made good and the line put in working order again in 13 days. Between Tunnel Hill and Resaca 25 miles of track and 230 feet of bridging were reconstructed in 7½ days.

THE ATTRITION OF COINS.

The people in the United Kingdom have to pay through the public treasury somewhere about 20,000 pounds sterling per annum for the privilege of using the current coin of the realm. Money, like every other article manufactured, wears out after a certain amount of active service, and the life of a coin in these days of rapid trading and travelling is very short. The results of attrition on the surfaces of a newly-minted shilling, for example, soon manifest themselves after its issue, and the same may be said of every other piece of money. When it passes from between the highly-polished dies of the stamping-press it has all the beauty of an article of plate for presentation. Her Majesty's lineaments are then clearly defined, and the "superscription" surrounds the "image" with a sharpness of outline that tells eloquently in favor of the engraver.

Alas! how soon does the rich polish disappear! How very speedily are the fine lines of the hair smoothed down to the uniformity of a bald, flat surface, and how rapidly is the lettering defaced, once the coin is tossed on the ruthless waves of general circulation! Its beauty, like that of the butterfly's wing, is marred by touching, and the rubbing to which it is subsequently exposed destroys its impressions entirely. From the instant that a coin leaves the mint or the bank, and is put to the use for which it was struck, its deterioration begins, and it loses both in appearance and in weight. It is the annual waste of the coinage by attrition or abrasion which involves the community in the heavy tax already named. If each coin diminishes in weight day by day, what must be the aggregate loss on the whole British coinage in a year, or in a series of years? It has been ascertained from official data that there are about 150,000,000 of sovereigns, and 620,000,000 of silver coins of all denominations, doing duty day by day in Great Britain and Ireland.

Of course they are all subject to the wasting laws of friction and attrition, and at the end of each year they are worth intrinsically less than they were at its beginning. As a rule the smaller coins wear out at a greater speed than their larger and more valuable relatives; and the sixpence is notoriously short-lived, because it is overworked; but they all get thinner and smoother in a pretty well-known ratio. They indeed become small by degrees, and it is necessary to withdraw the worn specimens periodically from circulation to recast them, and then to send them again to do battle with the world.

It takes possibly 100 old shillings to make 80 new ones, and hence will be seen at once the source of loss, for the same rule applies to all other moneys, though in regard to gold in a different degree. Gold is the standard of value in England, and all gold pieces should be both nominally and intrinsically worth the sums they represent. When, therefore, a sovereign has become lessened in weight by attrition to the extent of half a grain below the minimum legal weight at which it was originally issued, its circulation may be legally stopped, and compensation demanded from its last holder for its deficiency. This arrangement was acted upon with great rigor some years since, and hence the clamor about light gold which then arose. Silver and bronze coins are tokens of value only, their nominal being greater than their intrinsic value at the outset of their careers. So long as they retain the marks of the mint dies, however faintly defined, they are permitted to circulate, and hence they in some cases lose one-third of their substance before being withdrawn and remodelled.

To cover the constantly recurring waste of money by attrition, a sum of money averaging that mentioned above is set apart year by year, and it is said that it scarcely suffices for the purpose. If it be asked, "What becomes of the products of attrition, the particles of silver and gold daily detached from our coinage?" that is a question which we cannot solve. The precious metals are indestructible, and there must of necessity be a very large quantity in invisible existence in England at present. Probably samples of dust taken from the thoroughfares of the metropolis, if analyzed carefully, would yield a small percentage.

It has been estimated approximately that in 3 years of active circulation crown pieces lose 5 per cent. of their original weight, half-crown pieces 10 per cent., shillings 30 per cent., sixpences 40 per cent., and threepences 42 per cent. Bronze coins are made of sterner stuff than standard silver, and their rates of deterioration no doubt will be proportionally less. The penny is an actively circulated piece of money, while the farthing is very idle. It is likely, therefore, that the larger coins in this instance will first break down, and thus invert the law as to silver. Much would be done in the way of mitigating the loss by wear if all coins were furnished at their birth with broad and deep projecting rims. These would then bear the brunt of attrition and save the obverse and reverse impressions of coins from that speedy defacement which awaits their appearance in public. — *The Engineer.*

STATISTICAL SUMMARY.

Wages in Great Britain. — By the annexed paragraph, from a London newspaper, it appears that the average rate of wages in England and Ireland is higher than we are wont to suppose, fully justifying Mr. Bright's statement that the price of labor has risen 25 or 50 per cent. within the last 30 years. Reduced to our present currency, the daily wages are, in England, 1.50; in Scotland, 1.37; and in Ireland, 0.96. This allows 40 cents to the shilling, which is less than the rate of exchange to-day.

"It appears from an elaborate return, prepared by Mr. Leone Levi, in conjunction with Mr. Bass, M. P., that there are 10,697,000 working people in the United Kingdom between 20 and 60 years of age, and that their total earnings amount to 418,300,000 pounds sterling per annum, distributed as follows: England, 311,500,000 pounds; Scotland, 42,700,000; Ireland, 64,100,000. This gives an average weekly income of 22s. 6d. in England, 20s. 6d. in Scotland, and 14s. 4d. in Ireland."

Density of Population. — In the year 1865, Belgium had 365 inhabitants to the square mile, England and Wales had 367, and France 176. If the United States was as densely populated as France, our population would amount to 528,000,000; as England and Wales, 924,000,000; and, according to the Belgium density of population, the United States would contain 1,195,000,000 inhabitants, being 110,086,000 more than the entire population of the world in 1866.

Composition of the Armies of the War. — Dr. Bellows, President of the Sanitary Commission, has published a note saying that the statistics show that 80 per cent. of the soldiers of the Union armies were Americans; and that, as nearly as can be ascertained, of all those asking charity or assistance in any way since their discharge, 90 per cent. are foreigners.

California Quicksilver. — The exports of quicksilver to the different countries for the last five years were as follows: —

To	1860.	1861.	1862.	1863.	1864.	1865.
New York and Boston	400	600	2,265	95	1,495	6,800
Great Britain . .		2,500	1,500	1,063	1,609	10,400
Mexico . . .	3,886	12,061	14,778	11,590	7,483	2,789
China	2,715	13,788	8,725	8,889	18,908	14,248
Peru	750	2,804	3,439	3,376	4,300	5,500
Chile	1,140	2,059	1,746	500	2,674	2,000
Central America . .		110	40	89	41	8
Japan . . .		50	25		262	500
Australia . . .	100	1.850	800	300	100	20
Panama . . .	130	57	424	120	45	
Victoria, V. I. . .	326	116	5	42	21	24
Total flasks .	9,447	35,995	33,747	26,064	36,938	42,289

And our exports previously have been: —

In 1859, flasks, . .	3,399	In 1856, flasks, . .	23,740
In 1858 " . .	24,142	In 1855 " . .	27,165
In 1857 " . .	27,262	In 1854 " . .	20,963

Tobacco Product of the World. — The total amount of tobacco produced throughout the world is estimated as follows: — Asia, 309,900,000 pounds; Europe, 281,844.500; America, 248,280.500; Africa, 24,300,000; Australia, 714,000: making in all 865,039,000 pounds.

Food of New York City. — The New York "Sun," in a series of articles describing how the city is fed, gives some interesting statistics. The estimate is made that 5,525,000 pounds of beef, 112,500 of mutton, 72,000 of veal, and 2,400,000 of pork, are sold every week in Washington Market. The consumption is less during the months of March and April, owing to the abundant supply of fish. The daily quantity of milk used amounts to 125,000 quarts; of butter, 62,500 pounds; of cheese, 8,944 pounds. The actual table expenses for each day for every man, woman, and child of the population, averages 37 cents a head, divided as follows: meat supply, about 16 cents; fish supply, 2 cents; eggs and poultry, 2½ cents; vegetables, 3 cents; fruit, 1½ cents; bread, 7 cents; tea, coffee, and sugar, 5 cents; the total sum expended daily by the city in eating, 370,000 dollars.

OBITUARY

OF MEN EMINENT IN SCIENCE. 1867.

Bache, Prof. Alexander Dallas, American Physicist, and Superintendent of U. S. Coast Survey, Feb. 17, æt. 61.

Berg, Dr. Otto, German Botanist, Nov. 1866, æt. 51.

Bethell, John, English Inventor, Feb. 22, æt. 62.

Civiale, M., French Surgeon: an eminent Lithotritist, June 13.

Cotting, Dr. John R., American Geologist, Oct. 18, æt. 83.

Cousin, Victor, French Philosopher, January.

Daubeny, Dr. Chas. G. B., English Physicist, Dec. 12.

Deslongchamps, Prof. J. A. E., French Geologist.

Dewey, Prof. Chester, American Botanist, Nov. 15, æt. 83.

Faraday, Michael, English Chemist and Physicist, Aug. 27, æt. 73.

Flourens, Prof. M. J. P., French Physiologist, Dec., æt. 73.

Fourneyron, Benoit, French Inventor, æt. 65.

Gasparini, Prof. William, Italian Botanist, Dec., 1866.

Goodsir, Prof. John, English Anatomist and Zoölogist.

Hamilton, W. J., English Geologist.

Harris, Sir William Snow, English Physicist, Jan. 22, æt. 76.

Howe, Elias, Jr., American Inventor of the Sewing Machine, Oct. 3, æt. 48.

Norton, Capt. John, English Inventor of Projectiles, April.

Pelouze, Prof. Theophile J., French Chemist, May 31, æt. 60.

Rosse, Lord William, English Astronomer, Oct. 31, æt. 67.

Sartwell, Dr. Henry P., American Botanist, Nov. 15, æt. 75.

Schlechtendal, Prof. D. F. L. von, German Botanist, Oct. 12, 1866, æt. 82.

Selby, John Prideaux, English Ornithologist, April, æt. 87.

Smith, James, English Geologist.

South, Sir James, English Astronomer, æt. 84.

Velpeau, Prof. A. L. M. A., French Surgeon, Aug. 24, æt. 72.

AMERICAN SCIENTIFIC BIBLIOGRAPHY.

Academy, American, of Arts and Sciences; Proceedings of, Vol. VII. 8vo., and Memoirs 4to. Boston. 1867.

Academy, National, of Sciences; Annual of, for 1866. 12mo. 1867.

Academy of Natural Sciences of Philadelphia; Proceedings. 1867.

American Naturalist. 8vo. Salem, Mass. 1867.

Colton, G. W, and C. B. Journal of Geography and Collateral Sciences. 8vo. Oct. 1867.

Craig, Dr. B. F. Weights and Measures according to the Decimal System. New York. 1866.

Eliot, C. W. and Storer, F. H. A Manual of Inorganic Chemistry. 12mo. Boston. 1867.

Hilgard, J. E. Report of the Superintendent of the U. S. Coast Survey, showing the progress of the survey during the year 1865. 4to. Washington. 1867.

Institute, Essex. Proceedings. Vol. V. 8vo. Salem, Mass.

Kirkwood, Prof. Daniel. Meteoric Astronomy: a Treatise on Shooting Stars, Fire-balls, and Aerolites. 12mo. Phila. 1867.

Kneeland, Samuel, M. D. Annual of Scientific Discovery for 1866 and 1867. 12mo. Boston. 1867. Gould & Lincoln.

Lea, Isaac. Index to Vol. I. to XI. of Observations on the Genus Unio, with Descriptions of new Species. 4to. Phil. 1867.

Lyceum of Natural History of New York: Annals of. Vol. VIII. Nos. 13 and 14. 8vo. New York.

Museum of Comparative Zoölogy: Annual Report of the Trustees; with the Report of the Director. 8vo. Cambridge. 1866.

Norton, William A. A Treatise on Astronomy, Spherical and Physical. 4th Edition. New York. 1867.

Observatory, Astronomical, of Harvard College: Annals of. Vol. II., part II., Vol. V. 4to. Cambridge. 1867.

Perkins, Prof. Maurice. An Elementary Manual of Qualitative Analysis. 8vo. New York.

Rand, Howard, M. D. Elements of Medical Chemistry. Phila. 1867.

Rolfe, W. J. and Gillett, J. A. Cambridge Course of Elementary Physics. Part I.: Cohesion, Adhesion, Chemical Affinity, and Electricity. Part III.: Astronomy. 12mo. Boston. 1868.

Society, Boston, of Natural History: Memoirs of. Vol. I., Part II. 4to. 1867. Proceedings. Vol. XI. 8vo. Boston.

Society, Entomological, American, of Philadelphia: Transactions. Vol. I., No. 1. 8vo. Proceedings. Vol. VI. 1867.

Storer, D. Humphreys, M. D. A History of the Fishes of Massachusetts. 4to. Boston. 1867.

Swallow, G. C. Preliminary Report of the Geological Survey of Kansas. 8vo. Lawrence. 1866.

Warren, Prof. S. E. General Problems of Shades and Shadows. New York.

Wormley, Theodore G. M. D. Micro-Chemistry of Poisons, including their physiological, pathological, and legal Relations. 8vo. New York. 1867.

Worthen, A. H. Geological Survey of Illinois. Vol. II. 8vo. Springfield, Ill. 1866.

INDEX.

Valuable Works,

PUBLISHED BY

GOULD AND LINCOLN,

59 Washington Street, Boston.

HAMILTON'S LECTURES, embracing the METAPHYSICAL and LOGICAL COURSES; with Notes, from Original Materials, and an Appendix, containing the Author's Latest Development of his New Logical Theory. Edited by Rev. HENRY LONGUEVILLE MANSEL, B. D., Prof. of Moral and Metaphysical Philosophy in Magdalen College, Oxford, and JOHN VEITCH, M. A., of Edinburgh. In two royal octavo volumes, viz.,

I. METAPHYSICAL LECTURES. Royal octavo. cloth, 3.50.

II. LOGICAL LECTURES. Royal octavo, cloth, 3.50.

☞ G. & L., by a special arrangement with the family of the late Sir William Hamilton, are the authorized, and only authorized, American publishers of this distinguished author's *matchless* LECTURES ON METAPHYSICS AND LOGIC.

The above have already been introduced into nearly all our leading colleges.

LOOMIS' ELEMENTS OF GEOLOGY; adapted to Schools and Colleges. With numerous Illustrations. By J. R. LOOMIS, President of Lewisburg University, Pa. 12mo, cloth, 1.25.

"It is surpassed by no work before the American public." — *M. B. Anderson, LL. D., President Rochester University.*

PEABODY'S CHRISTIANITY THE RELIGION OF NATURE. Lectures delivered before the Lowell Institute in 1863, by A. P. PEABODY, D. D., LL. D , Preacher to the University, and Plummer Professor of Christian Morals, Harvard College. Royal 12mo, cloth, 1.50.

A masterly production, distinguished for its acuteness and earnestness, its force of logic and fairness of statement, written in a style of singular accuracy and beauty.

PALEY'S NATURAL THEOLOGY: Illustrated by forty Plates, with Selections from the Notes of Dr. Paxton, and Additional Notes, Original and Selected, with a Vocabulary of Scientific Terms. Edited by JOHN WARE, M. D. Improved edition, with elegant illustrations. 12mo, cloth, embossed, 1.75.

MANSEL'S PROLEGOMENA LOGICA; the Psychological Character of Logical Processes. By HENRY LONGUEVILLE MANSEL, B. D. 12mo, cloth, 1.25.

YOUNG LADIES' CLASS BOOK: a Selection of Lessons for Reading in Prose and Verse. By EBENEZER BAILEY, A.M. Cloth, embossed, 1.25.

ROGET'S THESAURUS OF ENGLISH WORDS AND PHRASES, so classified and arranged as to facilitate the expression of ideas, and assist in literary composition. New and improved edition. By PETER MARK ROGET, late Secretary of the Royal Society, London, etc. Revised and edited, with a List of Foreign Words defined in English, and other additions, by BARNAS SEARS, D. D., President of Brown University. A NEW AMERICAN Edition, with ADDITIONS AND IMPROVEMENTS. 12mo, cloth, 2.00.

The first American edition having been prepared by Prof. Sears for *strictly educational purposes*, those words and phrases properly termed "vulgar," incorporated in the original work, were omitted. These expurgated portions have, in the present edition, been *restored*, but by such an arrangement of the matter as not to interfere with the educational purposes of the American editor. Besides this it contains important additions not in the English edition, of words and phrases, and also an alphabetical list of "FOREIGN WORDS AND PHRASES"—Latin, French, Italian, Spanish, Greek, etc.—which most frequently occur in works of general literature, defined in English, making it in *all respects more full and perfect than the author's edition.*

GUYOT'S EARTH AND MAN; Lectures on COMPARATIVE PHYSICAL GEOGRAPHY, in its relation to the History of Mankind. By ARNOLD GUYOT. With Illustrations. 12mo, cloth, 1.75.

GUYOT'S MURAL MAPS. A series of elegant Colored Maps, projected on a large scale for the Recitation Room, consisting of a Map of the World, North and South America, Geographical Elements, &c., exhibiting the Physical Phenomena of the Globe. By Professor ARNOLD GUYOT, viz.,

GUYOT'S MAP OF THE WORLD, *mounted*, 12.00.

GUYOT'S MAP OF NORTH AMERICA, *mounted*, 11.00.

GUYOT'S MAP OF SOUTH AMERICA, *mounted*, 11.00.

GUYOT'S GEOGRAPHICAL ELEMENTS, *mounted*, 11.00.

☞ These elegant and entirely original Mural Maps are projected on a large scale, so that when suspended in the recitation room they may be seen from any point, and the delineations without difficulty traced distinctly with the eye. They are beautifully printed in colors, and neatly mounted for use.

BARTON'S EASY LESSONS IN ENGLISH GRAMMAR, for Young Beginners. By W. S. BARTON, A. M. 12mo, half mor., 75 cts.

Designed as a SEQUEL TO THE AUTHOR'S NEW SYSTEM OF ENGLISH GRAMMAR, which forms a gradual introduction to the first principles of composition.

BARTON'S NEW INTERMEDIATE SYSTEM OF ENGLISH GRAMMAR. By W. S. BARTON, A. M. 12mo, half mor., 1.00.

BARTON'S PRACTICAL EXERCISES IN ENGLISH COMPOSITION; or, THE YOUNG COMPOSER'S GUIDE. By W. S. BARTON, A. M. 12mo, half mor., 1.00.

BARTON'S HIGH SCHOOL GRAMMAR; or, an Exposition of Grammatical Structure of the English Language. By W. S. BARTON, A. M. 12mo. half mor., 1.50.

The above works by Prof. Barton, designed as text-books for the use of schools and academies, are the result of long experience, and will be found to possess many and peculiar merits.

MILLER'S CRUISE OF THE BETSEY: or, a Summer Ramble among the Fossiliferous Deposits of the Hebrides. With Rambles of a Geologist; or, Ten Thousand Miles over the Fossiliferous Deposits of Scotland. 12mo, pp. 524, cloth, 1.75.

MILLER'S ESSAYS, Historical and Biographical, Political and Social, Literary and Scientific. By HUGH MILLER. With Preface by Peter Bayne. 12mo, cloth, 1.75.

MILLER'S FOOT-PRINTS OF THE CREATOR; or, the Asterolepis of Stromness, with numerous Illustrations. With a Memoir of the Author, by LOUIS AGASSIZ. 12mo, cloth, 1.75.

MILLER'S FIRST IMPRESSIONS OF ENGLAND AND ITS PEOPLE. With a fine Engraving of the Author. 12mo, cloth, 1.50.

MILLER'S HEADSHIP OF CHRIST, and the Rights of the Christian People, a Collection of Personal Portraitures, Historical and Descriptive Sketches and Essays, with the Author's celebrated Letter to Lord Brougham. By HUGH MILLER. Edited, with a Preface, by PETER BAYNE, A. M. 12mo, cloth, 1.75.

MILLER'S OLD RED SANDSTONE; or, New Walks in an Old Field. Illustrated with Plates and Geological Sections. NEW EDITION, REVISED AND MUCH ENLARGED, by the addition of new matter and new Illustrations, &c. 12mo, cloth, 1.75.

MILLER'S POPULAR GEOLOGY; With Descriptive Sketches from a Geologist's Portfolio. By HUGH MILLER. With a Resume of the Progress of Geological Science during the last two years. By MRS. MILLER. 12mo, cloth, 1.75.

MILLER'S SCHOOLS AND SCHOOLMASTERS; or, the Story of my Education. AN AUTOBIOGRAPHY. With a full-length Portrait of the Author. 12mo, 1.75.

MILLER'S TALES AND SKETCHES. Edited, with a Preface, &c., by MRS. MILLER. 12mo, 1.50.

Among the subjects are: Recollections of Ferguson — Burns — The Salmon Fisher of Udoll — The Widow of Dunskaith — The Lykewake — Bill Whyte — The Young Surgeon — George Ross, the Scotch Agent — M'Culloch, the Mechanician — A True Story of the Life of a Scotch Merchant of the Eighteenth Century.

MILLER'S TESTIMONY OF THE ROCKS; or, Geology in its Bearings on the two Theologies, Natural and Revealed. "Thou shalt be in league with the stones of the field." — *Job.* With numerous elegant Illustrations. One volume, royal 12mo, cloth, 1.75.

HUGH MILLER'S WORKS. Ten volumes, uniform style, in an elegant box, embossed cloth, 17; library sheep, 20; half calf, 34; antique, 34.

MACAULAY ON SCOTLAND. A Critique from HUGH MILLER'S "Witness." 16mo, flexible cloth. 37 cts.

CHAMBERS' CYCLOPÆDIA OF ENGLISH LITERATURE. A Selection of the choicest productions of English Authors, from the earliest to the present time. Connected by a Critical and Biographical History. Forming two large imperial octavo volumes of 700 pages each, double-column letter press; with upwards of three hundred elegant Illustrations. Edited by ROBERT CHAMBERS. Embossed cloth, 6.50; sheep, 7.50; cloth, full gilt, 9.00; half calf, 12.00; full calf, 16.00.

This work embraces about *one thousand Authors*, chronologically arranged, and classed as poets, historians, dramatists, philosophers, metaphysicians, divines, &c., with choice selections from their writings, connected by a Biographical, Historical, and Critical Narrative; thus presenting a complete view of English Literature from the earliest to the present time. Let the reader open where he will, he cannot fail to find matter for profit and delight. The selections are gems—infinite riches in a little room; in the language of another, "A WHOLE ENGLISH LIBRARY FUSED DOWN INTO ONE CHEAP BOOK."

☞ THE AMERICAN edition of this valuable work is enriched by the addition of fine steel and mezzotint engravings of the heads of SHAKSPEARE, ADDISON, BYRON; a full-length portrait of DR. JOHNSON; and a beautifiul scenic representation of OLIVER GOLDSMITH and DR. JOHNSON. These important and elegant additions, together with superior paper and binding, and other improvements, render the AMERICAN far superior to the English edition.

CHAMBERS' HOME BOOK; or, Pocket Miscellany, containing a Choice Selection of Interesting and Instructive Reading, for the Old and Young. Six volumes. 16mo, cloth, 6.00; library sheep, 7.00.

ARVINE'S CYCLOPÆDIA OF ANECDOTES OF LITERATURE AND THE FINE ARTS. Containing a copious and choice Selection of Anecdotes of the various forms of Literature, of the Arts, of Architecture, Engravings, Music, Poetry, Painting, and Sculpture, and of the most celebrated Literary Characters and Artists of different Countries and Ages, &c. By KAZLITT ARVINE, A. M., author of "Cyclopædia of Moral and Religious Anecdotes." With numerous illustrations. 725 pp. octavo, cloth, 4.00; sheep, 5.00; cloth, gilt, 6.00; half calf, 7.00.

This is unquestionably the choicest collection of *Anecdotes* ever published. It contains *three thousand and forty Anecdotes:* and such is the wonderful variety, that it will be found an almost inexhaustible fund of interest for every class of readers. The elaborate classification and Indexes must commend it especially to public speakers, to the various classes of *literary and scientific men*, to *artists, mechanics*, and *others*, as a DICTIONARY *for reference*, in relation to facts on the numberless subjects and characters introduced. There are also more than *one hundred and fifty fine Illustrations.*

BAYNE'S ESSAYS IN BIOGRAPHY AND CRITICISM. By PETER BAYNE, M. A., author of "The Christian Life, Social and Individual." Arranged in two Series, or Parts. 12mo, cloth, each, 1.75.

These volumes have been prepared and a number of the Essays written by the author expressly for his American publishers.

THE LANDING AT CAPE ANNE; or, THE CHARTER OF THE FIRST PERMANENT COLONY ON THE TERRITORY OF THE MASSACHUSETTS COMPANY. Now discovered, and first published from the ORIGINAL MANUSCRIPT, with an inquiry into its authority, and a HISTORY OF THE COLONY, 1624–1628, Roger Conant, Governor. By J. WINGATE THORNTON. 8vo. cloth 2.50.

☞ "A rare contribution to the early history of New England."—*Journal.*

318, 328

MBL/WHOI LIBRARY
WH 18FC %