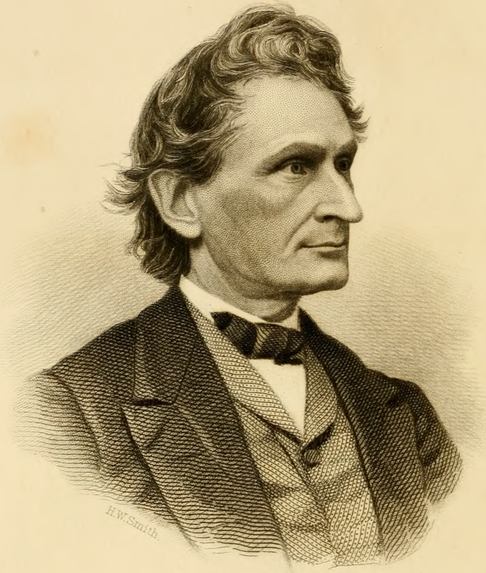


James D. Dana

Engd. for the Annual of Scientific Discovery 1869

Gould and Lincoln, Boston.

ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1869,

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

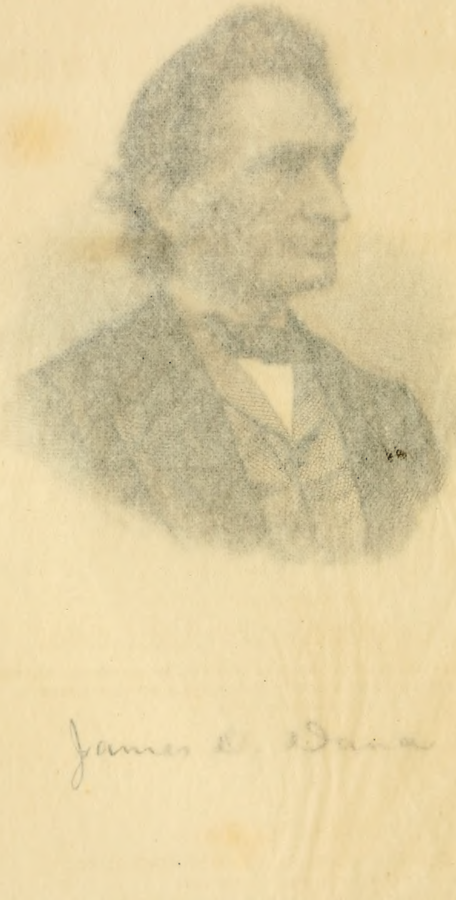
NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1868; A LIST OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF EMINENT SCIENTIFIC MEN, ETC.

EDITED BY

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

FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, SECRETARY OF AND INSTRUCTOR IN ZOOLOGY 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.
1869.



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ROCKWELL & ROLLINS,
PRINTERS AND STEREOTYPERS, BOSTON.

NOTES BY THE EDITOR,

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1868.

DURING the year 1868 the civilized world seems to have been in a state of extreme scientific tension, — discovery after discovery, and invention after invention, following each other so closely, that the chronicler of its progress is tempted to exclaim in the words of another, "If knowledge be power, then indeed is man getting powerful. To what is it all tending? What limit of knowledge can man attain?" The time was when the harvest of discovery was reaped only centuries after the seeds were planted; now a man may live to see both seedtime and harvest, and the poor inventor of to-day will be the millionnaire of to-morrow. "Wheatstone has lived to see the junction of two hemispheres by an invention at whose birth he was present."

This is emphatically the age of steel. Steel rails, steel boilers, steel in machinery, steel in construction, are fast superseding iron for the same purposes. The manufacture of steel is undoubtedly to be the most important and extensive in the world; and America is, beyond all others, the country of good iron ore. We have an inexhaustible supply of the best quality of iron ore, and an apparently inexhaustible supply of fuel to work it with; and are of necessity interested in any improvements in the manufacture of steel.

Among the noteworthy improvements in the manufacture of steel, to which the reader's attention is called in the present volume, are the processes of Bessemer, of Hargreaves and Heaton, of Whelpley and Storer, and of Ellershausen, the furnaces of Siemens and Wilson, and the use of pulverized fuel. In the Bessemer process, in which the metal is decarbonized by a blast of air passed through it, the spectroscope has been successfully employed to determine the exact moment of complete decarbonization, rendering the product more uniform in quality, and less dependent on the skill and attention of the workmen. In the second process above named, oxygen gas, disengaged from nitrate of soda, passes up through the molten metal, removing, it is claimed, not only the carbon, but the sulphur, silicium, phosphorus, and other impurities. It can render available very inferior qualities of iron ore, and there is an ample supply of the nitrate in various countries. In the third process mentioned (see p. 17), steel is made directly from the ores, even very impure ones, by the employment of the intense heat from pulverized fuel, with the powdered ores in connection with proper fluxes; occupying only 8 hours from the crude ore to the finished steel bar, instead of the several days of the usual processes, and at 50 per cent. less cost; making steel of any required quality, and combined with any desired alloy. Chrome iron is coming into extensive use, on account of its exceeding hardness; the ore is very abundant in Delaware and Pennsylvania. From the high temperature of the Siemens regenerative gas furnace, steel may be made on its open hearth by the mutual reaction of pig and wrought iron upon each other, in this way utilizing waste material unsuitable for the Bessemer process, and applicable in many localities deemed unfavorable to the production of steel. In the Ellershausen process, (see p. 122), two new metallurgical principles are carried out: namely, 1. That cast iron thoroughly intermingled with oxides will not melt; 2. That any impurities in the mixture thus effected are removed by reheating. The practical application of these consists in forming a conglomerate of the liquid cast iron, as it runs from the blast furnace, with a sufficient amount of oxide (crude ores pulverized), and subsequently heating this conglomerate to a welding heat. This process, which is considered by prominent iron masters as the most important yet discovered for lessening the cost and improving the quality of their manufactures, is fully described in the "Pittsburgh Gazette," for Jan. 26, 1869.

In an address by George Robertson, President of the Scottish Society of Arts, in Nov., 1867, occur the following remarks on the effect of trade unions on the prosperity of the country, much of which may be applicable in the United States at the present time.

"It appears to me that, in interfering so much with individual labor, these unions tend to undo a great deal of what the introduction of machinery has done to make England great and prosperous. Machinery tends to equalize labor, and to bring it to one standard; but it is to the highest possible standard. Machinery puts the child on the level with the adult. It enables any one of sufficient intelligence to attend a machine to do as much work, and as good work, as the most skilful man. Machinery spreads a given quantity of work over the fewest possible hands. But what are the unions doing? Their object is to bring down labor to the lowest practicable standard, and to lower the work of the adult; to prevent a man of industry and intelligence from doing more than a fixed low average of work; in short, to spread a given quantity of work over the greatest number of hands. Trade Unions are, therefore, antagonistic to machinery, and the introduction of the latter, instead of hand labor, into every department of industry, is one of the means of counteracting their bad effects. I do not, however, consider that strikes and unions are interfering with the general progress of arts and manufactures, or the civilization of the world at large. On the contrary, their tendency is perhaps to benefit the general cause of civilization, by improving the resources of other countries . . . . . . The price of labor in this country, combined with the low standard of work allowed by the unions and the uncertainty in the labor market, which prevents manufacturers entering into large contracts with safety, must break down some of the monopoly we have enjoyed, especially in the iron trade. It is for the working men of England seriously to consider whether they are wise to follow a course of action which may drive away trade to countries fully prepared, by low wages, by a high standard of technical education, by the introduction of railways, and by the development of mineral wealth, successfully to compete with us in the markets of the world."

The limitation of times of labor, the depression of the sober, industrious, and most skilful workmen to an average level of the more idle and unskilful; the exclusion of apprentices, and the dire effects in other branches of the trade or manufacture in which, without wishing to strike themselves, the workmen are dependent on the continued labor of others who will not work, — naturally drive capital away into other countries or other trades, and thus leave the infatuated workman with worse prospects of success than when he began the strike. There have been suggested as a powerful mode of co-operation, because it appeals more directly to the self-interest of the working-classes, industrial partnerships in which the masters and workmen may unite together, by the adoption of which it is believed the greater part of the difficulties between labor and production would vanish.

The "Scientific American" truly says: "The abolishment of the system of apprenticeship in this country, and the introduction of planers, engine lathes, and other labor-saving machines into the machine-shops have produced a scarcity of good workmen. The effect of the former has been to encourage a class of half-trained mechanics, who, having gained sufficient knowledge to enable them to perform certain kinds of work, and at that to obtain living wages, are content to remain without further effort at improvement. The introduction of machinery to perform what was formerly done by hand has obviated the necessity for that skill in manipulation and nice training of the eye, which in former times were essential for all kinds of work. It is a common thing to find men who can attend a lathe, or run a planer, who are utterly incapable of doing work with a file, and who, if they were set to constructing any machinery requiring nice fitting throughout, would utterly fail. The exceptions to this are rare, and we are afraid they are becoming more so. Mechanical engineers are frequently troubled to find workmen who can properly execute their designs. Especially is this so where new forms are introduced into machinery, when a general lack of resources and expedients will most probably manifest itself.

"The training of the eye, in which most deficiency is found, owing to the substitution of engine-lathe work for hand turning, and planing for the old-time chipping and filing, might easily be obtained by practice in drafting, which demands both skill of hand and eye, and to most mechanics would be found a pleasant recreation as well as a valuable accomplishment.

"If we expect good workmen we must have educated apprentices. In every business but that of mechanics a proper preparation is expected and exacted. Let our mechanical apprentices be compelled to pass a suitable examination after a suitable training and we shall have good workmen."

In this connection, it is a noteworthy fact that technical schools are springing up all about us, much needed exponents of the new and practical education.

Mr. Joseph Whitworth, the most noted of English mechanical engineers, from his connection with the improvement of machinists' tools and the perfection to which he has brought their manufacture, has donated £100,000 to the endowment of thirty scholarships of £100 per year for the education of engineers. It is worthy of note in speaking of such beneficence that, in England, as in our own country, the more earnest efforts to extend the facilities for popular education and mental advancement have been made by those who, as a general rule, have owed the least to such agencies in their own elevation, and the most to their own energy and perseverance. The munificence of Mr. Whitworth is a case in point parallel with that of Mr. Peter Cooper, who founded the Cooper Institute, in New York city; and both stand out in strong contrast to the old-time usage of endowing educational institutions by *will*, and leaving all the good capable of being secured thereby to be accomplished by the management of others after the death of the donors.

The object in making this endowment is to advance the cause of technical education, and the promotion of engineering and mechanical industry in his own country. In competing for these scholarships, proficiency must be shown in the use of one or more of the following classes of tools: the axe, file, saw, and plane, hammer, and chisel, and the forge; also a satisfactory knowledge of elementary mathematics and mechanics, practical and descriptive geometry, and free hand drawing. By making these requisites, the student, combining some practice with theory, and the artisan, who combines some theoretical knowledge with perfection of workmanship, start on fairly equal terms.

In carrying out the ideas of Mr. Whitworth, the successful competitors for these prizes may attend universities or colleges affording scientific or technical instruction, or they may travel and study abroad.

The Suez canal is steadily approaching completion, and will probably be open to the commerce of the world before 1870; changing the direction of the greater part of the shipments between the East Indies and Europe as well as America. The next great inter-oceanic canal will be between the Gulf of Mexico and the Pacific across the Isthmus of Darien, to which the attention of engineers and capitalists is now seriously turned. Another much-needed canal is one across the upper part of Florida, from the Atlantic to the Gulf of Mexico, which would save annually scores of lives and millions of treasure, and bring the gulf ports many days nearer to the northern cities.

In telegraphic communication two important improvements have been made in this country. The compound telegraph wire of Mr. M. G. Farmer, with a core of steel wire for strength, and a covering of copper wire, instead of galvanized iron, for conduction, renders these invaluable lines of communication stronger, lighter, and better conductors than the larger wires in ordinary use.

Another important recent improvement in Telegraph Instruments is the invention of a double transmitter by Mr. J. B. Stearns, of Boston, which consists of an apparatus capable of transmitting messages in opposite directions over a single wire, at one and the same time. Several previous attempts had been made and large sums expended, both in this country and Europe, to accomplish this object, but without developing any system of practical value.

This instrument (which, for the sake of a name is called "The Franklin") was first attached to a circuit of nearly 250 miles of wire, in March, 1868. So satisfactory was the result, that on the following day the invention was attached to a wire between Boston and New York, and since that time has been in constant and successful operation, bringing the capacity of the wire to which it is attached fully up to that of two separate wires operated by the ordinary Morse system, working in all weather as prompt and reliable as any of the other wires in the same office. In April, a second set of these instruments was placed upon a wire between New York and Philadelphia, and is now working with success.

Since the introduction of the Ransome process, the manufacture of artificial stone has become an extensive branch of industry in this country, and one of great value in localities, as in the West, where building stone is scarce.

Among the most important of the improvements of the year are the methods of preserving animal food, which, by simple and cheap chemical processes, promise to remedy the insufficiency of the supply of meat in our large cities by drawing upon the inexhaustible living herds in Texas, on the great prairies, and in South America; preserving the meat in bulk, without salt or desiccation. The most notable are those of Prof. Gamgee, by carbonic oxide and sulphurous acid gases, and of Dr. Sim, by the bisulphide of carbon.

In the use of paper for articles of utility we are fast overtaking oriental nations, employing it as a substitute for leather, for wood, for cloth, and even for making boats and dwellings.

Chemistry during the year has been largely extended, not only in the development of the carbon compounds, but in the synthetical or artificial formation of organic substances. Recent observations (see pp. 187, 188) go to show that there is no natural barrier between organic and inorganic chemistry, since chemists are able to ascend step by step from inorganic substances to some of the most complicated bodies secreted by animals and vegetables.

It has been reported in the journals that Prof. Graham, master of the Mint, has lately discovered the metallic base of hydrogen, or hydrogenium. He writes to Prof. Horsford as follows: "I am at this moment closing a paper to show that palladium, with occluded hydrogen gas, is an alloy of hydrogenium, — a white magnetic metal, of specific gravity about 2, appearing to have considerable analogy to magnesium." Should this discovery be verified, the field of chemical research is incalculably extended.

Among the improvements in the chemistry of common life may be mentioned the oxygen gas-light, which is more purely white, much more brilliant, more steady, and far less heating than any gas or ordinary flames. It is used with coal gas, the oxygen being cheaply supplied in sufficient quantity for its consumption, the carbon being wholly consumed, without the air being deprived of its oxygen to aid the combustion; beside these advantages, it is also more economical.

The utilization of the deodorizing properties of dry earth solves the difficult problem of what to do with human excreta in scattered populations, or in places where many persons are confined, from sickness or crime, and where the drainage is poor or neglected, — converting a nuisance and a constant source of disease into a valuable fertilizer.

Prof. David Forbes, in his researches in chemical geology, lays great stress upon the correlation of forces, and upon the compound and convertible action of these forces in explaining geological phenomena. There is something more to be considered than the mere Plutonic or cataclysmic and the Neptunic or quiescent theories; not only heat and water, but chemical action, light, electricity, magnetism and mechanical force, form important elements in these questions. Mechanical force may cause development of heat, and thereby chemical action, accounting for many of the facts of metamorphism and other disputed points in geology.

The fungoid origin of most, if not all contagious, epidemic, and malignant diseases, affecting both man and animals, and frequently transmitted by animals to man, is generally accepted by physiologists. Earth, air, and water teem with the germs of fungi, in great part originating in human excreta, and gaining admission into the animal body through food, drink, and breath. To prevent the vivification of these germs in the living body, both in medicine and surgery, carbolic acid is the best substance yet discovered.

The recent deep-sea dredgings between Florida and Cuba have revealed new and unexpected forms of life in the ocean depths, proving the existence of a large and varied fauna at a depth between 400 and 700 fathoms.

The theory of Darwin, of the origin of so-called species by "natural selection," seems to be steadily gaining ground among zoölogists. The apparently insurmountable difficulty of hybridism no longer stands in the way. Admitting that, as a rule, widely diverging types, or what are styled "species," are infertile with each other, we know that, as we descend in the animal scale, the crossing of many so-called species under certain conditions actually increases fertility; and the only escape from making this admission in many cases is by reasoning in a circle, and calling species varieties because they are fertile.

Says a writer in the "Quarterly Journal of Science," for July, 1868, "As we consider the terms 'variety,' 'species,' 'genus,' etc., to have been introduced into natural history by man for the guidance of his own limited intellect, and to have no actual existence in nature, we are unable to find any rational objection to the broad principle laid down by the author and his predecessors holding similar views, that all new forms of life are and have been modified descendants of pre-existing ones. Nor have we ever been able to see any other rational mode of accounting for the progression of nature. . . We conceive that at least sufficient valid evidence has now been laid before the scientific world to justify the acceptance, pure and simple, of the law of descent by modification, from the operation of which law there is no reason whatever to exclude man; and all unbiassed thinkers will now expect from the opponents of that theory that they will desist from attacking the new and rational doctrine with absurd theological denunciations, or with quibbles concerning the precise nature of the zoölogical term 'species;' but that they will put forward a clear defence of some definite doctrine of their own; will explain with ordinary clearness how they believe new types really have been introduced; and will support their defence by well-established scientific data."

"The facts are strongly in favor of the formation of new species by modified descent, and what evidence have the advocates of the opposite theory to advance in its favor? Indeed, it is difficult to find out what their theory really is, or, rather what their theories are, for it would hardly be possible to find half-a-dozen Anti-Darwinians who, if they think at all, think alike. . . But with the exception of a few thinking observers, the measure of whose information is only exceeded by their caution, which prevents them from accepting the new theory, the large majority of its opponents are really such reasoners as we have described. And it appears to us that the acceptance of the theory will depend more upon the decline of superstition than upon the ascendancy of knowledge."

"Though the author doubts the constant interposition of a designing mind in nature," a careful reading of his works will show "how thoroughly ungenerous, or how utterly ignorant, are those who brand his theory as atheistical and him as an atheist." Mr. Darwin's theory relates only to the *form* of life, not to the *principle* of life, still less to the moral principle or the *soul*. Says Dr. J. D. Hooker, in his address as President before the British Association in 1868, "So far from natural selection being a thing of the past, it is an accepted doctrine with every philosophical naturalist, including, it will be always understood, a considerable proportion who are not prepared to admit that it accounts for all Mr. Darwin assigns to it."

Says Prof. Tyndall, in his address before the British Association in 1868, "The process of things upon this earth has been one of amelioration. It is a long way from the iguanodon and its contemporaries to the members of this association. And whether we regard the improvement from the scientific or the theological point of view, as the result of progressive development, or as the result of successive exhibitions of creative energy, neither view entitles us to assume that man's present faculties end the series,— that the process of amelioration stops at him. A time may therefore come when this ultra-scientific region by which we are now enfolded may offer itself to terrestrial, if not to human, investigation. Two-thirds of the rays emitted by the sun fail to arouse in the eye the sense of vision. The rays exist, but the visual organ requisite for their translation into light does not exist. And so from this region of darkness and mystery which surrounds us, rays may now be darting which require but the development of the proper intellectual organs to translate them into knowledge as far surpassing ours, as ours does that of the wallowing reptiles which once held possession of this planet."

In an essay "on the origin of mankind," Dr. Haeckel gives his reasons for inferring that man has come into being by a process of development from the lower animals; and he regards the "Lamarck-Darwin" hypothesis as precisely equivalent to that of the "Copernicus-Newton" system of astronomy; for, while the latter proved the error of the old geocentric system, the former shows the falsity of the anthropocentric belief that looks upon man as the centre of an animate world created only to supply his wants.

The remarkable eclipse of the sun, of August 17 was faithfully observed by astronomers sent by England and France to India, and also by resident astronomers there, as very important questions in solar physics were to be settled by their observations. From spectroscopic examinations during the eclipse, the red protuberances of the sun were, by universal admission, shown to be gaseous in their nature. The comets of the year, and especially Brorsen's, have also been submitted to the spectroscope by Mr. Huggins, Father Secchi, and others, and have been found to have spectra like that of carbon, — a most interesting fact; these bodies are consequently believed to shine not merely by reflected solar light, but to be self-luminous.

In regard to the statements of Mr. Abbott, regarding the changes in the figure and aspect of the nebula round η Argus, not only in the luminosity of the nebula but in the arrangement of the nebulous masses and of the fixed stars strewn over the nebula, Sir J. Herschel says, in "Proc. Royal Astronomical Society, 1868," "There is no phenomenon in nebulous or sidereal astronomy presenting anything like the interest of this, or calculated to raise so many and such momentous points for inquiry and speculation. The question here is not one of minute variations in subordinate features, which may or may not be attributable to differences of optical power in the instruments used by different observers, as in the case of the nebula in Orion, but of a total change of form and character, a complete subversion of all the greatest and most striking features — accompanied with an amount of relative movement between the star and the nebula, and of the brighter portions of the latter *inter se*, which reminds us more of the capricious changes of form and place in a cloud drifted by the wind, than of anything heretofore witnessed in the sidereal heavens."

The wonderful revelations of the spectroscope are gradually letting us into the secrets of the cosmos, showing the constituents of the most remote planets. A very bold theory has recently been promulgated ("Atlantic Monthly," February, 1869) on the origin of the solar system, in which the author concludes as follows: "The earth is progressing by excessively slow changes toward the solar and nebulous condition. Its history is a repetition of the solar, and a time must arrive when the surface, becoming incandescent, will be obscured only by casual dark pits in a brilliant atmosphere, — a souvenir of the present darkness of the crust; yet during a certain period, within fixed limits of gravitating force and heat of mass, the human race may continue to exist; progressing, we may suppose, in force and fineness of organization. The race will perish, perhaps, in the order of nature, by failure or insufficient number of offspring, a principal cause of the extinction of superior races. The earth must become lone and voiceless long before the incandescence of the crust. Science may follow it into the condition of an attendant star, and then of an expanding nebula." He discards the popular hypothesis of an earth "gradually cooled from incandescence," and considers the earth as having grown larger and warmer from age to age. "The earth," says he, "began as a small, cold, dark body, whose mass has been, and is gradually increasing by accretion of meteoric matter from space; with its mass its heat has increased, the additions to the surface sustaining and increasing the heat of the centre."

No less progressive has been the science of pre-historic Archæology. In the words of Dr. Hooker: — "This science, including as it does the origin of language and of art, has been the latest to rise of a series of luminaries that have dispelled the mists of ages and replaced time-honored traditions by scientific truths. Astronomy first snatched the torch from the hands of dogmatic teachers, tore up the letter and cherished the spirit of the law. Geology next followed, but not till two centuries had elapsed, nor indeed, till this our day, in divesting religious teaching of many cobwebs of scientific error; it has told us that animal and vegetable life preceded the appearance of man on the globe not by days but by myriads of years. And, last of all, this new science proclaims man himself to have inhabited the earth for, perhaps, many thousands of years before the historic period, and now offers to lead us where man has hitherto not ventured to tread. Each fresh discovery concerning pre-historic man is as a pier built on some rock exposed in the sea of time, and from these piers arches will one day spring that will carry him further and further across its depths."

One of the most important plans lately developed in this country for mechanics and inventors, is the proposed "museum of the elements of machinery" under the auspices of the Massachusetts Institute of Technology. The author of the plan, Mr. S. P. Ruggles, himself a successful inventor, and knowing from experience the unnecessary difficulties encountered by inventors, does not propose to copy the unwieldy collections of models of complete machines, which have elsewhere been made at such cost of time and money, and with such feeble results in facilitating new invention.

The Institute of Technology, therefore, proposes to make a collection of the elements of machinery, and the simple combinations of those elements. Machines consist of infinitely various combinations of simpler parts, which repeat themselves in different proportions or modifications. Mr. Ruggles wishes to make a tangible encyclopædia of these elements of machinery. He proposes to collect and make working models of all the elements; for example, of all the varieties of reciprocating motions; of all the devices for converting a reciprocating into a rotatory motion, or a rotatory into a reciprocating; of all the varieties of cam motions, of quick and slow screws, so combined as to give both speed and power; of eccentric gear combinations; of reversing movements; of contrivances for pressing by means of screws, toggle-joints, cams, and levers; of the different escapement arrangements for watches and clocks; of universal joints like the gimbal and ball and socket joints, and of all other primary mechanical devices by which force and motion are transmitted, directed, or modified.

The proposed classification of models of the elements of machinery would be of especial service to inventors. A mechanical invention consists generally in a new combination of mechanical elements, so as to produce a machine having some new capacity or functions; but the inventor is too often unacquainted with the known elements and simple combinations of machinery. No collection contains them in an accessible form; no catalogue or index directs him to the movements which he needs in his new design. The elements of machinery are not in every-day use among all people, like the elements of language in common speech and familiar writings, but are hidden away in the machinery of scattered shops and factories. The inventor too often has to re-invent, at great expense of thought and money, elements or combinations which have long been in use, but which he has never seen. Even then he may not devise as good methods of producing the desired effects as have been previously invented, and are at his disposition if he only knew of them. The work of the inventor, like that of the author, is emphatically brain-work. But inventors have no such aids in their labor as literary men have. The proposed museum, with its catalogues and indexes, would aid inventors somewhat as libraries, dictionaries, and gazetteers help authors. An inventor, meditating upon his design, sees that he has need of some peculiar movement; but he knows no means of producing that movement. He consults such a classified collection of elementary movements, and sees at once among the various screw movements, for example, that a combination of quick and slow screws is capable of producing the particular movement which he has need of. He is thus saved the labor of inventing for his purpose. This is not an imaginary problem, but one which often actually occurs. Many simple and familiar contrivances are constantly re-invented. Examples will occur to all inventors. Who can tell how often the Archimedean screw has been discovered? Even the cam is constantly invented anew. Inventors have hitherto been too much left to their own unaided mental resources. Dictionaries and glossaries do not replace genius, nor make one talent go as far as ten; but they are important aids to genius, and they enable common men to do much accurate and useful work. So this collection of elementary models, will not diminish the field for inventive genius; but it will instruct inventors as a class in what has already been done, and it may be expected to prevent in some measure the waste of time and strength involved in reinvention.

The American community is made possible by American and foreign invention. The crops of the West could neither be harvested nor brought to their distant markets without the mechanical reapers, rakes, threshers, hullers, elevators, and cheap railways by which they are handled. The American dwelling-house is full of devices, great and small, to promote the comfort or luxury of its inmates. Education and liberty owe much to the inventors of power printing-presses. By the telegraph, the railways, and the swift steamers, this continental republic is made practically smaller than little England was fifty years ago. One man, with the aid of coal and the mechanical appliances which inventors have created, can do more work, or produce more wealth in a day than a thousand could without these aids.

We present the readers of the ANNUAL OF SCIENTIFIC DISCOVERY for 1869, with a fine portrait of JAMES D. DANA, LL. D., Professor of Natural History and Geology in Yale College. PROF. DANA is one of the most distinguished mineralogists living, and is equally eminent as a geologist and zoölogist. His works are regarded as standard authority both in this country and in Europe.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

MECHANICAL PROPERTIES OF IRON AND STEEL.

Bessemer has effected a revolution in the manufacture of iron and steel; and the present improvements exhibit a means of development by which the former will ultimately double its strength, and in the state of steel be substituted for purposes of construction. The result of this change, when applied to structural purposes, is considerable, as half the weight of steel is equal in strength, and consequently is cheaper than a given weight of iron. In almost every case where iron is at present used steel would then be employed; it only requires certainty and uniformity of character in its manufacture, to insure its superiority and extend its application. This has not as yet been accomplished; but the Bessemer process, by depriving the crude metal of its carbon in a separate vessel, certainly tends in that direction; for by this process increased facilities are not only afforded and new combinations formed, but the introduction of measured quantities of the same metal, containing the requisite quantity of carbon, poured into the converting vessel, appears to be the only true principle on which steel, in its varied conditions of ductility, tenacity, etc., can be produced. These quantities, when duly proportioned, indicate the quality of the steel to be obtained from this process, and when cast into ingots are ready either for the forge or the rolling-mill. From this it will be seen that every description of homogeneous iron or steel may be produced, care being taken to ascertain the exact percentage of carbon requisite to be infused in order to combine with the mass of refined metal.

The old method employed in the converting furnace, with the bars embedded in charcoal, required at least a fortnight for the refined iron to absorb the necessary quantity of carbon to form steel. By the new system steel is produced in the Bessemer vessel in less than 20 minutes, whereby a great saving of time, fuel, and other expenses is effected.

The process may be briefly described as follows: A quantity of pig iron, containing an average quantity of carbon, say 5 per cent., is melted in one or more reverberatory furnaces, according to the size of the converting vessel to be used, which varies in capacity from 5 to 10 or 12 tons. When the metal becomes fluid, it is run into the converting vessel, to which is applied a strong blast of air, which combines with the carbon at an intense white heat. This is continued for about 8 or 10 minutes, until the whole of the carbon is consumed, when the blast is stopped. In this stage a quantity of metal, containing the requisite percentage of carbon necessary to form the exact quality of the steel required, is poured into the vessel, and this, combining with the refined iron, gives to the mass all the properties and characteristics of steel. The converting vessel may be placed so near to the blast furnace as to allow the iron to flow directly into it; or the metal, in the shape of pig iron, may be melted in reverberatory furnaces, as is now generally the case, and thence run directly into the converting vessel.

From tables showing the comparative values of steel when subjected to transverse, compressive, and tensile strains, it appears that the mean of all the specimens experimented on is greatly in excess of iron, which, taken at a breaking strain of 20 tons per square inch of section, gives a ratio of 43.46 : 20, or as 2.17 to 1, being more than double that of iron in its resistance to tension; clearly showing the advantages which steel has over iron in its malleable state, and the important benefits which it is likely to confer when rightly applied in constructive art. The experiments also indicate the superior resisting powers of steel to a force tending to crush it, and its superiority to iron in all the varied forms of resistances to strain to which it may be subjected.

That the time is not far distant when steel will supersede iron in almost every case where strength is required, we have every reason to believe, and, assuming that the change will be of great national benefit, we shall hail with the liveliest satisfaction the disappearance of iron and the substitution of steel as a superior material for general purposes of construction. — W. FAIRBAIRN, *in Quarterly Journal of Science, January*, 1868.

THE SPECTROSCOPE AND THE BESSEMER PROCESS.

The application of the spectroscope for conducting the charges in the Bessemer apparatus has become a practical reality. By the aid of this instrument the manufacture of Bessemer steel, in the Gratz (Austria) works, has been considerably improved with regard to that exact uniformity of hardness which formerly was more difficult to insure under all circumstances. The great certainty with which the exact moment of complete decarburization can be fixed by spectral analysis has reacted upon the amount of care now bestowed upon keeping the percentage of carbon in the spiegeleisen to a uniform or at least to a correctly ascertained amount, and regulating the quantity of spiegel employed by exact calculation. The accidental irregularities and differences of hardness between the different charges have thereby been lessened to a very considerable extent, and an increased reliability has by these means been given to the Bessemer process.

The spectrum pointed out by Prof. Liellegg ("Austrian Gazette for Mining and Metallurgy") belongs to the flame of carbonic oxide. It can be seen in the flame escaping from the mouth of the converter during the preliminary operation of heating this vessel with coke only; in that case the lines referred to are very faint, and it requires some practice, or knowledge of the precise spots in the spectrum where these bright lines should be looked for, to discover them. During the first period of the Bessemer process the spectrum is very faint; the yellow portion is almost invisible, and even the sodium line is missing; the blue and purple portions are extremely faint. The absence of the sodium line can be accounted for only by the consideration that there is no real flame formed by incandescent gases escaping from the converter at that early stage, but only a mass of sparks carried by the nitrogen from the blast, the oxygen of which remains in the converter, combining with silicium. As the flame gradually appears in the centre of the volley of sparks, the spectrum widens and shows yellow light, until suddenly the sodium line in the yellow field becomes visible, at first, only for moments, as a flashing bright streak, and after less than one minute as a constant and clearly defined line. The appearance of the sodium line marks the commencement of the decarburization, although this line does not belong to the charge of iron at all, but rather to the accidental presence of sodium compounds in very minute quantities. It is, therefore, only indirectly connected with the combustion of carbon; that is, the appearance of the sodium line is a signal of the completion of the continuous spectrum, and this continuous spectrum belongs to the combustion of carbon. As soon as the sodium line has taken a steady and permanent appearance, the characteristic lines of the carbonic oxide may be looked for in the greenish-yellow, in the green, and in the purple field. In each of these three fields one bright line becomes clearly visible at that time. As the flame increases in size and brilliancy, the spectrum comes out more and more clearly; bright lines increase in number in each of the first-named three fields, and ultimately, at the height of the process, some bright lines show themselves in the red, and occasionally, also, in the blue field; the green field of the spectrum, however, is the real point of observation in practice, as in this the lines are most clearly visible, and in it they appear first and disappear last. The spectrum, as a whole, is by no means steady or constant, but its fluctuations do not displace any of the bright lines; they only alter the background or the continuous spectrum upon which they appear. After the "boil" the maximum intensity is reached; and at that stage, and only with very hot charges, a bundle of bright lines appears in the bluish-purple portion of the spectrum. About 4 or 5 minutes before the end of the charge of 3 tons, the lines begin to disappear in rapid succession, and in the inverted order of their appearance, — first, the bluish-purple, then the blue lines, after these the red, etc. When the last green line disappears, the vessel is turned, and the charge completed by the addition of spiegeleisen. The yellow sodium line does not disappear to the end of the operation. Sometimes the vessel is turned, when all lines in the green field with the exception of two have disappeared. This depends upon the special experience of the case, and it is clear that it is of less importance whether the one or the other mark be taken, if it is only regularly adhered to, and the charge of spiegeleisen regulated accordingly. The practical results are highly satisfactory, since they make the regularity of the "temper" of Bessemer steel practically independent of the skill and experience of the charge-manager, the changes of the spectrum being made more marked and unmistakable than those of the appearance of the flame itself.

It is highly probable that careful trials and observations in this country will prove very similar to those observed with Styrian charcoal iron. By the use of the spectroscope the steel-makers will be able to show to the disbelievers in the uniformity of Bessemer steel that a child may conduct the charge without the least chance of error, just the same as a boy can now work the whole mechanical apparatus of the converters; the steel-masters will become less dependent upon the skill and attention of their charge-managers and foremen, and the percentage of waste or unsuitable material produced by carelessness, or mistakes, will be lessened in the general run of practice. — *Engineering.*

According to the "London Chemical News," of April 3, 1868, Prof. Liellegg was anticipated in regard to the spectrum of the Bessemer flame, by Prof. Roscoe of England, in 1862.

MANUFACTURE OF STEEL.

Mr. F. Kohn, at the 1868 meeting of the British Association, read a paper on the recent progress of steel manufacture. The process of making steel upon the open hearth of a Siemens' furnace, by the mutual reaction of pig and wrought iron upon each other, recently introduced into England, realized the old idea of melting wrought iron in a bath of liquid pig iron, and thereby converting the whole mass into steel. It was distinguished from previous unsuccessful attempts by the high temperature and the non-oxidizing flame produced by the regenerative gas furnace, and by the method of charging the decarburized iron into the bath of pig iron in measured quantities. He stated that by the process the production of any desired temper of steel could be relied upon with absolute certainty. In the most successful charges the ball was made from a mixture of white Swedish iron and of spiegeleisen, and a quantity of the latter was added at the end of the operation. Into these charges Cleveland bars entered in the proportion of one half. The steel thus produced was very soft and of fine quality, and was chiefly used for boiler plates. The prime cost of the steel thus manufactured was about £7 10s. per ton, the same as that of the Bessemer steel ingots made from hematite pig iron. This process was of vast importance in many localities, as it was applicable to the conversion of old materials of wrought iron and steel, could utilize the waste and offal of other processes, and could be introduced into localities where the ore had hitherto been deemed unfavorable to the production of steel. There need be no rivalry between this and the Bessemer process, as the two worked with different materials. One of its chief applications was that of the conversion of old iron rails into steel. There can be no doubt that, in the course of time, the improvements making in the manufacture of steel would tend to reduce the price of steel almost to the present price of iron.

WHELPLEY AND STORER'S PROCESS FOR MAKING STEEL DIRECTLY FROM THE ORES.

The most ancient process for making steel produced it directly from the ore. By this method was made the fine steel of India for Damascus blades.

In more modern times many methods have been originated to produce steel from foreign and American ores, with but moderate success. The celebrated process of Chenot, in France, was by far the most successful of these, but failed, where all the others have failed, in its economy when compared with other and longer established methods of steel-making, which employed not ore, but either cast or wrought iron. In another important point all have failed, and that is in the production of steel from iron ores containing sulphur, phosphorus, and other impurities, in appreciable quantities. Meanwhile, good steel has not been produced from pig or bar metal by the Bessemer or any other method, when the raw material is so contaminated.

Messrs. Whelpley and Storer have overcome the objections to the use of impure ores, and easily and surely make good steel from them.

Their process is simple, and accomplishes in the large way what is done in the laboratory upon small quantities. The ores are first very finely pulverized in conjunction with those fluxes, reagents, and metallic oxides, well known to chemists as the proper purifiers. This first step secures the purity of the metal. They then subject this prepared mixture to a current of heated oxide of carbon gas, the same that is generated and used for the reduction of iron ores in all the known processes for making iron and steel.

Their method of generating the reducing agent is extremely rapid and economical. Oxide of carbon, or the gas of coal imperfectly or half burned, or oxidized, is the agent of iron and steel making in the German and English smelting furnaces, in the puddling and boiling furnaces for making steel and bar from pig iron, and the formation of this gas is no less the cause of steel and iron production in the well-known Bessemer process.

By the method of Messrs. Whelpley and Storer, a powerful oxide of carbon blast or "deoxidizing flame" is generated by a peculiar machine, of their device and construction, which imitates the mechanism and reproduces on a grand scale all the results of the chemist's blow-pipe. The gas is generated at the instant of using it upon the mass of ore, by the injection of a column of hot air carrying an excessively fine dust of coal or charcoal. The ore spread out upon the floor of a common reverberatory furnace receives the red-hot blast, while it is rapidly stirred by the workman, and pure iron, in minute grains, is produced in any desired quantity from 100 to 2,000 pounds or more at a heat.

If the mass is balled up, squeezed, and passed through rollers, it is bar iron. If the time of the process is extended one hour, or even less, the iron absorbs carbon from the blast, and becomes a light sponge of steel, which melts in the crucible or steel puddling furnace, and is cast into ingots of sound and pure metal. If the process is longer continued, larger quantities of carbon are absorbed, and the mass is converted into cast iron.

In the practice of this method there has appeared no difficulty, as yet, in producing either wrought iron, cast iron, or steel, of any degree of hardness and toughness, combined either with manganese, chrome, titanium, or other alloy, in any desirable quantities.

It is easily learned by workmen of fair intelligence, and appears thus far to cost, from the first step of the process to the end, not more than half as much as steel made from good pig or bar metal. A little experience enables the workmen to control the measure of carbonization.

The quality of the steel thus produced is unsurpassed for strength and toughness, and all the diverse qualities of steel for various purposes in the arts are readily communicated to this metal. The fracture of an ingot of the new steel is peculiar and different from others. The mass of the ingot seems to be composed of interlaced fibres crossing each other at various angles. In other words, it is a closely woven texture of long acicular crystals. This structure strongly contrasts with the varieties made from pig iron, and gives it extraordinary toughness, and in fact a good lamination and longitudinal fibre by the first action of the hammer and rolls.

The time occupied in the producing of this steel is singularly short, only 8 hours from crude ore to finished bar; while steel made from bar or pig iron requires many days, the ore being made into bar or pig, and the steel from these by a third and still more costly operation.

In order to use pulverized carbon in a large metallurgical blowpipe several inches in diameter, carrying a swift column of air, it must be reduced to a degree of fineness exceeding the capacity of any machines hitherto invented, except those of Messrs. Whelpley and Storer.

A cubic inch of coal must be broken into several trillions of atoms, extending the surface from 6 square inches to more than 300 square feet. Solid carbon in this condition must carry condensed upon its surface nearly enough oxygen to consume it. Hence extreme rapidity, intensity, and thoroughness of combustion.

The same is true of the iron or any fluxes which are reduced by similar machinery, but not to so great a degree of fineness. The action of deoxidation and carbonization, and other chemical reactions, is thus practically instantaneous and complete.

ECONOMICAL MANUFACTURE OF IRON: IMPROVED FURNACES.

At the meeting of the British Association at Norwich, in 1868, Mr. J. Jones read a paper, in which he referred to the economical application of fuel in the iron manufacture, more particularly in the finished iron processes, and remarked that the newer blast furnace plant left little to be accomplished in the economical use of fuel, except in utilizing the waste products given off in coking the fuel. In puddling, however, great waste of fuel went on, and two modifications of the ordinary puddling furnace were to be noticed as calculated to save from 20 to 25 per cent. of fuel, and to consume all the smoke usually produced. The Wilson furnace, in its most improved form, consisted of a sloping chamber, into which the fuel was fed at the top, and the volatile matters generally forming smoke were reduced by passing over the incandescent mass of fuel farther along the chamber. The air for combustion was delivered into the furnace in a heated condition, and a steam-jet was delivered underneath the grate, by means of which the formation of clinkers was avoided. The Newport furnace had a chamber constructed in the ordinary chimney-stack, and in this were placed a couple of cast-iron pipes with a partition reaching nearly to the top. These pipes were heated by the waste gases from the puddling furnace, and through them the air required for combustion was forced by means of a steam-jet, and was delivered in front of the grate in a highly heated condition. These furnaces, of which a considerable number were in operation at the Newport Works, effected a saving of at least 25 per cent. in fuel. The author next proceeded to describe the manufacture of iron by what is termed the Radcliffe process, which had been for some time in operation at the Cousett Iron Works, Newcastle. The puddled iron, which was usually rolled into rough bars, straightened and weighed, allowed to get cool; then cut up, piled, heated, rolled into blooms, reheated, and finally rolled into finished iron after a complicated series of operations, was, by the new method, finished off by a continuous and simple process. Five or more puddled balls were put together into a large bloom, under a very heavy steam hammer, shingled down into a bloom, passed for a short time through a heating-furnace, and rolled off into finished iron not more than half an hour after the iron left the puddling furnace. A great saving in the cost of manufacture was represented by this process in all departments of the manufacture of finished iron, and it was calculated that a saving of 1,500,000 tons of coal alone would result from the general application of this system. Particular stress was laid upon the fact that in carrying out this process no extensive or expensive alteration of existing works was required, and a saving of from 3½ to 4 cwt. of puddled iron would be secured upon each ton of finished rails or plates now turned out, the cost of making malleable iron being reduced to a very considerable extent.

The "London Mining Journal" says: "This paper was followed by one by Mr. Siemens, the inventor of the gas furnace, in which he gives some very interesting details of the working of a puddling furnace on his system, claiming extraordinary merit therefor, on account of its producing a larger quantity of iron than the ordinary system of furnace permits. Mr. Cowper stated that, in his opinion, one great cause of the superior yield, as also quality, of the iron was that the great heat of Mr. Siemens' furnace caused it to run more freely from the cinder than was possible in an ordinary furnace.

"Messrs. W. Whitwell & Co., Stockton-on-Tees, put up their first furnace in January this year; it was very successful, but it had grate bars at the bottom, partly to meet the prejudices of the men, and to overcome them. In the month of March Mr. Wilson persuaded them to allow him to put up a furnace without bars, which he did. Forthwith the success was positive; all difficulties had completely vanished. For a little time minor points of construction had to be met; but for some time every furnace was put up exactly like its neighbor, and at this moment nearly all the furnaces at the above works are on Mr. Wilson's system. Several of the works in the district have trial furnaces at work, the results fully bearing out those of Messrs. Whitwell.

"At a trial made by Messrs. Hopkins, Gilkes, & Co. (week 6th to 11th July inclusive) the coals used were 17 cwt., 1 qr., 22 lbs., to the ton of puddled bar; the yield of iron in excess. Another experiment (week ending Aug. 22), the coals used were 16¾ cwt. to the ton; 1¼ tons of fettling saved; iron charged, 13 tons, 16 cwt., 3 qrs., 13 lbs.; iron drawn, 12 tons, 18 cwt., 0 qr., 16 lbs.; loss, 18 cwt., 2 qrs., 27 lbs. Messrs. Richardson, Johnson, & Co., of the North Yorkshire Iron Works, Stockton, furnish a return (Aug. 31), coals, 18 cwt. to the ton of iron; yield 13 lbs. average per heat in excess of ordinary furnace. Messrs. Whitwell & Co. are charging all their patent furnaces 4¾ cwt. per heat, and they find very little loss of iron; the quality is in all cases superior. We think that these statements justify us in saying that the iron masters have an opportunity of saving a large amount of money in the manufacture of iron.

"We will now point out the improvements in the furnace. Air is forced into the flue-bridge by a steam-jet; it passes into a conduit at the back of the furnace, thence into the flame-bridge and up into a chamber, where it arrives red-hot; it thence passes into and on to the incandescent fuel.

"By this arrangement much fettling is saved, being the cause of a great economy. Mr. Siemens states that his furnace used an extra quantity of fettling, which reduced the benefit of his good yield of iron. But to obviate this he adopted water-bridges. They absorb much heat from the furnace, — this gentleman states equal to 8 or 10 pounds of coals per heat. We think this a low estimate, as the getting up has to be taken into account. However, it is obvious that, by the arrangement described above, the heat abstracted by the circulating current of air is restored to the furnace. This forms an important feature in the improvement. The fuel is fed at the highest point of the furnace by a slide door on the standing, and there are proper arrangements for shoring up, when required, also on the standing. A current or currents of air are also forced in below into a closed chamber, by which the cinders are most completely burnt up. The steam being decomposed, passing through the incandescent fuel, transfers the intense heat into the working chamber. The quantity of refuse produced is very small. The clinkers are readily removed with a light hook, and the men are never occupied more than a few minutes in the operation, generally one minute. Thus we are justified in saying this is perfect combustion; it appears to us there is no room for further improvement. But to restore the waste heat into the generator, furnaces are now being put up by Messrs. Hannah & Sons, where pretty nearly all the heat will be regenerated. These furnaces can go to any intensity, and the flame is under perfect control to oxidize or not; or the iron may be drenched with intensely hot air. The cost of alteration to existing furnaces is very small; when erecting new ones about the same price. The advantages obtained are no smoke, no cinders, a large yield of iron, and better in quality. If we assume 25 cwt. of coals used as the Cleveland average for puddling, it appears to be about 8 cwt. to the ton saved. Much fettling is saved, there are less repairs, and no grate bars to replace. We think there is sufficient inducement to ask its adoption."

MANUFACTURING STEEL BY THE USE OF NITRATE OF SODA.

Several attempts have been made to use nitrates in converting iron into steel by placing the substances below the level of the bath of molten metal, and thereby causing the oxygen of the other gases evolved by the decomposition under heat to pass up through the metal. Experience, however, showed that the reactions took place so rapidly and with such force as to throw about the metal. But Mr. Hargreaves has fully comprehended the necessity for finding a remedy for the too rapid decomposition of the salts. The salt taken by Mr. Hargreaves is the nitrate of soda, on account of its cheapness and high percentage of oxygen. The most important function of the nitrate of soda would not, however, so much consist in its decarbonizing powers, as in its being an agent "in removing the metalloids, silicium, sulphur, and phosphorus, and the semi-metal, arsenic, by forming with them compounds of sodium;" the materials are placed below the fused cast iron, and the products of the decomposition rise up through the fused metal.

By taking the nitrate of soda, the quantity of carbon to be removed can be regulated at will by the quantity of nitrate used, and the alkaline residue would "give rise to the formation of silicate of soda, sulphide of sodium, and phosphide of sodium."

The first experiments were instituted at the Widnes Foundry. On finding that the oxygen from the nitrate of soda and the chlorates of potash and soda is evolved so rapidly that it was dangerous at once to pour the molten iron upon them, the use of clay as a diluent, and a retarder of the action of the chemicals, occurred to Mr. Hargreaves. Its successful action in this way in its turn suggested the substitution for it of hematite ore. A cheap oxide of iron would thus, while diluting the action of that other chemical, offer an additional supply of oxygen and an increased yield of metal. The nitrate of soda is therefore mixed with a portion of hematite in order to retard its action, and the slightly moist paste thus composed is pressed into the bottom of a vessel lined with fire-brick. This paste is then dried into a solid block, either by means of the heat left in the vessel after the last operation, or specially produced. When dry, the molten iron is poured into the vessel, and the layers of the composition scraped up. The high ferrostatic pressure soon carries portions into the mass of molten metal, and the reactions take place between them. The molten metal appears to boil, and a frothy slag, said to contain "the impurities extracted from the iron," rises to the top, in company with some oxide of iron and compounds of soda. The metal can then be tapped out. In order to be enabled to apply the process of the puddling furnace, and thus employ established plant, he got over the difficulty of the bottom of the puddling furnace being too hot, and hence at once uselessly decomposing the salt, by making the converting materials into hard, dry blocks. Several such blocks are successively pushed to the bottom of the molten metal in the furnace, the products, of course, rising up as in the fixed vessel. By this means it is said that the puddling operation is shortened, with an attending saving of labor and fuel; and, above all, that the yield is better, from "the soda forming a base which readily combines with the silicic and phosphoric acids eliminated from the iron." Mr. Hargreaves states that he can make refined iron for puddling by the use of about 3 per cent. of nitrate and 6 per cent. of peroxide of iron; steel, by 8 to 10 per cent. of nitrate and an equal weight of binoxide of manganese; and malleable iron, by 8 per cent. of nitrate and 20 per cent. of peroxide of iron, — in each case iron with 5 per cent. of carbon being used. The bulk of the slag produced is materially increased by the presence of the silicate of soda. — *Engineer*.

Mr. Hargreaves further says, that he can by his process obtain a larger yield and a better quality of steel, using iron costing 16 to 20s. per ton less than anything Mr. Bessemer can use, with less cost of plant and labor.

The supply of nitrate of soda is unlimited, a single source in Peru having been estimated to contain 63 millions of tons.

A somewhat similar method, called the "Heaton Process," is thus spoken of by the "Mining Journal": —

"It will be recollected that the process consists in the use of an improved purifying agent, which appears to exercise a most important influence in the removal of the sole impurities which have prevented the ores of Cleveland and Northamptonshire being used in the production of the best quality iron. The Heaton process has been described by Robert Mallet, F.R.S., as one of those metallurgic advances which, both with respect to economy of production and utilization of inferior pig iron, leave their mark indelibly on great national industries. The report of Prof. Miller, of King's College, is quite as satisfactory as that of Robert Mallet. It appears that Prof. Miller visited the works in order to be enabled to report upon the process, and certify that the metal analyzed by him was really the result of the process. The "converter" consists of a wrought-iron pot, lined with fire-clay; into the bottom of this a suitable quantity of crude nitrate of soda, combined with silicious sand, is introduced, and the whole covered with a cast-iron perforated plate. The molten pig is now poured in, and in about 2 minutes the reaction commences. At first brown nitrous fumes are evolved, and these are followed by others of a more watery nature. After the lapse of 5 or 6 minutes a violent deflagration occurred, attended with a loud, roaring noise, and a burst from the top of the chimney of brilliant yellow flame, which, in about a minute and a half, subsided as rapidly as it commenced. When all had become tranquil, the converter was detached from the chimney, and its contents were emptied upon the iron pavement of the foundry. Prof. Miller took samples of the various materials used, and carefully analyzed the iron, both before and after it had been submitted to the process; and, as the result of his experiments, he states that it was proved that the reaction of the nitrate of soda had removed a large proportion of the carbon, silicon, and phosphorus, as well as most of the sulphur; the phosphorus retained was not sufficient to injure the quality of the steel produced. Steel made by the Heaton process has been tested, and the results obtained afford strong evidence that uniformity of quality is practically attainable. With regard to the principle of the process, Prof. Miller considers it to be good, and the mode of attaining the result both simple and rapid. The nitric acid in the nitrate, in this operation, imparts oxygen to the impurities always present in cast iron, converting them into compounds which combine with the sodium, and these are removed with the sodium in the slag. The action of the sodium is one of the peculiar features of Heaton's process, and gives it an advantage over former methods."

MANUFACTURE OF CAST STEEL AND HOMOGENEOUS IRON.

In treating puddled steel, raw steel, and puddled iron, for the production of cast steel and homogeneous iron, the material to be treated has usually been at great expense balled and shingled to clear it from the cinder, and subsequently generally rolled into bars, cut up in pieces, and remelted. According to an invention recently patented by Mr. John Gjers, of Middlesborough, when crude iron or refined iron is caused through the action of iron cinder or other additional matter to boil and to come to nature, the material is transferred under treatment from the puddling even before the process of balling. By remelting or keeping fluid the material, it is caused to separate from the cinder and to attain a uniform quality ready to run into ingots. Thus Mr. Gjers melts crude pig iron, or refined iron, or recarbonized puddled iron, and works it in the usual way in a puddling furnace, and causes it, through the action of rich pure iron cinder or other additional matter commonly used when making puddled steel, — such for instance as manganese and salt, — to boil and to come to nature in the manner adopted for making puddled steel or puddled iron. At or before the stage called top-boil, just before the metal begins to thicken and to come to nature, but before the stage when it is fit or ready for balling up, the material under treatment is tapped with as much of the cinder as cannot at this period of the process be separated. It is transferred into a receptacle, in a reverberatory furnace on Siemens' regenerative principle. It may also be run on to the open hearth of a reverberatory gas furnace, which may be either on Siemens' regenerative plan, or on the blow-pipe plan in which gas is used in conjunction with a hot blast. The essential feature of the furnace to be employed is that it should be capable of producing a temperature sufficiently high to melt steel or homogeneous iron, and it is also important that the flame should be capable of regulation to either an oxidizing or a carbonizing flame.

Here, in the reverberatory furnace, Mr. Gjers allows the transferred metal in a fluid state to remain at rest for a length of time, exposed to a neutral or to a carbonizing or an oxidizing heat, according as the crude steel metal requires more or less decarbonizing; the heat being sufficient to keep it perfectly fluid until the metal has thoroughly separated from the cinder, which will float on the top, and until it has arrived at the requisite point of carbonization to form the steel or homogeneous iron which may now be tapped into ingot moulds. Or the cinder may first be tapped or removed, and other flux (such as oxides of iron and manganese, in the shape of pure ores of those metals) may, if necessary, be added to assist in decarbonizing and to protect the metal. To the metal may be added a certain quantity of either wrought or crude iron, of the shape of spiegel iron or other matter (manganiferous), so as to arrive at the point of carbonization and temper desired.

As far as possible the process is regulated so that the transference from the puddling furnace may be made at such a period of the coming to nature, as will enable the metal, after having been made thoroughly fluid and remained so sufficiently long to decarbonize in the reverberatory furnace, to be obtained, without addition of malleable iron or ore, at the degree of carbonization desired. If the proper precautions are taken to boil and to work the iron well in a suitable cinder in the puddling furnace, it will generally be pure enough for steel. At the last stage of fluidity, while it is yet fluid enough to run, and just when it is about to congeal or come to nature, it still contains about 2 per cent. too much carbon. By transferring and exposing it, for 3 or 4 hours, in the reverberatory furnace in a liquid state, to a neutral or slightly oxidizing flame under a cover of oxidizing cinder, this excess of carbon gradually works off; and when it is worked down to the point desired (which may be ascertained by testing samples), it is tapped into ingots. To temper and improve the steel or homogeneous iron, in most cases, before tapping the metal, a small proportion of manganese in some of its combinations is added.

It has been found beneficial to let the metal decarbonize to an extent slightly below the desired degree of carbonization of the steel or homogeneous iron, and then to improve and recarbonize the metal by adding a small proportion of spiegel iron, amounting to about 1 per cent. of the whole. The carbon may, in some cases, be partly reduced by the addition of wrought iron, or, it may be, other malleable iron, in any form containing less carbon than the desired steel. In practice, it has been found advantageous for this purpose to make use of scrap bars, blooms, or balls in a heated state, which are gradually introduced and melted with the fluid metal tapped from the puddling furnace.

In some cases, cast steel or homogeneous iron is made by using ordinary puddle balls in combination with the fluid metal tapped from the puddling furnace, for which purpose it is found convenient to partially tap or transfer the contents of the puddling furnace just before the metal comes to nature, and to allow one half, less or more, of its contents to run into the reverberatory melting furnace. The rest may be allowed to continue working in the puddling furnace until it has thoroughly come to nature, and has become malleable, and the cinder has dropped, when it may be transferred either by shovels or in lumps and added to the fluid metal previously tapped from the puddling furnace on to the hearth of the reverberatory melting furnace.

The whole of the metal thus mixed, after being thoroughly fluidified and brought to the desired point of carbonization in the reverberatory steel-melting furnace, may then be run into ingots. Or four or more puddling furnaces may be employed to one melting furnace, and the entire contents of one or several of the puddling furnaces may be transferred before the period of coming to nature, while yet fluid, and the contents of the remaining furnaces may be transferred after the contents have got into nature; the entire contents of the whole of the puddling furnaces may then be melted together in the steel-melting furnace. Or the crude steel metal, tapped from the puddling furnace at the period named, may, particularly when it is desired to treat it in crucibles, be run into moulds as flat cakes, which, being broken in pieces, may be remelted in crucibles (or in the reverberatory furnace), in conjunction with malleable iron or with iron ore, to form steel. —*Mechanics' Magazine, Aug.*, 1868.

IMPROVEMENT IN THE MANUFACTURE OF IRON.

The following are extracts from a recent patent by David Stewart, of Kittaning, Penn., as published in the "Scientific American": —

"My invention consists in an improved method of treating iron as it comes from the blast furnace, or remelted pig iron, to remove therefrom the carbon, silica, sulphur, phosphorus, and other impurities which are found in the iron, and which are not removed from or have been contracted by the iron by the process of reduction from the ore.

"It is well known that pig iron, or iron from the blast furnace, contains a large amount of carbon, which it receives in the process of reduction, and which must be more or less completely removed in order to produce wrought iron or steel. Carbon has a great affinity for oxygen, greater than either carbon or oxygen have for iron, and as the union of carbon and oxygen, at a sufficient temperature to produce combustion, evolves a great amount of heat, it follows that by mixing oxygen with molten pig iron, the carbon ignites with vivid combustion, and is thereby eliminated, while the increase of heat thereby obtained renders the iron more fluid, and obviates the necessity of using other fuel or fire than is furnished by the carbon contained in the molten iron.

"The most improved mode of accomplishing this object, heretofore introduced into practice, is to pour the melted metal from the blast furnace into a receiver or vessel through which a stream of atmospheric air is forced at sufficient pressure. This, known as the pneumatic process, is attended with the use of very expensive apparatus and machinery, and, moreover, requires to be closely watched, as the operation, if continued too long, injures the metal; besides, it is not effectual in removing the impurities other than carbon, such as silicon, sulphur, phosphorus, etc.; and even as respects the removal of the carbon, its operation is not always satisfactory, as it is difficult to secure the equal action of the oxygen on all the particles of iron in the receiver. My improvement produces a much more satisfactory result, with little or no special apparatus, and produces immediately from the molten pig metal wrought iron, which may be at once taken to the rolls and worked in like manner as iron which has been puddled and squeezed.

"My improvement consists in subjecting molten pig metal or iron direct from the blast furnace to the action of oxygen (in any convenient shape, as atmospheric air, ozone, or other vapor or gas containing oxygen), by passing the molten metal in a stream or shower, either poured or forced upwards or sideways, so as to secure an intimate admixture of the particles of iron with the oxygen, or other oxygen-bearing gas or vapor. In order to carry this into effect, no special apparatus is required; indeed, each manufacturer will probably vary the arrangement of his furnace to suit the mode of accomplishing the desired result which will best suit his convenience or the requirements of his business.

"The melted iron may be run directly out of the tap-hole of the blast furnace, or may be first poured out into a pot. It is then allowed to run from an elevation of 30 feet, more or less, to the ground, and by this means the iron is brought into intimate contact with the air, so that the carbon is rapidly ignited, increasing the temperature of the metal and its fluidity, and, at the same time, carrying off in a great measure the other impurities, such as silicon, sulphur, and phosphorus, which also ignite with the carbon, and are thus eliminated. If it is desired to prevent the metal becoming spattered around as it falls, when it reaches the ground, it may be poured through a pipe, cylinder, or tube, open at both ends, so as to permit the free passage of the air upwards through the cylinder. This plan has the advantage of securing a more uniform current of air, which will flow upwards through the cylinder, in consequence of the rarefaction caused by the heat of the metal. A stream or current of atmospheric air, either hot or cold, or of ozone, or steam, or a mixture of any of the gases or vapors, singly or combined, may be introduced into the cylinder, pipe, or tube, through which the metal is poured; and, if desired, pressure may be applied so as to create a stronger current or blast up through the cylinder. If it is desired to add any fluxes to the iron (or physic it, as the iron-workers term it), this may be done before the iron is poured out. The height from which the metal is caused to fall may be varied according to the quality of the metal, and also somewhat according to its quantity; as the more impure the iron, the greater the height from which it should fall, the consequent distance through which it should be exposed to the action of the air or other oxygen-bearing gas or vapor; and the larger the quantity, the greater the height should be, so as to secure the more complete action on the particles of iron. A more complete separation of the particles of metal may be secured by pouring it through holes or perforations in a plate or otherwise. Instead of pouring the metal downwards, the same result would be produced by an upward jet; but the plan above indicated, it is believed, will be found the best and simplest in practice.

"By the means above described, of pouring molten pig metal through a cylinder 30 feet high, I have produced iron which, when heated and passed through the squeezers, gave out no cinder, thus showing that the silica had been nearly if not entirely removed, and from which, in the condition in which it passed from the muck-bar rolls, it was ready to be worked for any desired purpose. So that by my process, wrought iron ready for the rolls is produced directly from pig iron by a process requiring little or no machinery or apparatus, and scarcely any time, and dispensing with the ordinary troublesome and tedious processes.

"I also apply the above mode of purifying iron to the manufacture of semi-steel and steel, the process being the same, though a more perfect and longer-continued admixture of air or other oxygen-bearing gas may be required therefor."

PROCESS FOR CASTING STEEL UNDER HIGH PRESSURE.

The following is an extract from A. Galy-Cayalat's patent for casting steel under high pressure: —

"It is well known that cast steel run into moulds is subject to blister, and is otherwise porous, which defect reduces considerably its toughness. In order to give this metal its requisite tenacity, it is subsequently reheated and then rolled and hammered. As many articles, such as cannon, cannot be treated in this manner, I have devised to submit them to a high pressure while in a liquid state inclosed in their sand moulds maintained in iron flasks. For this purpose, immediately after running a cannon, I cover hermetically the head by a metallic cap, by means of bolts or other devices attached to the flask. This cap is fitted in its centre with a vertical pipe, and provided with a cock at its lower extremity, while its upper extremity is closed by a washer pressed with a bolt in such a manner as to act as a safety valve. Before attaching the cap at, supposing an inch from, the surface of the liquid metal, I introduce in the vertical pipe, and between the cock and the washer a charge of about one quarter of an ounce of gunpowder, in the proportion of 80 parts of saltpetre and 20 of charcoal, with no sulphur. On opening the cock this powder falls on the metal, ignites, and engenders about one third of a cubic foot of gas at 1,400° Cent. These gases exert on the liquid metal a pressure which is transmitted through the entire mass, thereby condensing the same and expelling the blisters. The effect thus produced is equivalent to the pressure of a head of liquid metal 90 feet high, admitting that the capacity between the cap and the surface of the metal contains 30 cubic inches. By making the flasks sufficiently strong the charges of powder may be varied, so as to produce by its ignition a uniform and general pressure, which is preferable to the partial, irregular, and momentary action of a hammer."

CHROME IRON AND STEEL.

Iron and Chromium and Chromium Steel.— Iron and chromium may be alloyed in every proportion by heating the mixed oxides strongly under addition of charcoal powder, to effect reduction. Frémy formed an alloy by heating in a blast furnace oxide of chromium and metallic iron, thereby obtaining a product resembling cast iron. These alloys are generally hard, brittle, with a bright fracture, and crystalline in structure. When they contain a large percentage of chromium they crystallize in long needles. They are also less fusible, not as magnetic, nor so easily attacked by acids as iron. The alloy of 95 per cent. iron and 5 per cent. chromium is stated to be hard, splitting under the hammer and scratching glass. The fracture is very bright, with crystalline plates extending across the fractured surface. The alloy of 75.2 per cent. iron is readily reduced to powder; its fracture is tin white, finely granular, and crystalline; that of 50.3 iron yields a somewhat spongy button with metallic globules; its fracture finely granular, bright, and grayish white. The alloy of 25.3 per cent. iron is obtained as an imperfectly fused spongy mass, of less coherence than the former, a yellowish-gray white color and somewhat dull lustre. The alloy containing 17 per cent. of chromium is described by Berthier as almost silver white, fibrous in structure, and with difficulty attacked by acids. That containing 60 per cent. of chromium scratches glass better than tungsten steel, and almost as deeply as the diamond.

With regard to steel, Berthier found that 1 or 2 per cent. of chromium when added to molten metal communicates hardness and the property of taking a very beautiful damask, without diminishing its malleability. Faraday and Stodart examined steel containing nearly 3 per cent. of chromium, and found it to be as malleable as pure iron and giving a very fine damask. The damask was removed by polishing, and restored by heat without the use of any acid.

The use of chromate of iron, or chrome ore, for hardening iron, has long been known; but it is only recently that attention has been paid to its practical use for this purpose, the chrome ores having been almost exclusively used for the manufacture of bi-chromate of potash for coloring purposes. Late experiments have demonstrated its superiority as an alloy for hardening steel, and for the manufacture of burglar-proof safes. The chrome-iron safes are cast, and are impervious to acids or drills, and the material is by far the hardest metal ever discovered.

These alloys may also be made with chrome-iron ores, by using a flux to retain the silica and alumina which may be present in the ores. A good flux for this purpose is a mixture of 100 parts glass (free from lead), and 40 of glass of borax, to 100 of ore.

The supply of chrome-iron ore in this country is quite extensive; and it is found of superior quality at the Bare Hill, about 6 miles from Baltimore, in Harford County, and in other parts of Baltimore County, and many parts of Chester, Delaware, and other counties of Pennsylvania. — *Scientific American.*

CARBON IN IRON.

It is well known that there are two states in which carbon exists in solid iron, — a state of chemical combination with the iron, and a state of merely mechanical diffusion through its mass. It is also known that the carbon existing in iron in the last-mentioned state is always in the form of graphite. Dr. Phipson has recently announced to the Academy of Sciences that he has discovered that silicium also may exist in cast iron, either in a state of combination, or in a state of diffusion merely, and that, like carbon, when merely diffused through the iron, and not in combination therewith, it is always in the graphite form. He adds, what, if true, is of great practical importance, that, upon the condition of the silicium in any given sample of cast iron, depends, in a very great degree, the practicability of converting that iron into steel by the Bessemer process. He regards diffused or uncombined silicium as the least injurious, stating that while iron containing as much as 3 or 4 per cent. of *free* silicium can be converted into excellent steel by the Bessemer method, the presence of a very much smaller quantity of *combined* silicium will either render the iron containing it incapable of being converted into steel by that method at all, or will cause the steel produced from such iron to be so hard and bad as to be quite incapable of being worked. He promises to publish shortly a full account of his method of determining the condition in which silicium exists in iron, with details of his experiments upon the influence of that condition upon the results of the iron by the process referred to.

RECIPES FOR STEEL HAVING VARIOUS QUALITIES.

James R. Bradley and Moses D. Brown, of Chicago, Ill., have lately patented the following: —

"For treating scrap iron or malleable iron of good quality, produced by the ordinary processes, and producing therefrom different kinds of steel, we melt the scrap or malleable iron in crucibles, adding thereto chemical ingredients of different properties, and in different proportions, as follows, to wit: To make shear steel, to a pot of 50 pounds, add potash, 1¼ ounce; sal-ammoniac, 1½ ounce; manganese, 4¼ ounces; charcoal, 7 ounces; sodium, 3 ounces. To make cast steel, to a pot of 50 pounds, add potash, 1½ ounce; sal-ammoniac, 1½ ounce; manganese, 4¼ ounces; rock salt, 3¼ ounces; charcoal, 7 ounces. To make German steel, to a pot of 50 pounds, add potash, 1½ ounce; sal-ammoniac, 1½ ounce; manganese, 4½ ounces; charcoal, 7 ounces. To make Damascus steel, to a pot of 50 pounds, add potash, 1¾ ounce; sal-ammoniac, 1¾ ounce; manganese, 5 ounces; saltpetre, 4 ounces; charcoal, 7 ounces. To make saw steel, to a pot of 50 pounds, add potash, 1¼ ounce; sal-ammoniac, 1½ ounce; manganese, 4½ ounces; charcoal, 8½ ounces; common salt, 3½ ounces; saltpetre, 1 ounce. To make silver steel, to a pot of 50 pounds, add potash, 1½ ounce; sal-ammoniac, 1¾ ounce; manganese, 4¾ ounces; charcoal, 8 ounces; salt, 3½ ounces; alum, 1 ounce. To make file steel, to a pot of 50 pounds, add potash, 1 ounce; sal-ammoniac, ¾ ounce; manganese, 4 ounces; charcoal, 9 ounces; salt 3½ ounces; alum, ¼ ounce. To make rifle steel, to a pot of 50 pounds, add potash, ¾ ounce; manganese, 4 ounces; charcoal, 3½ ounces; salt, 3 ounces; alum. — *Scientific American*.

HARDENING OF STEEL.

According to M. Landrin, notwithstanding what has been said, and the so-called experience of some practical metallurgists, pure water is the best liquid for hardening steel. It is a mistake to believe, with the ancients, that certain waters are more adapted to this operation than others. The only difference lies in their temperature.

Mercury has no other property than that of being cold, and of producing a hardness which can be obtained with water at the same temperature. Tallow and oils, where carbon is one of the constituent elements, produce an imperfect hardening, but prevent a loss of carbon. When, by over-heating, steel has been burned and decarbonized, the oils and fatty matters are useful, because they give back to the steel a part of the carbon lost in the fire. Some acids, such as sulphuric, are justly considered as imparting more hardness to steel, by dissolving a film of iron from the surface and exposing the carbon. As for urine, alcohol, brandy, and numerous other liquids extolled by ignorant workmen, they are not worth as much as water, which has the advantage of being abundant everywhere, cheap, and adapted to all changes of temperature.

PURE IRON.

M. Troost advocates the following method of obtaining a very pure soft iron, which would be of great utility if oxygen can be prepared at a cheap rate on a large scale. He melts cast iron in a lime crucible by the oxy-hydrogen flame; when the metal is fused, he increases the proportion of oxygen, and thus burns away the silicon, carbon, and sulphur, the slag which is formed being absorbed by the crucible; at the close of the process a button of very pure metal remains at the bottom of the crucible

RUTHVEN'S HYDRAULIC PROPELLER.

Mr. Isaac Newton communicates to the "Journal of the Franklin Institute" for March, 1868, a paper on this subject, in which he compares at length the hydraulic propeller with the ordinary screw propeller, showing that the former is much more liable to be disabled by an enemy's shot, that it gives an inferior manœuvring or turning power, affords no advantages in reversing power, and is more affected by the motion of the vessel in a sea way; the opposite of all of these has been heretofore claimed for the hydraulic propeller. He states the following as the result of the official trials: immersed midsection of "Waterwitch," 347 square feet; horse-power, 777; speed, 9.2 knots, — that is, by the usual calculation, 2.8 horse-power are required for each square foot of immersed midsection to give a speed of 10 knots; extensive experience with our bluff freighting propellers shows that but 1.8 horse-power per square foot of immersed section is necessary for the speed of 10 knots. Hence, the hydraulic propeller in the "Waterwitch" is, as a propelling instrument, 36 per cent. less efficient than the ordinary screw propeller; or, in other words, it wastes 36 per cent. more power than that method of propulsion.

WATER VELOCIPEDE.

An ingenious application of the principle of the velocipede to water locomotion has recently been made in Paris. A pair of hollow water-tight pontoons, about 12 feet long, 10 inches wide in the thickest part, and tapered to a point at each end, are fastened together about 20 inches apart by transverse bars near the extremities. The seat is placed in the centre, and is raised on iron rods about 2 feet above the water. In front is the paddle-wheel, about 3 feet in diameter and 8 inches wide, provided with 16 floats, the axle turning on stout iron uprights, the rotary motion being obtained from cranks worked by the feet. The vessel is steered by rudders at each of the sterns, moved by lines. If made of light wood the whole has little weight, and may be propelled with astonishing rapidity. It was invented by M. Thierry, an architect of Paris.

LONG VS. SHORT SPAN BRIDGES.

There seems to be a complete change of opinion going on with regard to bridges possessing very long spans. As soon as the advantages of wrought iron over older materials for constructive purposes were demonstrated, it was imagined by some, that all our rivers, over which it was necessary to carry a bridge, would be crossed at a single bound. It is well known now that some of the few existing long-span railway bridges could have been built in a more economical manner on a different principle.

Disregarding the somewhat treacherous nature of the material, the limits of cast-iron girders, especially for railway purposes, are soon reached; the arch is not really an exception to this rule, unless for light travel, and the real objection to its employment on a large scale is the impossibility of affording a sufficient amount of rise to enable a curve to be obtained endowed with the property of correct equilibrium. Engineers then began to look at wrought iron for the accomplishment of their stupendous designs; but, curiously enough, the arch was abandoned at the introduction of the new material, it being generally impracticable to employ this form. The centre spans of the new Blackfriars bridge, which are 185 feet across, will, we believe, be the representative of the largest example of a wrought-iron arch. The horizontal girder appeared to offer, especially in the matter of headway, considerable advantages over the arch form, and consequently the first specimens were instances of that principle. This determined its application to the crossing of the Menai Straits, which contains at present the longest single span of any railway bridge in the world.

There is no question but that the multi-span principle has proved itself in point of economy superior to the system of crossing an intervening space in one gigantic leap. The whole question rests upon the relative economy of piers balanced against superstructure. A point which bears somewhat favorably upon the long-span system is, that the cost of sinking a pier, or even a number of piles, is always an unknown quantity, whereas the erection of the superstructure can be estimated to a few pounds. It is rarely the latter item that delays the progress of a structure, but the former is a common source of vexation and expense, whenever the foundations have to be got in under water. The argument that tells most strongly against the long or single span principle is, that the cost of constructing a girder increases in a far higher ratio than that of the mere augmentation of its span. With piers it is different; for, *ceteris paribus*, the cost of any number of piers in the same situation will, upon the average, be in simple arithmetical progression.

Across an impassable gorge, a precipitous ravine, or a furious torrent, it may be impossible to employ any other than a bridge of single span, and the importance attached to the connection of the opposite sides must determine whether the necessary outlay is justifiable or otherwise. For the future it may be asserted, judging from the data, that short spans will be the rule, long ones the exception. — *Mechanics' Magazine.*

FLAT ARCHES IN ENGINEERING.

At the Paris Exposition was exhibited the model of a novel masonry arch, designed and built by M. Vaudray, preliminary to the construction of a bridge over the Seine, in Paris. The bridge had to span the river exactly over the locks of the Canal de la Monnaie; and the necessity, on the one hand, of keeping the springing of the arch above the lock walls, and, on the other, of keeping the level of the roadway down to the existing level of the streets leading to it, confined the rise of the arch to a height not exceeding 7 feet, while the span had to be nearly 125 feet. The possibility of building so flat an arch with this span of stone being questioned, an experimental one fulfilling the required conditions was built.

The description and general dimensions of the arch are as follows: its form is a segment of a circle, of which the chord is 124 feet, the versed sine 6 feet 11 inches. It is built entirely of cut stone; the number of the voussoirs in each ring is 77, diminishing in depth from 3 feet 7 inches at the springing, to 2 feet 8 inches at the keystone; the beds and joints of the voussoirs are dressed with the greatest care, and laid in Portland cement; the thickness allowed to the mortar joints was three-eighths of an inch. The joints next the skewback were not flushed until after the completion of the ring, having been meantime kept open with fir wedges. The artificial abutment is 27 feet in height, 49 feet in mean thickness, and 12 feet wide, — this also being the width of the arch, — built of rubble masonry, well bonded together and laid in Portland cement, — 1 part cement to 3 parts of sand. The arrangement for striking the centring was by means of dry sand contained in iron cylinders, — a method peculiarly well adapted for such a critical experiment. The arch was left to set 4 months; the centring was then eased by allowing the sand to flow regularly from the cylinders. When the arch and centring were separate, it was found that the crown had come down .6 of an inch, and the joints of the skew-back had opened on the built abutment side .007 of an inch; after 3 days the arch had come down .07 of an inch more. It was then loaded with a weight of 360 tons, disposed over the whole surface of the roadway, the loading occupying 13 days; when complete the crown was found to have come down .3 of an inch. Since then nothing has stirred. The arch was afterward tested by a weight of 5 tons being allowed to fall on the roadway vertically over the keystone, from a height of 1½ feet; but no joint opened, nor did the ridge sustain the slightest injury. This proves that the relative proportions of rise to span in large masonry arches to which engineers have hitherto limited themselves may be largely modified; though such structures as the above will require very accurate work and the greatest care in execution. — *Civ. Eng. and Arch. Jour., Jan.*, 1868.

NEW METHOD OF STRIKING CENTRING.

A method frequently adopted by French engineers for easing large centrings from arches on completion of works, is by resting the principals of the centring upon sand contained in iron cylinders, from the bottom of which the sand is allowed slowly to escape. Each principal is supported upon round props, fitting as a piston into a cylinder containing fine, dry sand. The cylinders are of sheet iron one-thirty-second of an inch thick, 1 foot high, and 1 foot in diameter; about 2 inches from the bottom they are pierced with holes about three-fourths of an inch in diameter, which are stopped with common corks. To ease the centring the corks are removed; the sand then escapes through the holes, until a cone of sand is formed at the base of the cylinder; the formation of this cone arrests the further escape of the sand, and therefore the descent of the piston, until the cone is swept away, when it re-forms. The sweeping is repeated until the piston has descended sufficiently to detach the centring from the masonry. By taking care to sweep away the same cones simultaneously, the lowering of the centring can be performed with perfect evenness, and as gradually as may be desired, by one-millionth of an inch, if necessary; whilst, as no force is required to be used, the arch is not subjected to the slightest shock during the operation. This system was originated by M. Beaudemoulin. — *Civ. Eng. and Arch. Jour., Jan.*, 1868.

PRESSURE OF THE WIND.

In the case of roofs and similar structures a pressure of from 28 to 30 pounds per square foot is generally considered by architects an ample margin to allow for, and in exposed situations, as in bridges, 40 to 50 pounds. Many of the earlier suspension bridges were broken down by the wind, it throwing them into a state of undulation to the extent of 4 or 5 feet. Scientific and judicious bracing has been found a sufficient remedy in ordinary cases. The engineer of the bridge over the Menai Straits considered the wind pressure on this large tubular structure as a trifle, not more likely to be felt than in a well-made chimney. Though bridges may not be injured by the wind, railroad trains passing over them have met with serious accidents from this cause. A train on the Midland Railway, in France, consisting of 7 carriages, had 2 of its carriages overturned, while running on a straight piece of line at the rate of 20 miles an hour; the wind was north-west, nearly perpendicular to the line of the route. The weight of the car was 7 tons, its moment of resistance 5 tons, the surface exposed to the force of the wind 150 square feet, and the lateral pressure required for its equilibrium 39 pounds per square foot. On the same train a luggage van, weighing 7¼ tons, with a surface exposed of only 110 square feet, was not overturned, requiring a force of 62 pounds to overthrow it. In case a train was running round a sharp curve, with the wind blowing from the centre to the circumference of the arc, this addition to the centrifugal force might cause an overturn with a less high wind. — *Civ. Eng. and Arch. Jour.*, 1868.

ROAD-MAKING.

The common practice of road-making in this country, says the "Railway Times," is one of waste and utter want of economy in every respect. The process is something like this: the upper soil is removed, and coarse gravel or broken stone supplied to bring up the grade, and the road is then left to be worn down smooth by passing teams and carriages. Think what a waste of power is thus involved, what an immense and useless wear of vehicles, what loss of time, and what amount of general discomfort. Drainage is seldom thought of, and during the wet seasons, and especially when the frost is coming out of the ground, the roads are nearly impassable. The common remedy for all this is to pile on more gravel or broken stone, and then again commences the destruction of wheels. This useless tax to the owners of horses and vehicles could nearly all be prevented if the roads were properly made, drained, and cared for. Proper drainage is the first essential; then the road dressed with gravel or stone should be formed and rolled into proper form to shed water, — a very slight incline to either side is all that is necessary, — and then you have a road that is easy to horses, and the load is carried with half the power that is expended in hauling over many of the roads in our suburban towns. Less gravel or broken stone, but more care that it is kept in place and smooth, is what is required. In England and France they are using powerful steam rollers with beneficial results.

A London paper describes the process thus: "The road is first prepared by being loosened with pickaxes, then covered with the ordinary broken granite. Above this a dressing of sand is laid;

the whole is then watered. An immense roller is propelled by steam, and moved slowly over the prepared surface. It exerts a pressure of 28 tons, and the result is that in an unusually short time a firm and compact Macadamized road is formed, so smooth that the lightest vehicles may be immediately driven over it without fear of injuring the springs. The engine works almost without noise, and appears to consume nearly all its own smoke."

Daily care is required, for a while, to prevent the forming of ruts; as soon as the ruts appear they should be filled and then rolled over again. This costs something, but the eventual or resultant cost is less, both to the town authorities and those who use the roads, than is that of our present system. A smooth and even surface is nearly as important on common roads as it is on the railway. The science of road-making is simple enough, but our people almost always fail in it. Once properly constructed and drained, our common roads could be kept in good working order for a tithe of what it now costs. The use of the steam roller simplifies the matter very much, and probably before long it will be freely used in nearly all our larger towns. — *Scientific American.*

STREET RAILWAYS.

Mr. Thorold read a paper, at the last meeting of the British Association, giving a description of an auxiliary railway invented by him for the purpose of utilizing turnpike roads and highways and the streets of towns. Mr. Thorold remarked that this railway would only require a single rail, which he proposed should be laid on one side of the road, out of the way of the ordinary traffic. An arrangement of grooved wheels under the centre of the engine and carriages, so constructed that they will be capable of maintaining their grip upon curves of 20 feet radius, gives the vehicles the power of turning corners with the greatest facility. The inventor thinks his principle peculiarly adapted to locomotion through new countries, and for passing through ravines, or up and down the sides of mountains up any gradient not exceeding 1 in 12. He proposed to propel the carriages by steam-traction engines, although they might also be drawn by elephants, horses, or other beasts of burden. The adhesion of the traction wheels could be regulated to any weight, and by the application of a special apparatus the engine might be made to lift the traction wheels out of a soft place. The cost of the new railway would be about £500 per mile.

In Bright's patent tramway, instead of the ordinary tramway flange, the rail is inclined, and the wheels of the carriage are tapered so as to fit the bevel of the rail. Among the alleged advantages of this method are the facilities afforded for the carriages quitting the rail and again coming on to it (a portion of the wheel being flat, and adapted to road travelling), and the ease with which ordinary carriages may cross the road, the slight inclination of which presents no serious obstruction to a vehicle.

The invention of the application of vulcanized India-rubber to the tires of road steamers forms the greatest step which has ever been made in the use of steam on common roads. It completely removes the two fatal difficulties which have hitherto barred the way to the use of traction engines, — namely, the mutual destruction of the traction engine and the roads. The India-rubber tires, interposing a soft and elastic cushion between the two, effectually protect them both from every jar and jolt, — in fact, as much so as if the engine were travelling over a tramway of India-rubber.

A RAIL OF BESSEMER STEEL.

In the early part of the year 1857, a steel bloom was made by melting in crucibles Bessemer metal with spiegeleisen. This bloom was rolled into a double-headed rail, and in the spring of 1857 it was laid down at Derby station. On the 21st of December, 1867, 10 years and 6 months after it had been laid down, it was reported to be apparently little the worse for wear. Now the wear amounted to, on an average, 250 trains passing over it daily, and a like number of transits of engines and tenders. Reckoning now the weight of each train at 100 tons average, and that of engines and tenders at 20 tons, we have an amount of 30,000 tons per diem passing over this rail, and this continued for, say 300 days per annum, 10½ years, gives a total of 94,500,000 tons. Now on the Canadian railways the iron rails are worn out by a traffic ranging from 4 millions to 30 millions of tons, according to the quality of the iron rails. The Derby rail, therefore, of Bessemer steel, has already sustained more than three times the amount of traffic which suffices to destroy the best iron rails, and, in spite of this, it is still "apparently little the worse for wear." The opponents of steel rails will argue, no doubt, that this rail is an exception, and was better than other Bessemer steel rails, because the metal was remelted. Such, however, is not the fact, for steel is always more or less deteriorated by remelting; and the rail ends from Bessemer steel rails, made at Crewe, and therefore, of course, the rails themselves, are of as good and as durable a quality of steel as this Derby rail. — *Robert Mushet.*

WEST SIDE ELEVATED RAILWAY.

As has been before noted in our columns, the section now completed, running between the Battery and Greenwich Street, was built as an experiment, to test the practicability of the plan. On Thursday, the legislative Commissioners and Governor Fenton examined the railway, and expressed their entire approval of its mode of working.

The road is about one-half mile in length, is 14 feet in the clear above street level, and is supported by cast-iron pillars placed from 20 to 40 feet apart. An endless wire cable of three-quarters inch diameter, carrying with it a series of small trucks every 50 yards, is put in motion by steam-power below ground, midway between the extreme stations. Motion is imparted to the car on bringing a projecting lip below the car floor in contact with the swiftly moving trucks, but by means of a series of leafed elliptic springs, having India-rubber buffers between each, there is far less shock at starting than is experienced in ordinary horse-cars, being hardly perceptible. The car can be stopped at any time by releasing the truck and applying the brake. The rails are of the ordinary pattern used on steam roads, and their wheels flanged, so that no apprehension need be felt of the cars leaving the track. To make assurance doubly sure, each end of the car is provided with an extra axle and guide-wheels with safety-flanges. The speed attained on Friday was from ten to fifteen miles per hour. The projectors propose making the wire cable larger, so that the rate can be considerably increased; other minor alterations and improvements, which the trials have suggested, will also be introduced. — *Scientific American.*

ENGINEERING ITEMS.

Mont-Cenis Railway. — On April 20, an engine, with a load of 25 tons, made the trip from St. Michel to Susa, returning the following day. On the 23d, another engine made the double trip from St. Michel to Susa and back, 96 miles, on the same day, running the 48 miles in 5½ hours, including an hour of stoppages on the road. The average running speed was about 12 miles an hour. Whether the "grip" of the horizontal brake wheels of the Mont Cenis Railway will be seriously affected in winter by the hard frosts remains to be proved; but in summer Mr. Fell's railway transports one in a far pleasanter manner over Mont Cenis than the diligence. Six hours and 20 francs a head are saved by it, to say nothing of the greater comfort and less fatigue.

Pacific Railroad. — On the 18th of April the rails of the Pacific Railroad were laid across the Rocky Mountain summit of the line, a point about 8,240 feet above the level of the sea, the highest point reached by any railroad in the world.

Suez Canal. — In the month ending March 15, 1868, the extraction of earth amounted to 1,554,630 cubic metres, considerably more than the amount removed in January and February. The quantity remaining to be extracted is about 36,000,000 cubic metres. As the extraction is progressively increasing, it is generally believed that the canal will be finished in 1869. In February, 1868, it was opened for vessels of light draft, and a French and Greek schooner passed through from the Mediterranean to the Red Sea. In January, 1867, the receipts for conveying merchandise and passengers from sea to sea were 47,664 francs; in January, 1868, 197,317 francs, — showing a great and steady increase. The last number of the "Isthme de Suez" journal gives details of the works, which are being prosecuted with such vigor that the directors persist in affirming that the canal will be finished in 1869. The transit is becoming more and more developed, and from January 4th to February 7th, 137 barges of merchandise passed from one sea to the other. On February 6th there were at Port Said 4 three-masters and 3 brigs occupied in landing large cargoes of coal. The receipts in 1867 amounted to 1,292,822 francs. The first quarters gave 250,000 francs, and the fourth 474,000 francs. The transit continued to be active in January, 1868.

London Underground Railway.—The engines are of the usual form, but are so arranged that the exhaust may, at will, be turned into the tank instead of the chimney, and that the furnace may at a moment's notice be shut up air-tight. The road is not a continuous tunnel, but a series of alternate tunnels and open cuttings. In the open cutting the engines are run as on any other road, but as soon as a tunnel is reached, the exhaust is turned into the tank, the fire-box shut tight, and the engine run through by the accumulated heat in the furnace and boiler. The cost of this road was about $4,000,000 per mile.—*Franklin Journal.*

SUEZ CANAL.

The line of the Suez ship canal, as determined by the commission of engineers, runs nearly north and south, from Port Said, on the Mediterranean, to Suez, at the head of the Red Sea, a distance of 100 miles. The width at the water line will be 330 feet, with a uniform depth of 26 feet. The alignment is very favorable, there being but 8 curves; the shortest radius is 6,666 feet, with an angle of 143 degrees. For nearly three-quarters of the distance the canal will be dredged through a line of shallow lakes, some of them containing brackish water, filtered in from the sea, and others being at present dry, indicating the locality of former lakes. The intervening strips of land are parts of the great desert, an arid, desolate waste, with nothing to sustain animal or vegetable life. To supply the fresh water necessary for the men and steam engines, an old canal at Gassassine was extended to a point on the line of the ship canal midway between Port Said and Suez; the length of this fresh-water canal is 30 miles, the width at the water line 66 feet, the depth 6 feet, and the fall about 2 inches per mile; its direction is nearly east, and it comes in at right angles to the ship canal at a point now called Ismailia. From Ismailia, the water is forced by steam through 2 cast-iron pipes to Port Said, a distance of 50 miles, to the amount of 54,000 cubic feet of water per day; these pipes are tapped at such parts of the line as may be necessary to supply the men and engines. At a point on the fresh-water canal, 2½ miles above Ismailia, a branch canal takes off the water southward to Suez, 58 miles. In this way drinkable water is furnished from the Nile along the whole route, whereas formerly it had to be brought from Cairo, across the country by railroad, a distance of 90 miles. It is by the last-mentioned canal that water communication has been opened between the two seas, and not through the ship canal proper, as the public have been led to believe. The northern end of the ship canal, however, from Port Said to Ismailia is sufficiently advanced to allow the passage of boats drawing 5 feet of water.

The whole extent of the isthmus is covered with marine shells, similar to those now found in the neighboring seas, indicating that at a comparatively recent geological period the salt water stood at a higher level than it now does, and that the isthmus, as such, did not then exist. There is a remarkable depression in this neck of land, as now seen, and through this depression or valley the canal will be constructed. Port Said is in latitude 31° 16′ N., longitude 32°, 19′ E. This point was selected because the line of 33 feet soundings was nearer to the beach than elsewhere along the coast, being only about 2 miles from the shore. The beach, in all this region, is merely a narrow strip of sand, 1 or 200 yards wide, inside of which are numerous shallow lakes, or mere salt marshes, some of great extent.

Through one of these shallow lakes, called Menzaleh, the canal will be dug for nearly 30 miles; at the end of this is Lake Ballah, about 8 miles in extent as crossed by the canal, and at the southern side of this is the highest point of land in the whole line. The extreme width of this ridge, called El Guisr, is about 10 miles, with a summit 61 feet above the sea level, which, added to 26 feet, the depth of the canal, will require a cutting of 87 feet. On the southern side of El Guisr is Lake Timsah, through which the canal will be dredged for about 5 miles; it then crosses the ridge of Serapeum, about 8 miles in width, with a maximum cut of 61 feet. After this, proceeding southward, the line strikes the immense basin of the Bitter Lakes, where the level is, in many places, as great as will be required, and where comparatively little work will have to be done for 23 miles. This depression is bounded on the south by the ridge of Chalouf, about 5 miles wide, where there must be a cutting 55 feet deep for a short distance. Between Chalouf and the Red Sea is the plain of Suez, 10 miles in extent, as crossed by the canal, and elevated only a few feet above the sea level.

The construction of the entrance to the canal at the Suez end presents no great engineering obstacle; the head of the Red Sea is so completely land-locked as never to be troubled with a very heavy swell, and there is no current at all; so that it will only be necessary to dredge out a channel into deep water.

At Port Said there will be more difficulty; the harbor there will be formed of 2 jetties or piers, the western one extending into the sea about 2½ miles in a north-north-east direction; the other pier will extend a little more than 1½ miles in a direction nearly north; a triangular area of 575 acres between the two, forming an outer harbor, will be dredged to a depth of 30 feet.

The piers were commenced with stone, but are now constructed of a concrete made of hydraulic lime from France and the sand in the harbor, about 715 pounds of lime to 37 cubic feet of sand; after having been submerged a few months the concrete becomes nearly as hard as granite; the interstices are filled by sand brought by the current from the west, thus forming a solid mass, which promises to stand for all time. From 1859 to 1863, the work was done principally by Fellahs or native Egyptians; but they did comparatively little work, and the withdrawal of 20,000 to 30,000 men from the agricultural force of the country caused a general derangement of affairs and greatly diminished the amount of taxes received; the jealousy of England also introduced various complications and delays. Steam machinery now takes the place of the Fellahs, and with great success; the engineers agree to have the excavations finished in 1869, receiving a large bonus if completed before the end of that year, and incurring a heavy penalty for each month of delay beyond the time specified. The principal instrument employed is a large dredging machine, with iron buckets fastened to an endless chain revolving over 2 drums; one at the end of a long movable arm, to regulate the depth at which the buckets shall work, and the other at the top of a heavy frame-work of iron in the centre of the body or hull of the machine. The largest machines have the hull 110 feet long by 27 broad, with the axis of the upper drum 48 feet above the water; their capacity is equal to 2,500 cubic yards per day of 12 uninterrupted working hours; their engines are of 75 horse-power. The material excavated is either conveyed in steam barges to deep water, or is discharged by long spouts on each side of the canal, where it arranges itself in gentle slopes, being swept along by a current of water; by the latter method 200 cubic yards of material can be disposed of for each lineal yard of canal. Where the land is so as to bring the barges too low for the use of the spouts, an inclined plane or travelling elevator is used. These three methods will be employed for digging all those portions of the canal where the earth is not more than 6 feet above the water line, amounting to a total distance of about 76 miles. The quantities to be moved are about 7,000,000 cubic yards by the elevators, 13,000,000 by the barges, and 35,000,000 by the spouts, — in all, 55,000,000 cubic yards.

Where the cutting exceeds 6 feet, the preliminary work must be done by hand labor before the dredges can be made available. At the deep cut of El Guisr the Fellahs were employed for 3 years; the work is now going on by means of locomotives drawing cars loaded by hand. The hand labor is done by Arabs, Egyptians, and Syrians; the masons, carpenters, and machinists are mainly Italians, Austrians, and Dalmatians; the men employed on the dredges are mostly Greeks; the engineers, clerks, cashiers, and chief artisans are nearly all French.

The mortality among the workmen is about 1½ per cent. About one-third of the total amount of excavation to be done is now accomplished, and there is every prospect of the completion of the canal in 1869. By means of the narrow channel through the ridge at El Guisr, there is salt-water communication from Port Said to Lake Timsah, and thence by the fresh-water canal to Suez.

The objections urged against the practicability of the canal are now found to be almost wholly without foundation. So little does the drifting of the sand in the desert amount to, that the chief engineer declares that with one of his dredges he can keep the channel clear, and maintain the full depth of water throughout the whole length of the canal. The mud from the Nile, which it was feared would fill up any harbor at the Mediterranean entrance, has made no deposit at Port Said during the past 6 years, this being now one of the best harbors on the Egyptian or Syrian coast, allowing vessels drawing 15 feet to run in, in any weather.

This canal, when completed, is almost certain to change the direction of the greater part of the shipments between Europe and the East Indies, and must have a marked influence on the trade of the United States with India and China. The company are allowed to charge 10 francs per ton on all vessels passing through the canal; and, if the amount of tonnage which now doubles the Cape of Good Hope should be diverted into this channel, it will prove a great financial success. — *Journal of Franklin Institute, April, May, and June*, 1868.

ILLINOIS AND ST. LOUIS BRIDGE.

According to the report of Mr. J. B. Eads, Engineer-in-Chief, of which a review is published in the "Journal of the Franklin Institute," for September, 1868, the method adopted in this bridge is the one employed by Sternberg for the great ribbed arch over the Rhine, at Coblentz. The problem involved in the consideration of an arched rib is one of peculiar difficulty, especially when the rib is neither hinged at the crown nor abutments. Some modifications were necessary in the method of Sternberg, who treated the centre line of the arch as a parabola, and also considered the arch as hinged at the skewbacks. In the St. Louis bridge the ends were considered fixed at the piers, which reduced the computed deflections caused by the load under the hinged condition, allowing of a reduction of the weight of the material, provided a short distance from each end was strengthened. This last provision was required from the fact that, with fixed ends, the deflections were greater near the abutments than when the ends were hinged, and also because the effects from change of temperature were increased.

The ribs are formed from 2 circular flanges, separated about 9 feet from each other by a system of triangular bracing. In this not only lies the carrying system, but it also contains the provision for counter-bracing, the spandril filling merely serving to support the roadway. The arch, therefore, acts in the double capacity of a rib under direct compression, and a beam under a transverse load, and the strains at each point are the resultants of the strains arising from the direct compressive action of the load, and from its bending action. The plan adopted consists of 3 cast-steel arches of 500 feet span.

SOUTHPORT PIER.

This pier, capable of resisting severe strains from wind and water, as experience has proved, capable of sustaining a load of 35 tons for each bay, — 3,600 feet long and 15 wide, with approaches, tool-house, etc, — was constructed for $46,595. The entire number of piles, 237, were sunk in the space of 6 weeks, in a location where work could be prosecuted only at low tide.

The methods for sinking the iron piles were as follows: The lower ends of the piles were provided with circular disks, 1½ feet in diameter, on which projections or cutters were cast, and through which, at the centre, passed a pipe delivering water from the regular mains under a pressure of 50 pounds to the square inch. The pile was supported and lowered, as necessary, by a small piling machine, and a rotary reciprocating motion being given, the sand, etc., was loosened from beneath and carried away by the stream of water. The water being stopped, the pile settled, so as to sustain 12 tons, without moving, in 5 minutes.

NEW BRIDGES.

Bridge at Niagara Falls. — They are building a new suspension bridge at Niagara close to the Falls, for carriages and foot passengers. On the American side the towers are within a few hundred feet of the Falls, and the cables are already swung across to corresponding towers close to the Clifton House. In some respects this bridge is more remarkable than the other. In length it exceeds it 450 feet, being 1,250 feet in the span. The towers are 105 feet high, and are built 13½ feet apart. Unlike the heavy stone columns of the lower bridge, they are light wooded trestles, 28 feet square at the base and tapering to the top. When finished they will be roofed and weather-boarded.

The bridge will be sustained by 2 cables, which were swung last winter when the ice filled the river below the Falls. The lower bridge is sustained by 4 cables. Those of the new bridge are composed of 7 strands of twisted steel wire, each measuring 2⅜ inches in diameter, which form a cable about 9 inches thick. The ends are fastened by the new shackles invented by Mr. Hewlett, of Niagara, in a manner very different from that formerly adopted. The strands of the cable are untwisted at the ends, and hang separately from the tops of the towers. Each is secured to a separate shackle, which looks something like a pulley with a fixed wheel. These are grooved so as to hold the cable by means of friction, independent of the fastening at the ends, if necessary. The shackles are of various lengths, so as to divide the strain as much as possible, and are secured to a base firmly planted in beds of masonry 18 feet square. This will probably hold the weight of the bridge against any ordinary pressure; and unless the slight towers are racked and weakened by the lateral motion caused by the high winds of the winter season, it will probably last as long as the other. The inside measurement of the bridge will be 10 feet in the clear. Publicly opened Jan. 2, 1869.

The Nashville Suspension Bridge. — The floor of this bridge over the Cumberland River, Tennessee, connecting Nashville and Edgefield, to replace one destroyed during the war, is about 100 feet above low-water mark. It has a carriage-way with a foot-path on each side. Two cables, 8 inches in diameter, support the structure, the span being 650 feet and the roadway being 28 feet 2 inches wide. At the north end it is slightly higher than at the other. It was built under the direction and superintendence of W. F. Foster, C. E.

Bridge over the Mersey. — One of the finest railway bridges in Great Britain has just been thrown across the Mersey River, at Runcom. It is a girder bridge 1,000 feet long, and is supported on stone piers rising 75 feet above high-water mark. The span of each division is 327 feet, and there are 97 arches, each of 60 feet span. By the completion of this bridge the distance between London and Liverpool is shortened by 15 miles. The cost of the structure was about $1,250,000.

Bridge over Seekonk River. — The Boston and Providence Railroad are constructing a bridge from India Point, over the Seekonk River, on a plan which embraces some new features. The whole length of the bridge is 876 feet, and the supports in the river are iron cylinders filled with wooden piles and concrete. Six of these cylinders are 6 feet in diameter, and contain 12 piles, which were driven into the mud 40 feet, the cylinders being sunk 10 feet. Iron cylinders filled with concrete have been used before, but driving piles within them, and the combining of wood and concrete, is a new experiment.

Projected Lever Bridge. — Under this name, Mr. Liscom, of Boston, has constructed a bridge by which he claims that he can span streams or ravines 250 feet wide, without using in the process of construction any piers or supports below, or suspensory chains above, and doing away with braces and stringers. By weighting the shore end properly, he projects forward his bridge, gradually extending it and adding corresponding shore weights, till the structure meets a similar projection in mid-stream from the other side. He states that he has built, at a small expense, several bridges on this plan, which apparently sustained the weight in a satisfactory manner. A stream of 200 feet in width would require 260 feet of bridge. Many bridges, constructed on this principle, are thrown across chasms in the Himalaya mountains, and in India, where any support from below, during or after the construction, would have been impossible.

Proposed Railroad Suspension Bridge across the Hudson River. — The precise locality has not yet been determined, but it will be somewhere between Verplanck's Point and Buttermilk Falls. The proposed bridge is one link in the railway intended to connect the Erie road with railroads on the east side of the river. The road will run from Turner's on the Erie Railroad, to Derby in Connecticut.

The following are some of the dimensions of the proposed bridge: Clear span, 1,600 feet; length of bridge between the towers, 1,665 feet; total length, including approaches, 2,499 feet; height of bridge above high water, 155 feet; height of towers above the water, 280 feet; working safe load for the railroad lines, 2,400 tons; working safe load for the highways, 2,880 tons; total safe load for the bridge, 5,280 tons; load that would break the bridge, 25,171 tons; miles of steel wire in cables, 70,302; total weight of iron and steel in the bridge, 17,005 tons; total amount of masonry, 58,084 cubic yards; total suspended weights, 9,651 tons.

There will be 20 cables in 4 systems; each cable will be 14 inches in diameter. The bridge will carry at one time 32 passenger-cars; it would carry safely 34,560 people and 60 locomotives, if they could be placed upon it at once; 18,000 people and 53 locomotives would fill it. From the dimensions given above, it will be seen that this bridge will be longer than any one yet built on the continent, though a span of 1,610 feet is projected in the bridge undertaken to be built across the St. Lawrence at Quebec. — *Scientific American.*

Franz Joseph Bridge at Prague. — This is built on the rigid suspension principle of Mr. R. M. Ordish, of Westminster, England. It was formally opened June 21, 1868. About a month before the opening it was tested in the following manner: The foot-paths were loaded with bricks, 80 pounds per superficial foot. While this load was on, a double line of vehicles, each loaded with 4 tons of old rails, was driven on to the bridge, remaining there for about 10 minutes. The total deflection obtained with the bricks and the moving load was 7⅞ inches, the calculated deflection having been 8 inches. After moving the loads a permanent set of seven-eighths of an inch was registered, the test giving entire satisfaction. The bridge is 820 feet long between abutments, and 32 feet wide. The total cost was £57,000.

Railroad Bridge across the Mississippi. — On the 7th of November the formal opening of the Quincy (Ill.) Railroad Bridge across the Mississippi River took place, making an unbroken railway line from the East, via Chicago, to Kansas City on the Missouri. When the bridge at this place shall be finished the through line will penetrate the heart of Kansas. We copy from the "Chicago Railway Review" the following description of the bridge: —

"The first stone was laid Sept. 25, 1867, the last Aug. 5, 1868. Its total length, including embankments, from the Chicago, Burlington, and Quincy to the St. Joseph Railroad tracks, is about 2 miles. The draw portion of the bridge spanning the main channel of the river consists of 2 spans of 160 feet each; and the main bridge consists, otherwise, of 2 spans of 250 feet, 3 of 200, and 11 of 157 each, — making a total, with the mason work, of 3,250 feet. The embankments and trestle-work between are 1,400 feet in length; Bay Bridge, 613 feet; 1 draw, 190 feet long; and 4 spans of 85 feet each. The bridge is elevated 10 feet above high-water mark, and 20 feet above low-water mark, on stone piers. The masonry and foundations are the work of the Bridge Company, under the direction of the Chief Engineer. The superstructure is of iron, on the Pratt truss principle. Every piece of wrought iron in the ties, links, bolts, etc., was tested in a hydraulic press up to 23,600 pounds to the square inch, and struck with a hammer, while under tension, before being used in the bridge. Theoretically, the strength before the effect of the load becomes apparent in stretching is 28,000 pounds to the square inch; while the ultimate strength is 60,000 pounds to the square inch. The bridge is so proportioned that a train of 2 locomotives and the heaviest freight cars strain the iron only about 7,500 pounds to the inch."

The tests made were these: —

Three of the heaviest locomotives were coupled and placed at rest centrally upon the span 250 feet long, and the deflection or yielding of bridge very accurately observed by means of instruments. The total weight of the load was 300,000 pounds, and the maximum deflection at the centre of the span was 2.4223 inches, being one-sixteenth of an inch less than the deflection previously calculated.

The same load was then placed upon a span 157 feet long, and a deflection produced of 1.375 inches, which varied but little from the result of previous calculations.

The 3 locomotives, still coupled, were then run over the 157 feet span several times, at rates of speed varying from 10 to 16 miles per hour. The deflection produced was 1.406 inches, being an increase of only 3.1 inches over the deflection while at rest. Probably no severer strain than the above will ever be applied to the bridge in actual use. In each case, on the removal of the load, the bridge at once resumed its previous form.

The strain applied to-day was 5,100 pounds to the square inch of wrought iron, and 5,800 pounds per square inch of cast iron.

On the 157 feet span, the strain applied was 9,000 pounds to the square inch on the wrought iron, and 10,200 pounds to the square inch on cast, being about one-quarter more than the strain produced by the passage of the heaviest freight trains. All the wrought iron had been tested before being used by a strain of 23,000 pounds per square inch. Specimens of the wrought iron which were subjected to the ultimate strain broke only at from 60,000 to 80,000 pounds per square inch. The total cost of the structure was $1,500,000. — *Scientific American.*

THE LIFE OF IRON BRIDGES.

It may be assumed that a wrought-iron girder-bridge, subjected at intervals to a dynamical load not exceeding the fourth part of its powers of ultimate resistance, will be safe for traffic for a period of 328 years. This assumption is based upon the proviso that the successive alternations of strain and repose should not be repeated more than 100 times during the same day. With the exception of some country lines and rural branch railways, the number of trains of every description passing over bridges in 24 hours considerably surpasses the limited number 100. Taking the traffic during the night to be only one-third of that during the day, we may conclude that, as a low average, 200 trains pass daily over the majority of our metropolitan and suburban railway bridges, and, as a maximum, the hardest-worked member of the bridge tribe possibly undergoes as many as 300 alternate changes of active and passive conditions from sunrise to sunset. Adapting this calculation to our theory, we may estimate the life of the hardest-worked railway girder to extend over a period, in round numbers, of 100 years, under ordinary circumstances.

A difference will obviously present itself respecting the ultimate durability of cast and wrought iron girders individually. When the former fail they fail completely; there is no repairing a fractured cast-iron beam, whatever shape it may possess; it is only fit for the cupola or the puddling furnace. The same circumstances do not attend the dissolution of wrought-iron girders, provided they are well watched and the "first symptoms" attended to. The Menai Bridge, for example, might be replaced piecemeal, accordingly as every plate, angle iron, or other portion of it becomes deteriorated to an extent sufficient to imperil the safety of the structure. In this sense a wrought-iron bridge is practically indestructible, since it admits of any and every degree of partial repair, and, after the lapse of its first hundred years of life, may be completely rejuvenated and commence a fresh career. Lattice bridges — those constructed upon the open-web system — in general afford special facilities for this process of gradual reconstruction, since a bar can be taken out and replaced without in any manner jeopardizing the safety of the remainder. The external effects, or visible appearance of the influence of time, must not be confounded with that invisible and inexplicable action that is incessantly in progress in connection with the molecular composition of the material. For similar reasons that the wrought-iron girder, as a structure, can be preserved by successive reparation from the results of visible corrosion and decay, so is it also independent, in some degree, of any atomic alteration, unless we imagine the whole girder to be equally affected, and to fracture precipitately like one of cast iron. It has always been a puzzle to engineers to satisfactorily account for the sudden fracture of cast iron, whether in the form of girders, axles, or engine-beams, under a much smaller strain than what they had previously borne with impunity for a long period of time.

Whatever the exact nature of the change may be, or the rate at which it progresses, until the cohesive power of the material is injured, it is impossible to assert; but we are nevertheless certain that the continual repetition of severe strains on a girder must ultimately impair its powers of resistance. In a word, then, upon this hypothesis, every cast-iron girder is doomed to break at some time or another, and, what is worse, break suddenly, the precipitation of the passing load into the gulf beneath being the first sign of danger. —*Engineer.*

EAST BOSTON TUNNEL.

Mr. Clemens Herschel made a communication to the Massachusetts Institute of Technology, illustrated by models, on a method of building subaqueous tunnels. The subject was interesting at the present time on account of the advantages derivable from a direct communication of some sort between Boston and East Boston. The great objection that has heretofore been constantly brought up against tunnels under rivers is the supposed extreme difficulty and cost of their construction. The cause of this general opinion is traceable to the difficulties encountered in building the Thames Tunnel.

It was shown how in that case the work was done under constant danger of the water breaking in; how the water did break in a number of times, and how the bed of the river was then artificially restored by filling in with bags of clay, through which the tunnel was afterwards carried,—operations necessarily very costly. By the proposed method there is no tunnelling, properly so called, to be done. The water above and in front of the tunnel is got rid of by means of an iron coffer-dam, and the tunnel is built in sections or lengths of about 100 feet at a time, inside the coffer-dam, open to the sky, making little more work, after the coffer-dam is in place and the water pumped out, than it would be to dig a cellar and arch it over. The coffer-dam is sunk by digging out the earth immediately under its walls; the walls are double and the space between is divided into chambers, each one of which is accessible from above, and in which any labor can be performed that has already been done in such compartments, when used for making the foundation for bridge piers, by the known pneumatic methods.

At a recent hearing before the Harbor Committee of Boston, at which the State Harbor Commissioners and many engineers were present, it was generally acknowledged that the old objections of excessive cost and difficulty were not valid against the method proposed in this communication.

The objection often made, that tunnels are too disagreeable for foot travel, does not hold good on examination. Judging by railroad tunnels, it is inferred that all tunnels are necessarily dark, damp, and unpleasant places, whereas, by ordinary efforts, they may be made pleasant. The advantages of a tunnel over a bridge are, that it offers absolutely no impediment to navigation, and requires less cost to maintain it. By making the descent on this, and the ascent on the other side, with no steeper grade than 3½ in 100, a common grade as found in the streets, we should have for a tunnel between Boston and East Boston about 550 feet of open cut, and 1,000 feet of tunnel under ground on each side, and 1,500 feet under the river. The estimated cost of such a tunnel, to be built by this method, is $1,337,685.

The greatest depth in this channel at low water would be 32 feet, and about 40 feet at high water. The bed of the channel is a firm clay, and very favorable for the building of such a tunnel from

Boston to East Boston. The tunnel would be sunk below the bed of the channel, and the weight of its solid masonry would be such as to overcome any tendency to rise from hydrostatic pressure, if by chance a film of water, communicating with the superincumbent water, should gain access to the under surface of the tunnel.

HOOSAC TUNNEL.

The Joint Standing Committee of the Legislature of 1867, upon the Hoosac Tunnel, have made a report to the Legislature in regard to the progress made in the work during the last year.

The total progress made on the east-end heading during the year was 1,187 feet, — more than double the advance made in 1866, and giving an average of 118.17 feet per month during the last half of the year. The sides of the tunnel have been enlarged to the full width during the past year, a distance of 2,400 feet from the portal.

The total number of men employed upon the tunnel on the 1st of January last was 509, and the amount expended on the tunnel from November 1, 1866, to January 1, 1868, was $603,666. The total cost of the tunnel up to the commencement of the present year has been $2,086,640.

The distance accomplished in the east heading in November was 126 feet; in December, 101 feet; in January work was suspended owing to the accumulation of anchor ice; in February, 131 feet; March, 112 feet; average cost per cubic yard, $9,14. Thirteen hundred feet of the east end has been enlarged since November, at an average cost of $5.98 per cubic yard.

The following figures show what had been accomplished in the entire work to April 1st, and also what remains to be done to complete the tunnel: East-End Heading, 4,951 feet; West Shaft, East Heading, 1,396 feet; West Shaft, West Heading, 692 feet; West End, 659 feet; West-End Arch, 612 feet; Well No 4, 207 feet; Depth of Central Shaft, 583 feet.

Distance yet to go: From East-End Heading to Central Shaft, 7,886 feet; from Central Shaft to East Heading, West Shaft, 8,351 feet; from West Heading, West Shaft, to Well No. 4, 232 feet; from Well No. 4 to West-End Heading, 864 feet; from bottom of Well No. 4 to Grade, 8 feet; from bottom of Central Shaft to Grade, 447 feet.

TUNNEL UNDER THE TEES.

The following is a plan of Mr. Head, of England, for tunnelling the River Tees from Middlesboro' to Norton Junction.

"I propose that it should be a single wrought-iron tube, but divided into two passages by a water-tight web or bulkhead. This division should be strong enough to resist the pressure of the water, and preserve, at least, one side for traffic in case of accident to the other.

"As to the construction of the main tube, I would recommend something on the same principle as that exhibited in the hull of the *Great Eastern* steamship; that is, an outer and inner shell, for security and strength. The bottom should be made flat, or slightly arched downward. The whole section would thus resemble that of a gas retort or culvert.

"The best plan for placing the tube in position seems to be as follows: as near as possible to the point of crossing it should be constructed by the river side, in a temporary dry-dock formed by earthen embankments, and at such a level that the tide would float it, if admitted by the removal of a dam. The tube should be erected upon timber balks placed crosswise at intervals of 5 feet, and bolted to the structure.

"These would be floated away with it, and afterward serve as sleepers.

"Meantime, the groove in which it was intended to lie would be cut across the channel of the river by dredges. It is no new thing to dredge to an increased depth of 30 feet. It is, in fact, the cheapest method of excavating in all cases where it can be applied. The new Suez Canal has been greatly indebted to the use of dredging in the formation of its approaches. Dredgers have even been made to cut their way into the solid shore, the water following to float them as they made a channel for it.

"In the bottom of the groove so prepared concrete must be tipped from barges, and spread to a level by the aid of diving-bells.

"When the tube was completed it would be necessary to cover over the ends temporarily to make it water-tight. It would then easily be floated out of the dock to its permanent position. To let in sufficient water to sink it would not occupy many minutes more. The interval between the ebb and flow, which at spring tides is about an hour, would be ample to accomplish everything necessary. Concrete might then be put in at the sides and over the top, and in this way, assisted by the natural tendency to silt up, it would soon become permanently fixed. Embankments of clay would now be thrown out from the shore on each side of the line of the approaches, and would join across the end of the tube. As soon as they were made water-tight with clay puddle, the water between must be pumped out and the approaches built in the intervening space." — *Engineering.*

SYPHON UNDER THE SEINE.

The city of Paris is now trying to execute a new piece of engineering work, which has thus far taxed all their engineers to the utmost. The problem to solve was to unite the two systems of main sewers, which are now nearly finished on both sides the Seine, by means of a syphon. The width of the river at the point to be crossed is 350 feet. Two wrought-iron tubes, each 3 feet 10 inches in diameter, were built upon the quay, by the side of the spot to be crossed. Then they were firmly riveted together and made air-tight, closed at both ends and launched sideways into the water. These floating tubes, slightly raised in form at each end, but raised higher on the side of the sewerage entrance than at the other end, were then wheeled round over the spot where they were to be sunk. Preparatory to this, a bed had been dug out at about 10 feet below the bed of the river and filled in with concrete. On this bed the two syphons are to rest, then to be covered with concrete flush with the bed of the Seine. They were first loaded with about 1,200 tons of pig iron, and not being sufficiently "stiff" in position they capsized and dropped the pig iron into the river. They have now, however, placed heavy timber to prevent a recurrence of this, and in the course of a day or two these enormous tubes are expected to lie quietly, side by side, in the placid stream, and do their part in purifying its waters within the boundaries of Paris, as all this sewerage is carried under the city and pours into the river at Asnieres, about 14 miles below the city.

THE CHICAGO-RIVER TUNNEL.

Work on the Washington-Street tunnel is rapidly progressing, and there is little doubt that this great thoroughfare may be opened in the early spring. The obstructions are to be removed from the river by December 1. Six hundred and sixty-five feet of the arching are already finished, leaving 265 feet still to be built. The east excavation is now 80 feet inside the river-bed. On the west side the excavations are within 25 feet of the river. The general plan of the tunnel is already known.

Single passages, for horse and foot separately, are built to the water's edge, where the passage is doubled for the carriage-way, extending 220 feet, one side for going east, and the other side for the west, thus preventing any danger of collision. The foot-path is 6 feet above the carriage-road, in the middle of the tunnel. When all the arches are completed, the top is to be covered with masonry, making all level; over this will be a coating of government asphaltum, poured on hot, and thus running into and filling all the seams, and forming a water-tight sheeting; over this again, large, heavy flag-stones, of the usual white stone, are to be laid, and the joints filled with asphaltum. Then the water is allowed to flow over all. Between each course of brick in the arches is a half inch of cement. Beneath the centre of the passage-way, under foot, is a sewer 120 feet long, — over 100 feet of which is now built, — leading to a well in the centre of the tunnel bottom, into which all water accumulating in the tunnel flows, and is pumped up by a powerful engine to the surface and back to the river. The cost of the tunnel for material and labor is about $8,000 per week. The original contract was $328,500, but the actual cost will not be less than $500,000. — *Chicago Post.*

The whole length of the work from the centre of Franklin Street to the centre of Clinton Street is 1,605 feet, of which 932 feet is the length of the tunnel; the remainder consists of the open approaches. Opened to the public Jan. 1, 1869.

The old company began work close to the river, and excavated vertically down; but the present company commenced at the ends, and are approaching the river both ways. The main tunnel forms a double-track passage, and a separate tunnel in the same excavation a passage-way for pedestrians. A coffer dam encloses half the width of the river, and an open cut will be made to the centre of the river, and the tunnel built to the end of the excavation and closed. The water will then be let in, and the other half enclosed in a similar way, and the remainder of the cut made and the tunnel completed.

MOUNT CENIS TUNNEL.

On June 1st, 1868, 8,384 metres had been completed. During the month 60 metres additional were finished on the southern side, and 54 on the northern, making a total of 8,498 out of the whole length of 12,220, leaving 3,722 metres yet to be executed. It appears that at the close of 1867, 4 miles and 5,035 feet of the Mount Cenis tunnel had been completed, leaving 2 miles and 4,018 feet still to be pierced. The distance pierced in 1867 was 5,040 feet, as compared with 3,416 feet in 1866, 4,079 feet in 1865, and 1,144 feet in 1860. The outlay, during 10 years, upon the work, amounted, at the close of 1867, to about $8,000,000. The year 1871, it is expected, will witness the completion of the tunnel. Its total length when finished will be 7 miles, 3,773 feet, and its total cost is estimated to reach the sum of $12,000,000, or something more than $1,500,000 per mile.

HEMPEN TELEGRAPH CABLES.

Capt. Rowett, R.N., has patented a simple hemp covering for the external part of telegraph cables, leaving the conductor and the insulation of the cable to electricians. Iron cables, like the first Atlantic, become fragile from oxidation; the iron wires of the present cable, though galvanized, and protected by a hemp covering, will rust in course of time, and in so doing will destroy the hemp immediately around them, just as a rusty nail does the wood in which it is driven. Hemp alone will remain good for more than 50 years. In his process the hemp is steeped in a preserving solution, which renders it safe from the attacks of teredos and worms, and the attachment of marine plants. His ropes are flexible, easily handled, and, being of a very light specific gravity, comparatively much stronger than a cable of mixed iron and hemp. An iron wire will break with 3 miles of its length in the sea; the Atlantic cable will bear 11 miles of its length; but a hempen cable alone will bear nearly 20 miles of its length; so that the latter will afford ample strength to bridge any submarine valley over which it may happen to be suspended. The Atlantic cable cost £300 per mile; the hempen cable will cost only £130 per mile.

AMERICAN COMPOUND TELEGRAPH WIRE.

There is a growing tendency in this and other countries to employ larger wire for telegraph purposes, in order to obtain a greater conducting capacity.

Notwithstanding the many disadvantages attending the use of large telegraph wire, No. 4 has been adopted on important lines and for long circuits, in England, Russia, and other countries, solely for its superior conductivity; and it is well understood by telegraphers in general, that, for the rapid and successful operations of the circuits, much depends upon this element. Especially is this the case in wet weather and upon long lines.

Under certain conditions of the lines, consequent upon wet weather, superior conductivity will accomplish that which increased battery power utterly fails to do; and repeaters at intermediate offices, with their necessary main batteries, accomplish but imperfectly and unsatisfactorily, as a general rule, and in many cases fail altogether.

Pure copper wire, having a conducting capacity of nearly 7 times that of galvanized iron wire, has a great advantage in this respect for telegraph purposes. Its use, however, has been prevented in consequence of lack of sufficient strength to sustain itself.

In the American Compound Telegraph Wire this vital objection to the employment of copper alone for this purpose is obviated, and a conductivity and relative strength, superior to that of galvanized iron, are combined in a lighter wire.

The composite parts of this wire are steel and copper, the steel forming the core, and serving mainly for strength, while the copper serves more especially as a superior conductor.

In regard to relative strength, it is well known that the breaks in ordinary galvanized telegraph wire, occasioned by accumulations of ice and snow, and from other causes, occur at weak points, or at imperfections which are caused by flaws existing in the iron before galvanizing, as well as from the effects of that process.

It is therefore claimed that the compound wire, even with a relative strength no greater, theoretically, than that of a galvanized iron wire, will be much less liable to breakage from these causes, in consequence of the uniformity of strength in the steel core, while, in fact, the relative strength itself of the compound wire is very much the better of the two.

Steel wires, of sizes varying from No. 12 to No. 16, stretched from pole to pole, across streams from one-quarter to three-quarters of a mile in width, in the United States, which have withstood the accumulations of ice and sleet for years, are good illustrations in this connection. One special instance may be cited, of a No. 16 steel wire, between 1,400 and 1,500 feet in length, which has been in operation across the Kennebec River, in Maine, for the past 8 years, and which has parted twice only during that period, — in each case having been untwisted at a joint by the great strain upon it caused by an immense accumulation of ice, the wire itself remaining intact.

Large wire is used only because of its superior conductivity; and it is obvious that a light wire is preferable in handling and stringing, which can be done with less labor.

Also, maintaining a superior conductivity and relative strength, the lightness of this wire will admit of an average of at least 10 poles to the mile less than would otherwise be necessary.

This reduction in the number of poles per mile will not only conduce to economy in construction, but it will effect a decrease of 25 per cent. or more in escape of the electric current.

In stringing over the tops of buildings, stretches may be safely made double the length of those taken with the ordinary telegraph wire, and yet with less strain upon the insulators.

Another point in its favor is the imperishable nature of copper, which, in this wire, is the exposed metal; the zinc coating of the galvanized iron being deteriorated near the sea, and from the effect of gases, etc., from chimneys, while copper will remain, under such conditions, unimpaired. In fact, under all circumstances, the durability of the compound wire is greatly superior to that of the galvanized wire in general use.

In the construction of lines there are many cases in which the expense of transportation of telegraph wire from the manufactory to its destination is an item of considerable magnitude. With the same or a much greater conductivity, as compared with galvanized iron, the compound wire weighs materially less, with no disadvantage whatever arising from its lightness.

Referring again to conductivity, which has been the chief point in the production of this wire, it will be observed that this element may be largely increased without sacrificing strength, and without recourse to an unwieldy medium for conduction.

Increased conductivity admits of a reduction in battery power, with a consequent decrease in the escape of electricity. Long circuits are worked with greater facility, and the rains and the fogs lose their power to prevent the passage of the electric current where it should properly flow.

The term "relative strength" denotes the quotient obtained by dividing the strain which would break the wire by its weight per mile.

The compound wire need have only about one-third the weight of galvanized iron wire to be relatively stronger, and at the same time to possess equal or greater conductivity.

It is evident why this should be so, since the best commercial copper possesses more than 6 times the average conducting capacity of galvanized iron wire; and the steel which enters into the compound wire has nearly 3 times the tensile strength of galvanized iron wire of equal size.

The relative strength of the steel which is used in the American compound telegraph wire averages 7.47; that of the copper, 1.72; while the average relative strength of galvanized iron wire, as found by testing various samples of the best in the market, is only 2.9.

It is evident that, by varying the proportions of steel and copper in the compound wire, any desired relative strength can be given between the limits of 1.72 and 7.47; and at the same time any desired conductivity can be had along with it.

It will be seen, however, that a high relative strength is more costly than a low one; for the reason that steel possesses a less specific conductivity than copper, and this difference of conductivity is greater than the difference of cost.

But, in the construction of lines of telegraph, while an increased relative strength adds to the cost of the wire used, it, on the other hand, effects a saving in the number of poles and insulators required, thus reducing the total cost of material and its transportation, which is often of great importance; therefore, increased relative strength is on the whole more economical.

We can get the conductivity of a No. 8 galvanized iron wire by using a compound wire weighing only 80 pounds per mile. Such a wire would be handled with the greatest ease, as a man could readily carry a mile or more upon his back.

All the advantages of a heavy iron wire, which would weigh from 500 to 700 pounds per mile, can be secured by a compound wire weighing less than 175 pounds per mile.

Other sizes than these can be made possessing intermediate or greater relative strength, and of any desirable conductivity.

The foregoing results are based on the employment of a copper which shall possess seventy-eight one-hundredths of the conductivity of a chemically pure copper wire.

The standard unit of conductivity here employed is that of a round copper wire one-twentieth of an inch in diameter, chemically pure, and 1 foot in length.

ARTIFICIAL STONE.

A method of manufacturing artificial granite has recently been patented in England. The materials of this artificial granite are disintegrated natural granite, mixed with clay, together with pounded glass, lava, and iron slags. The disintegrated granite is obtained by submitting fragments of natural granite to a strong heat, about 700° or 800° C., in an oven, by which, after a sufficient time, it becomes dissolved into a granitic sand, the constituent parts of which, quartz, or feldspar, possess great powers of adhesion. One part of this granitic sand is then mixed with an equal quantity of pounded glass, or the constituents of glass, or lava, or iron slag, to which is added from 20 to 30 parts of refractory clay, or from 30 to 50 parts of ordinary clay. This mixture is thoroughly kneaded together with a sufficient quantity of water to make it of a pasty consistency. It is then moulded to any form required, and submitted to a degree of heat sufficient to vitrify the mass for about 36 hours, which converts it into a durable substance resembling granite. The artificial granite thus produced may be moulded into any forms required to render it suitable for various kinds of buildings, fortifications, docks, and other engineering structures, and particularly for all kinds of pavements, for which its great hardness renders it particularly suitable. When very large blocks are required, it is preferable to make them hollow, and, after they have been baked or burnt, they may be filled with concrete, rubble, etc., to make them solid. Any kind of furnace in which the requisite heat can be generated will answer for dissolving the granite, and baking or vitrifying the blocks or bricks. — *Scientific American.*

The following is the process of Mr. G. A. Frear, of Chicago: —

"The nature of my invention consists in the use of an aqueous solution of gum-shellac, or its equivalent, in cementing together particles of silex, alumina, calcium, or other mineral substances, to produce, artificially, a hard and durable stone, stucco, cement, or paint, for useful or ornamental purposes.

"My shellac solution is best obtained by boiling the gum-shellac of commerce in water previously made alkaline by the addition of any suitable alkaline salt in proper proportion. The proportion of shellac, alkali, and water may, and necessarily will, vary with the strength and quality of the solution required in producing various descriptions of stones, cements, etc.

"In the manufacture of artificial stones for building purposes, I use a solution obtained by first dissolving from 2 to 4 ounces saleratus, potash, soda, or other equivalent alkali, in about 1 gallon of pure boiling water, and then adding thereto 1 pound of gum-shellac, boiling the mixture until the gum is entirely dissolved.

"A firm and durable stone, impervious to moisture, is produced by dampening a mixture of about 1 part of lime or cement and 4 parts of sand or other silicious material (with or without gravel or other ingredients) with my aqueous solution of shellac, and then firmly compressing the composition into moulds of any desired form, either by suitable machinery or by hand, with mallets or tamping rods.

"The blocks or other articles thus produced will rapidly harden when removed from the moulds, and in a few days are ready for building purposes. I prefer to obtain the compression of the material by percussion rather than by simple pressure.

"To produce a more perfect finish, I contemplate washing the surface or face of the artificial stone thus manufactured, 5 or 6 days after moulding the same, with a weak solution of shellac dissolved in alcohol, ether, or spirits of turpentine (say about 1 pound of shellac in 1 gallon of the spirits).

"Instead of using a mixture of lime or cement and sand, to produce an artificial stone, I contemplate moistening simple sand, clay, lime, chalk, or other earthy or mineral substance, as well as any combinations thereof, with my aqueous shellac solution, and the moulding the same, by percussion into suitable blocks or other devices, so that an endless variety may be obtained therein at pleasure.

"To produce a mastic or stucco, I add so much of my shellac solution to lime, sand, clay, or any earthy or silicious material, or to mixtures thereof, that the material or mixture shall be reduced by the solution to a pasty consistency, which can be readily worked and applied with a trowel. If then applied to any surface it will firmly adhere thereto, and, upon hardening, produce a firm, water-proof surface, which may be made to resemble stone so closely as not to be readily distinguished therefrom. By making the composition still thinner, it may be used as a substitute for paint, and it will also form a strong and adhesive cement for stone-work, etc.

"Through a proper choice of the sand or other substances forming the basis of my improved artificial stones, etc., or by the use of coloring matter in connection therewith, nearly all descriptions of natural stone may be imitated, and any colors or shades of material obtained, at pleasure.

"In applying my improved stucco or mastic to buildings, whether of brick or stone, I first wash the surface with my aqueous shellac solution preparatory to laying on the composition hereinbefore described."

Making stone is a business in St. Louis. There is a firm there which makes out of common sand a mantel equal to one of white marble, and sells it for about 10 dollars. The sand in a few hours is converted into rock precisely similar to the strata and ledges beneath the earth that required ages of aqueous and igneous action to form them. The process is strictly scientific and chemical. The materials used are common brown or white sand, soda, flint, chlorine, and calcium. The flint, which is the cementing agent, is melted by being subjected to heat, in connection with soda. Flint, in its chemical constitution, is an acid, and, like all other acids, readily combines with an alkali. Combined with soda, the flint (silica) forms a silicate of soda, — a thick, viscid, transparent substance, very much like glue. If it is too thin when first made, it is reduced by evaporation in pans till it reaches the proper consistency. It is then mixed with the sand, in a mill from which the mixture comes forth a good deal like wet brown sugar. This substance is called "pug." It is very plastic, and works as easily in the hand as wet clay or putty. Each moulder has a quantity of the "pug" placed in a box on the end of his work-bench, from which he takes handfuls as he requires it to press into the mould. It matters not whether the mould is a rosette, a diamond, a flower, or a leaf ornament, a keystone, a vase, a pedestal, or a section of a mantel-piece, he moulds anything and everything with equal ease, beauty, and accuracy; and when the form is taken from the mould the product is a plastic ornament more perfect and beautiful than a carver could execute in a week of constant and patient labor.

The following is the process of the Messrs. McCaine, of Groton, Mass: —

"In the preparation of such stone, we use, as a cementitious agent or agents, calcined magnesia and bittern water, and our invention consists in an artificial stone, made by combining, with stone chips and finely pulverized or powdered stone, magnesia and 'bittern water,' the residuum from salt works.

"The proportions and the process of combination preferred by us are as follows: to 20 parts, by weight, of comminuted stone and chips of stone, we add about 1 part of calcined magnesia, and mix them together, with sufficient bittern water to form a stiff mortar, which mortar may be moulded and pressed, or simply moulded, or applied with a trowel.

"Heat may be used to hasten the hardening process; but this is not generally necessary, as the stone dries well in the open air, and indurates perfectly in 2 or 3 weeks, without any application of artificial heat.

"By this process, sand, soapstone, marble, or other mineral substances, in broken, pulverized, and comminuted form, may be used for the production of blocks and slabs, the invention being particularly valuable for the utilization of chips in stone quarries, and of marble, soap-stone, and slate-stone dust and chips, in places where these minerals are worked. The stone so made answers perfectly for building purposes, for tiles, for stone sinks, stoves, etc., and, generally, the same purposes for which bricks, clay, and stone blocks and slabs are employed.

"The relative quantities of finely pulverized and of broken materials that are used depend somewhat upon the size of blocks that are to be formed; but it is only necessary for the producing of the stone that the mortar, made up of the pulverized stone and the calcined magnesia and bittern water, should fill all the interstices and spaces between the broken stones or chips."

PRESERVATION OF BUILDING STONE.

An Illinois architect has invented a process for preserving from decay and disfigurement the beautifully colored stone called "Athens marble," which is now used very extensively at the West for building fronts. This stone is composed principally of carbonate of lime, carbonate of magnesia, and silica, but among the minor ingredients, protoxide of iron pervades the whole mass, giving the characteristic blue-greenish tint, the main cause of its beauty, but the cause also of its decay, as exposure to the atmosphere converts the protoxide into hydrated sesquioxide of iron, or iron rust. To remedy this action the stone is coated with a soluble glass, made by melting a mixture of 15 parts of silica, 10 of soda, and 1 of charcoal, until it forms a glass which is reduced to the liquid form by boiling in water. This solution permanently fastens itself to the surface and protects the stone from the atmosphere, smoke, and dust. — *Scientific American.*

LARGE ROOF.

The metropolitan station now being erected for the Midland Railway at King's Cross, London, is nearly as great an advance in the construction of roofs as the Great Eastern was in the building of ships. The new building is erected alongside of the Great Northern Station, which was a short time since regarded as a tremendous structure. Some idea of the advance made of late years may be obtained from the fact that the span of the single arch is 30 feet wider than the span of the 2 arches which cover the Great Northern Station. It has never before been attempted to cover a space of 240 feet with 1 span for the purpose of forming a roof. In bridge-building much wider distances have been spanned, but it has hitherto been thought unnecessary to cover so wide a space with 1 roof. It is not very apparent why the attempt has now been made, as 2 arches would have been much more economical, and, we should have supposed, equally convenient. The height of the arch from the rail level is 99 feet, and the rails 13 feet 6 inches above the road level. There will be 11 lines of rails, and the space underneath is to be made available for cellars, of which there will be about 4 acres. —*English paper.*

FIRE-PROOF FLOORS.

At different periods within the last few months a series of experiments have been instituted, by Mr. Richard M. Hoe, for the purpose of finding a cheap substitute for the iron beams and brick now commonly used in fire-proof buildings. The last experiment was made on Friday, May 15, at which many persons were present, including members of numerous insurance companies and officers of the fire department. The trial was made in a vacant lot on Sheriff Street, New York, where a specimen floor had been erected. This floor was 10 feet by 10, and was placed upon upright posts of about 4 feet in height, beneath which, precisely at 9 o'clock, a large fire was kindled. Several men were kept constantly engaged in feeding the flames, and a high degree of heat was attained. This was kept up to 12 o'clock, — 3 hours, — when, there being no indications that the floor would be destroyed, the fire was allowed to die out, and the men were permitted to build one on the top. This being done, the flame was rekindled below. These two fires were now constantly supplied, and the burning was continued until 4 o'clock, when all present were satisfied of the successful issue of the experiment. The floor was then taken to pieces and its construction explained. It is about the usual thickness of floors separating different stories, the lower surface being made of thin plain sheets of iron, No. 21 wire-gauge, which are nailed to the beams. Spread out upon this sheet-iron ceiling was poured a layer of plaster of Paris to the depth of 1¼ inches; on the top of the cross-beams were nailed more sheets of iron, and upon these a layer of plaster of Paris one-quarter of an inch in thickness. Above the whole were fastened the planks, forming the upper surface of the floor. On examination it was shown that the beams were not at all injured, and this, too, after an intense flame had been burning steadily above and below for more than 4 hours. The planks on the upper part had, of course, been burnt, but that detracts but little from the worth of the invention. The cost of a floor of the size described above is $30.10; the cost of a building made in this way will be about one-half as much as the brick and iron beam buildings. Fire-proof paints protect only the exterior of a house, or the part least likely to catch fire; while, on the other hand, a building constructed after the Hoe plan will be thoroughly free from danger. — *American Artisan.*

HEAVY LOCOMOTIVES.

There are good reasons for believing that as soon as steel rails shall have been generally substituted for iron, thereby permitting of weights of from 7 to 9 tons per engine wheel, a much more powerful class of locomotives will be in request. The economy of working the heaviest goods trains is now well understood, and it is only the want of strength in the permanent way that limits the weight and power of 6-coupled engines to the existing standard. Six-coupled engines of a weight of 50 tons or thereabouts, with the weight equally distributed, would require cylinders from 20 to 21 inches in diameter, for 2 feet stroke and 5 feet wheels, and the boiler should not have less than 1,800 square feet of surface, and 30 square feet of fire grate. — *Engineering.*

EUROPEAN AND AMERICAN LOCOMOTIVES.

In England, we see the locomotive engineers, as a general rule, aiming at high speed, as little complication as possible in the parts of the engine, utmost simplicity in all things, perfection of adjustment and workmanship, and high-boiler pressure. Upon this last point we may note that a few years since 50 pounds to the inch was considered high; now 120 pounds and 130 pounds are ordinary pressure, and on the North London line engines are being run at 180 pounds.

France has slow speed and very heavy trains; her engineers aim at large tractive force, do not spare complication, use large quantities of material, and couple numbers of driving-wheels together, making, for example, 12-wheeled coupled engines, things utterly unknown in England, but at the same time they put light weight on those wheels, not more, in fact, than 10 or 12 tons on the axle. The French deserve credit for having developed their engines into a form suitable for their shareholders' ideas of traffic; that is, a heavy engine at slow speed pulling a long load. One expensive necessity has already been evolved in our own country by the quick running of small trains, namely, the necessity for laying down third and fourth lines of rails to accommodate the traffic, at an enormous expense, which could have been avoided if the trains had been worked as on the Great Northern of France. The fuel for a heavy train is much the same as for a light one, or very little increased; but in running double sets of trains over double lines of rails, the wages are doubled; the first cost — that is, line accommodation — is doubled, the number of engines is doubled, while the wear of engines and road is quadrupled.

The American idea is cheap engines. Their locomotives have their parts very accessible, and they run them at fair but not high speeds. The American engines have special arrangements for clearing and lighting the road, and for burning wood in their furnaces. Notwithstanding the superiority of English-made engines, not one of them can run over American lines with anything like the speed, safety, or endurance of their own. Strange as this may at first appear, it is easily accounted for, and the explanation bears on the points we shall presently bring forward. The explanation is, that the leading ends of the American engines are supported on 4-wheeled trucks, or bogies, which, while giving a long wheel-base, and consequently steadiness, allow the engine to travel on exceedingly bad roads, and to traverse sharp curves with ease and security.

The German engines go even slower than the French. The quickest French lines are those from Lyons to Paris, and from Paris to Calais. The proportions of parts of all the foreign engines — particularly the German — are very bad. For instance, the cranks in many cases have double the quantity of material necessary for the strength required, and this extra portion so disposed as to be a perpetual stumbling-weight in their revolutions. Of the Italian lines we know of nothing specific to be said.

The Belgians run their engines at speeds intermediate between the German and French; they follow a medium of English and French make in their construction, and their lines contrast favorably in their working with many others on the continent. This may be attributed to their being under the general superintendence of an Englishman.

The Russians are much the same as the Germans. The engines are mostly of English type, in some cases a cross between the English and American. — *London Herald.*

THE PRINCIPLE OF THE GIFFARD INJECTOR.

Probably there is no mechanical device in common use which is such a puzzle to mechanics and others as the Giffard injector. Its operation seems to defy the best-known laws of the equilibrium of fluids, yet it acts effectually, and under some circumstances is preferable to the pump for feeding boilers with water.

Its construction is simply a pipe fed from the steam space of the boiler to the water space below the water level. The steam-leading pipe is contracted at its lower extremity, between the steam and water level, in a space which is filled with the feed water, a fine jet of steam acting against the feed water and forcing it into the reception-pipe through a small aperture. Of course, necessary valves and cocks are employed.

A correspondent asks, what is the principle employed in the action of this injector? We cannot state it more clearly, so far as it is understood, than to give the opinion of Mr. John Robinson, of Manchester, England. He says: "The pressure on all parts of the interior of steam boilers being equal, some reason must be sought why steam taken from one part is able to overcome the resistance opposed to its entrance in another part of the same boiler. If a pipe conveying steam were turned directly back into the water of the same boiler, it is evident that equilibrium would ensue and no effect be produced. If, on the other hand, a break were made in the continuity of the pipe, so as to leave an interval open to the atmosphere, steam would rush from one pipe and water from the other in the boiler with a velocity proportioned to their different densities. In constructing the injector, the feed-water chamber is placed at the break in the pipe, and this arrangement accounts for the power of the steam to overcome the resistance to its entrance into the receiving-pipe of the boiler. The jet of steam, being concentrated on the water, forces its way through the interval surrounded by feed water, by contact with which it is gradually condensed, and reduced in volume and velocity, until it is entirely converted into water at the throat. In doing so, it imparts to the feed water a velocity proportioned to the pressure in the boiler and its own temperature; and, the water being non-elastic, it acquires sufficient momentum to overcome the resistance in the water space of the boiler." —*Scientific American.*

LOCOMOTIVES FOR COMMON ROADS.

Mr. R. W. Thomson, of Edinburgh, has recently patented a locomotive engine for common roads which promises more success than any other previously invented. Efforts to bring steam into play on ordinary roads long preceded the introduction of railways, the latter of which were used from the uniform failure of engineers to devise a steam carriage capable of running on common roads. Even before the time of Watt attempts of this kind were made. The main difficulty was that the great weight caused the wheels to sink into some kinds of roads, and to slip on others; the whole difficulty lies in the wheels. In Boyder's endless railway there was a common road engine with very large wheels, round the tires of which were loosely fastened short lengths of rails, secured to flat sleepers. As the wheels went slowly round, these pieces came down in succession in front of the wheels, which thus had a kind of very ill-laid railway to travel over. This ugly-looking machine travelled very slowly, and its costly and complex mechanism was soon put out of order; its only merits were that it did not injure the roads, nor did the wheels slip. In Bray's plan the tires were smooth, without any permanent projections; but, in order to secure the necessary hold on the road, there were claws projected and retracted through the tires, operated by ingenious machinery; the claws were soon worn out, and the road punched full of holes. Wheels with flat teeth riveted on the tires take a good hold of the ground, but are very destructive to roads, while smooth wheels slip; so that until wheels can be made that will neither slip nor destroy roads, steam carriages for common roads cannot come into general use.

In Mr. Thomson's engine the tires are made of bands of vulcanized India-rubber, about 12 inches wide and 5 inches thick. This soft and elastic substance not only carries the great weight of the steamer (between 4 and 5 tons) without injury, but it is not even marked by flints and other sharp objects over which the wheels may pass; the wheels do not in the least sink into the road, and pass over the surface stones without crushing them. These tires somewhat resemble the feet of the elephant and camel, whose soft cushions it is well known are much less injured by hard roads than solid hoofs. As it floats along on the India-rubber tires, neither sinking nor crushing, much less power is required to propel it than if it had rigid tires, and scarcely any more on soft or loose roads than on the best-paved streets. Experiments with an engine of this kind are given as follows in the "Civil Engineer and Architect's Journal," January, 1868: —

"The trials commenced by running the road steamer across a soft grass field, and it was afterward taken across a part of the field which had just been covered with loose earth to the depth of 1 or 2 feet, and run straight across, and then back through the deep, soft soil. The weight of the road steamer is between 4 and 5 tons; and yet the wheels, in passing over the loose earth, compressed it so little that a walking-stick could easily be pushed down in the track of the wheels without any exertion. After various evolutions, showing the ability of the road steamer to run where there were no roads, it passed out into the street, and, taking a large omnibus full of passengers in tow, it proceeded up the Bonnington road, where it took a large wagon, weighing, with its load of flour, about 10 tons, up a steep lane full of holes and ruts, and rising with a gradient of 1 in 20. It was obvious that the road steamer was able to do a great deal more than it had to do in this trial. The bite on the road is something marvellous, and the easy way in which it floated along on its soft and elastic tires was very curious. When riding on the road steamer, the feeling is like what would be experienced in driving over a smooth, soft grass lawn. There is, absolutely, no jarring at all. There was no appearance of wear on the India-rubber tires. The original surface which the rubber had when it left the manufactory is still visible. The engine is destined for Java, where it will be employed in drawing trains of wagons between two ports."

NEW ELECTRICAL ENGINE.

This engine, the invention of Mr. Laban C. Stuart, as exhibited in New York, consists essentially of a horizontal central axis about 3 feet in length, armed with a series of electro-magnets, and having opposed to them a set of stationary magnets. With a Bunsen's battery of 40 cells, the axis revolves 500 times per minute. When connection was made with a pump, a simple calculation showed the working power of the apparatus to be one-tenth of a horse-power.

According to the report of the sub-director of the *écoles imperiales d'arts et metiers*, the most efficient electrical engine in

France, where great attention has been bestowed upon the perfecting of these motors, is the apparatus of M. Dubos, which, with a battery of 70 cups, gives a working power of 2 kilogrammetres, or one-thirty-eighth of 1 horse-power. The same authority pronounces the next best engine to be that of Loiseau. This machine, with 12 Bunsen's cells, gives only the one-hundred-twenty-seventh of 1 horse-power. An electrical motor exhibited by an Englishman attracted considerable attention at the Paris Exposition. It was worked by a battery of 50 cells, and was warranted of 1 horse-power. When, however, subjected to an actual test, it was found to be but the one-hundred-fifty-second of 1 horse-power.

Mr. Stuart's engine is evidently superior to either of these machines. The principle of its construction has been so highly commended that he is going on to construct larger ones. In its present incipient state, the apparatus may be employed to advantage in pumping, running sewing-machines, or turning lathes, or other light work. The inventor feels confident that larger engines can be built, with not a proportionate but a far greater increase of power; founding his belief on the fact that doubling the size of the battery much more than doubled its efficiency. The immunity from danger by fire or explosion is a great recommendation which this motor enjoys in common with others of its class. The claims for superiority peculiar to this machine are, the arrangement of the magnets, so that a steady and uniform electrical current is kept up, and so that they are only magnetized twice in each revolution, instead of many times, as in most other motors.— *Scientific American.*

ERICSSON'S SOLAR ENGINE.

Mr. C. H. Delamater communicates an article to the "Scientific American," from which the following are extracts: —

"Captain Ericsson, at the centennial celebration of the University of Lund, in Sweden, last spring, forwarded to that ancient institution an essay showing that solar heat may be so employed as to furnish a large amount of motive power for practical purposes.

"I have witnessed the operation of one of Ericsson's solar engines, to be actuated by atmospheric air heated by the direct intervention of concentrated solar heat. Mechanical readers will be surprised on hearing that the working piston of the model engine makes upward of 300 strokes per minute.

"The simplicity and moderate cost of the means devised to concentrate the solar heat are such that no practical difficulties present themselves to prevent the construction of solar engines of any desirable power; the facility with which the radiant heat of the sun may be collected and concentrated from acres of surface, by the means contrived, will alike surprise and interest the mechanical and commercial community."

"The following translation of the essential part of Captain

Ericsson's communication to the philosophical faculty of Lund, cannot fail to interest your readers:

"'I have, of late years, spent much time and considerable means on experiments to ascertain if the radiating heat of the sun can be concentrated in such a manner as to render it available for the production of motive power.

"'Sir John Herschel's and Mr. Pouillet's experiments relating to the radiating heat of the sun, although interesting, are not satisfactory, as they deal only with low temperatures, showing how much ice may be melted, or what elevation of temperature of water under the boiling-point may be effected in a given time on a given surface. The purpose of my investigations and experiments, on the other hand, has been to ascertain what amount of heat can be developed at the high temperature obtained by concentrating the solar rays, namely, bringing their power to bear on a reduced surface, and to devise the most efficient means for effecting such a concentration of the radiating heat. Apart from these preparatory experiments, I have also, at the commencement of the present year, constructed 3 different motors, which I term *solar engines*. One of these is actuated by steam formed by the concentration of the heat of the solar rays, while the other 2 are actuated by the expansive force of atmospheric air heated directly by concentrated radiant heat. With regard to the motive force itself, I have briefly to state that my experiments show that, at the high temperature requisite for steam engines and caloric engines, the heating power of the sun on a surface 10 feet square will, although in *itself* too feeble, evaporate on an average 489 cubic inches of water in the hour, by means of my mechanical contrivance for effecting the necessary concentration. The importance of this result cannot be overestimated when we reflect that such an amount of evaporation demonstrates the presence of sufficient heat to develop a force capable of lifting 35,000 pounds 1 foot high in a minute, thus exceeding 1 horse-power.

"'The result of my experiments having established the fact that, without an inconvenient extension of the mechanism which I have devised for concentrating the radiant heat, sufficient power can be obtained for practical purposes, it will now be proper to point out what amount of mechanical power may be obtained by occupying a Swedish square mile with solar engines. My several experiments having shown that the concentration of the solar heat on 100 square feet of surface is more than sufficient to develop a horse-power, it follows that 64,800 engines, each of 100 horse-power, may be kept in motion by the radiant heat of the sun on a Swedish square mile.

"'It is true that the solar heat is often prevented from reaching the earth. On the other hand, the skilful engineer knows many ways of laying up a supply when the sky is clear and that great storehouse is opened where the fuel may be obtained free of cost and transportation. At the same time a great portion of our planet enjoys perpetual sunshine. The field, therefore, awaiting the application of the solar engine is almost beyond computation, while the source of its power is boundless.

"'It is also said that an English engineer proposes employing solar heat in generating steam. By using a lens of small diameter the sun's rays have been concentrated in a vessel containing water, to such a degree that enough steam has been generated to drive a small engine. Increasing the size of the lens will, he contends, have the effect of still further intensifying the solar heat, and the power that may be obtained is only to be limited by the dimensions of apparatus employed.'"

PULVERIZED FUEL.

Mr. James D. Whelpley read a paper before the Massachusetts Institute of Technology, on a new form of furnace for burning solid, but more especially pulverized, fuel, giving the results of trials made by naval engineers appointed by the department; these, though interrupted by accident, were sufficient to establish the great superiority of dust coal, reduced to excessive fineness, over solid fuel in the generation of steam. The inventors had found it necessary to apply the principle of the burning glass to the combustion of ores; in other words, to concentrate heat of reflection and radiation by covering the interior lines of fire-walls so that they should radiate their heat upon the central line or axis of combustion. The practical conclusion is, that radiation, and not convection or conveyance, is the most effective method of imparting heat to boilers.

The experiments show that, with properly constructed and managed furnaces, the poorest, most sulphurous, and earthy varieties of waste coal and shales, even those containing only 60 per cent. of carbon, can be burned as thoroughly and completely, after fine pulverization, as the best-selected coals of England or Pennsylvania, and with equally good effects, measured by the quantity of pure carbon contained in them. Solid and dust fuels seemed at first to give the same results, but the effect of pulverization rose gradually to the enormous difference of 44 per cent. over solid fuel, when equal quantities were put in competition. The only explanation of this gain is to be found in the employment of extended radiation from solid particles in place of convection by gases. The efficiency of a mass of particles, as an agent of radiation, is inversely as its diameter. The thermotic efficiency of a cubic inch of coal is made 1,000 times greater by subdivision into a thousand parts by pulverization, by the extent of surface thus made an agent of radiation. In addition to minute subdivision of the fuel, every particle should be invested with an atmosphere of oxygen, either in air or a mixture of air and carbonic acid. The proportion of any gas which a sphere or cube of solid matter can condense on its surface is inversely as the diameter of the particle, since this condensation is simply an affair of surface. In pulverizing carbon we arrive finally at a size of particle small enough to condense upon its surface all the oxygen it requires for the formation of carbonic acid. This will be the ideal limit to be attained for perfect and instantaneous combustion.

Among the effects of fine reduction of fuels, the extraordinary length and volume of the flames generated is one of the most noticeable. A jet of coal-dust and air, 4 inches in diameter, driven into a hollow brick chamber with a velocity of 6,000 feet a minute, will create a flame 3 or 4 feet in diameter and from 20 to 30 feet long. These long flames are probably caused by the repeated formation, decomposition, and reproduction of carbonic acid. Minute particles of carbon float the entire length of the flame, and serve at once to generate and to decompose the gas, producing a continued flame.

ELECTRICITY VS. BOILER INCRUSTATION.

In the "Journal of the Franklin Institute," for February, 1868, Dr. C. M. Cresson communicates an article on this interesting and important subject. At the outset the electrical explanation was surrounded by so many popular errors and such conflicting views on the nature of electricity, that the facts in the case were lost sight of. Testimony of the strongest character having shown that this agent does produce the effects claimed for it, Dr. Cresson offers this answer to the question "how these results are produced."

The apparatus, in its simplest form, consists of a magnetic bar of hardened steel, suspended horizontally within the steam boiler, in the upper part of the steam space, the south pole connected with the shell of the boiler, and the north pole supported by an insulated hook.

After explaining the relations of heat, electricity, and magnetism to each other, and the modes of their conversion, on principles announced by Faraday, Grove, Prout, and others, with illustrations of their action, he arrives at the following conclusions: —

"1. In a steam boiler, the thermal, and consequently the electrical, currents flow alternately toward and from the heated shell, as induced by variations of the temperature of the different parts of the shell and water, until some great disturbance of electrical tension is made by taking off steam or water rapidly; when in order to restore the equilibrium of tension, electrical currents near to the shell of the boiler flow constantly to it, as the metal is a better conductor of electricity than water, carrying with them any matter that may be in solution or in suspension, and thus cause formation of scale in compact columnar form.

"2. The thermo-electrical currents can be controlled by a suitable magnetic force; and therefore the magnets used in the boiler direct the lines of thermo-electric action, and thus remove or enfeeble the causes of the compact deposition of bodies in solution or suspension in the water in the boiler.

"3. Where scale has been formed previous to the application of the magnets, it is repelled by the agency of magnetic and diamagnetic forces, exerted in consequence of the polarity of the shell of the boiler, induced by the movement of the thermo-electric currents, directed or governed by the magnetic bar of the instrument; which repulsion favors the intrusion of a minute film of water between the iron of the boiler and the scale, and the latter is loosened and broken up by the expansion of the watery film into steam. By exalting the intensity of magnetic action, by the substitution of a powerful electro-magnet in place of the weaker permanent magnets commonly used, the effects of deposition and removal of scale take place with such increased rapidity as to produce in a few hours, results which, with the ordinary apparatus, have required many weeks or months."

The introduction of metals in the water of the boiler, which are electro-negative or electro-positive, to the metal in the shell (copper or zinc), either tends to corrode the boiler, or to oppose the action of the instruments. In the whole course of the experiments there was no evidence of the production of any galvanic action having the slightest tendency to oxidize or in any way injure the metal of the boiler.

PARAFFINE AS A LUBRICATOR.

The oils and lubricators at present used on machinery at high temperatures are decomposed by heat, and leave a residual coating, more or less thick and viscid, the adhesion of which to the sides of the cylinder interferes considerably with the free movement of the piston. In fact, it is impossible to attain the full limit of power in hot-air engines, like those of Ericsson and others, because it is impossible to lubricate them, and to prevent the adhesion of the moving parts. M. Monet, in "Cosmos," advises the use of *mèlène* ($C_{50}H_{60}$), a substance obtained from the paraffines, insoluble in water, soluble in the fixed oils, volatile without decomposition, not boiling under 370° F., of the consistency of wax at ordinary temperatures, and floating on the surface of cold water. It is cheap enough to be employed on the large scale, and preserves from oxidation and adhesion.

PETROLEUM FUEL FOR STEAM SHIPS.

According to the "American Artisan," the absolute theoretical evaporative powers of a pound of anthracite and a pound of petroleum stand respectively at 12 and 22 lbs. of water. The average cost of crude petroleum is about 21 cents a gallon, and of coal 5 dollars a ton; in other words, the petroleum costs 3 cents per lb., while the cost of coal is between the fourth and fifth of a cent per lb.; hence the petroleum costs 13 times as much as the coal, and, its absolute heating power considered, its heat costs 7 times as much as the heat from coal, and it costs considerably more than this in its practical application. The cost of the apparatus for using petroleum is great, and its durability small; some economy would result in the cost of attendance on the fires, but the other disadvantages named are decisive against its economical use as a steam fuel. Moreover, extraordinary care in storing and using this fuel must be constantly exercised. Under these circumstances there does not seem to be the slightest probability that petroleum at present can take the place of coal as a steam fuel.

LIQUID FUEL.

At the Annual Meeting of the "London Institution of Naval Architects," in 1868, Capt. Selwyn read a paper on "Liquid Fuel," by the use of which, instead of coal, a ship could, with the same weight of fuel, be supplied for a voyage of 3 weeks under steam instead of 1, with less expense for fuel and more room for freight.

He spoke particularly of the fluid generally known by the name of creosote, the price of which is at present three-quarters of a penny per gallon, or 13s. 9d. per ton. From its specific gravity being greater than that of sea-water, in case of fire from any cause the fuel might be run into the bilge-water in the hold or into the sea. Being not inflammable under 240° F., there is no danger of explosion, and it is not liable, like coal, to spontaneous combustion. Great economy is said to be the result of the use of this fuel.

TESTING STEAM BOILERS.

Prof. S. W. Robinson, of the University of Michigan, communicates an article to the "Journal of the Franklin Institute" for January, 1868, as follows: "It is generally believed that steam boilers become weakened, for resistance to internal pressure, after continued use, from various known and unknown causes; so that the engineer cannot judge of the pressure to which his boiler can be worked with safety. But this he may determine by a very simple process, and means which are always at command. It is as follows: Let the boiler be filled entirely full of cold water, even to the throttle and safety-valves, and all closed tight to prevent any escape. Now, by lighting a fire under the boiler, the water will be gradually expanded, and produce a pressure sufficient even to rupture the iron before the temperature of the water arrives at the boiling-point. While the pressure is increasing, let the steam gauge or pressure indicator be watched; and when the test pressure, which may be twice or more times as great as the working pressure, is reached, a portion of the water may be allowed to escape and the pressure reduced. The pressure results from the fact that water is expanded more by heat than iron. The process above given is attended with as much safety as the use of the hydrostatic press, unless the water be heated above 212°, which would not be required unless the boiler leaks. Below this temperature no disastrous consequences would follow, even if the boiler should be torn asunder, inasmuch as explosions result from the sudden expansion of gases or vapors."

CAST-STEEL AND WROUGHT-IRON BOILERS.

The relative merits of cast steel and wrought iron for boiler-plates have been practically tested at the Harkorter Works in Westphalia, and the results were decidedly in favor of steel. Two boilers were used in connection with the puddling and rolling mills, both of the same form and size, cylindrical, 30 feet long, 4 feet in diameter, with dome 2 feet high by 2 feet wide; the thickness of the iron plates was a little over four-tenths of an inch, and that of the steel plates one-fourth of an inch, and the respective weights, 8,975 lbs. for the iron, and 5,842 lbs. for the steel. It was found that while a pound of coal evaporated 3.20 lbs. of water in the steel boiler, it evaporated only 2.51 lbs. in the iron one. To perform the same amount of work it required in the wrought-iron boiler 28 per cent. more fuel and 30 per cent. more time. At these works they now have 15 steel boilers in use, and one of them, which is made of soft Bessemer steel, gives as good results as the others. There was also a marked diminution in the amount of incrustation in the steel boilers, owing, probably, to the extreme smoothness of the surface; water which gave an incrustation of one-eighth of an inch in 2 years in the wrought-iron boilers, gave in the steel boilers an incrustation hardly perceptible. — *Mechanics' Magazine.*

The following on the same subject is taken from the "Scientific American": —

"The use of steel in the manufacture of steam boilers is of comparatively recent date, and the relative advantages, if any, over ordinary iron boilers, except on the score of their less weight, has hardly yet been satisfactorily determined. We have before us perhaps the latest information bearing on this subject, being the results of an important series of experiments made recently at the rolling-mills of Messrs. Funk & Elbers, of Hagan, Prussia, for the purpose of ascertaining the respective evaporating power of the new compared with the old style of boiler.

"The two boilers experimented with were each 5 feet in diameter, and 34 feet long, constructed to stand 5 atmospheres 'over' pressure. One was made of wrought iron, and the other of soft cast steel. The thickness of the sides in the cylindrical portions of the iron boiler was 0.50 of an inch, and of the cast-steel boiler 0.33 of an inch. Each boiler had a heating surface of 293 square feet, and 12 square feet of grate surface. Both were new, and had never been before heated. They were set alike in brick-work, one above the other, but entirely separated by masonry; the gaseous products of combustion passed through a single flue underneath each boiler, and passed directly into the same chimney. At first both boilers were filled, and fires were kept under them for several days in order to dry the brick-work, after which the fires were extinguished and the boilers emptied and cleaned. Each boiler then received exactly 712 cubic feet of water at 95° F. temperature; the man-holes were closed, and the water was heated to the boiling-point; again the fires were put out, and all the ashes and coals taken away. From this point the boilers were fired afresh, and fed with weighed fuel; the man-holes, hitherto kept closed, were now opened to let the steam escape; and the firing was so well regulated, by means of dampers, that the velocity of the escaping steam was the same in each boiler. The temperature of the gases from the fire was measured, at a point 6 feet from the rear end of each boiler, and found to vary from 644° to 734° F.

"After consuming on each grate 3,150 pounds of coal of the same quality, the cinders of which were burned over and over again, the fires were put out, and the man-holes closed. On the following day the remaining water of the boilers, showing a temperature of 95°, was let on through the emptying tube, situated at the lowest part of the boiler, and measured by means of a hydrometer adapted to the tube. The iron boiler showed 387 cubic feet, and the steel boiler 331 cubic feet of the remaining feed water. Therefore the water evaporated in the iron boiler was 712 — 387 = 325 cubic feet, or 20,065 pounds; and that evaporated in the steel boiler was 712 — 331 = 381 cubic feet, or 23,523 pounds. Hence the evaporating capacity was proved to be 17.20 per cent. in favor of the steel boiler. One pound of coal evaporated in the iron boiler 6,350 pounds of water, and the steel boiler 7,467 pounds of water at 212° F. At the next trial the whole operation was performed in the same manner, only the velocity of the escaping steam was less. It resulted in showing 19.62 per cent. in favor of the steel boiler. One pound of coal evaporated in the iron boiler 5,809 pounds, and in the steel boiler 7,008 pounds of water.

"These two experiments were verified in the following manner: To an equal quantity of feed water in each boiler an equal volume of a strong solution of salt was added. After stirring the water for some time, by means of long poles, and boiling it with closed man-holes, samples were taken out for future analysis. In completing this experiment, in which equal quantities of fuel and water were used, further samples were taken out. The analysis of the samples by Dr. List, of Hagan, showed that in the iron boiler 1 quart of water contained before evaporation 4,629 grammes of chloride of sodium, and after, 5,985; in the steel boiler 1 quart contained 4,371 grammes before, and 7,385 grammes of salt after evaporation; the iron boiler lost 33.76 quarts, and the steel boiler 40.81 quarts of water, showing 20.85 per cent. in favor of the latter. The average percentage of these three experiments is 19.24 per cent. in favor of the steel boiler, which it will be noted had a shell 33 per cent. thinner than that of the wrought-iron boiler."

BAILEY'S STEAM ENGINE.

The essential requisites in a steam engine are now lightness, strength, compactness, and simplicity, so that it will occupy little space, be easily transported, and be readily put up and operated by engineers of ordinary capacity; the working parts should be few and durable, and protected from dust and dirt. In Bailey's engine the crank, with its connecting-rod, etc., is enclosed in a steam-tight head, so arranged as to form an extension from one end of the cylinder in which the piston works, and to this piston the connecting rod is directly pivoted, the opposite end actuating the fly-wheel. To close the communication between the cylinder and the hollow head, a transverse slide is fitted with a rocking-block through which the connecting-rod passes, the combined action of which provides for the free motion of the connecting-rod, and, at the same time, forms a sufficiently steam-tight division between the cylinder and head. — *American Gas-Light Journal.*

HUGON GAS ENGINE.

In this engine, as now perfected, by a simple arrangement, the gas, as soon as it is turned on, enters the cylinder mixed with about 9 times its bulk of common air. All that is necessary to start the engine is to light 2 ordinary jets of gas, which in their turn light 2 others; these last inflame the explosive mixture of gas and air conveyed to the cylinder, and, being extinguished by the explosion, are relit by the 2 jets fixed outside the cylinder. At the moment of explosion, a very fine spray of water falls on the piston, and (the heat being then 1,200° F.) becomes steam, thus reducing the heat and equalizing the pressure throughout the stroke, so that the engine lubricates itself by its own action. Among its advantages are: from perfect rest to full activity not 2 minutes elapse; it is as easily set to work as a gas-jet is lit, and is as instantly stopped, and is thus, at all times of day or night, at the service of its owner. It is simple, economical, clean, safe, and remarkably steady in its working; it requires no skill to start it, nor attention while in operation.

TREATMENT OF ANIMAL REFUSE.

In the second Annual Report of the New York "Metropolitan Board of Health," is a paper upon the operations of the "New York Rendering Company," by Drs. Morris and Janes, from which the following are extracts: —

A dock at the foot of 38th Street, North River, was set apart by city ordinance for the reception of butchers' offal and all dead animals found in the city limits; boats, provided for the purpose, were moored at this dock during the day, upon which the materials were loaded until night, when they were taken down the bay to Barren Island and discharged. In consequence of the daily accumulation and of the delay in removal, this dock had been for years a most offensive nuisance; many kindred obnoxious kinds of business had gradually been located in the neighborhood, for several blocks around, whose offensive odors impregnated the air for a great distance. The accumulations of butchers' offal, dead animals, and market refuse, exhaled the most obnoxious and air-poisoning odors, lying upon the dock during the whole day, and exposed to the direct action of the sun's rays while in the most active stage of decomposition.

The "New York Rendering Company" have located a vessel on each side of the dock, which extends about 200 feet into the river. On these vessels have been fitted up 9 sets of apparatus, for the purpose of immediately suppressing this nuisance and utilizing the material here deposited. The offal, brought to the dock in butchers' carts, is dumped directly into iron tubs, provided for the purpose; these are hoisted over the vessel, and immediately discharged into the tanks, which, as soon as filled, are hermetically closed, so that no further odor escapes from them. Steam heat is then applied by means of a steam-jacket surrounding the tank. The vapors and obnoxious gases evolved during the process of rendering are wholly conducted by an iron pipe into a coil, several hundred feet in length, located in a separate furnace, where, being superheated, they are brought into contact with the flame of the furnace, and, united with certain proportions of atmospheric air, which render them combustible, are entirely consumed. No offensive odor could be detected, after repeated and critical observation, during any stage of the process. Dead animals are disposed of in the same way, the larger ones being cut up. When the contents of the tanks are sufficiently cooked, the steam is shut off, and they are allowed to cool down; the grease is then taken out, and the greaves or scrap, after being washed, is discharged from the bottom of the tanks, drained, and removed upon sloops lying alongside, and the remainder is transported beyond the city limits to be used for purposes of fertilization. During the operations there are two periods when an offensive odor escapes: while emptying the contents of the carts into the tanks, and during the evisceration of the large animals; but this is confined to the immediate vicinity of the boats, and is not perceptible 50 feet therefrom. Thus, these poisonous and destructive materials are, by this process, rapidly changed into life-sustaining principles, and a fruitful source of disease effectually suppressed.

USE OF REFUSE LEATHER AND HIDE.

In Capt. Brown's process for making compressed leather, the cuttings and heretofore useless waste of shoemakers are first cleansed from dirt and foreign matters; the cuttings and refuse of hides, unfit to tan, and usually sold to glue-makers, are also reduced to a fibrous mass. These are combined together with water, to which is added 1 part of sulphuric acid to 100 parts of water, until a plastic mass is formed, which may be pressed into moulds of any size and thickness. When dried in a steam-heated room, they are passed through heavy pulp rolls, glazed on one side and rough on the other, to represent the grain and flesh sides of the leather. An addition of 5 to 20 per cent. of the raw fibre may be added to the tanned filaments, the former giving a vitality to the latter by agglutinating them and imparting the albumen and gelatine which were destroyed by the tannic acid. To render it supple, about a pint of glycerine is occasionally incorporated with a hundred weight of the mass. It is less permeable than ordinary sole leather, harder, closer, more compact, and 50 per cent. cheaper than the natural hide. It is not suited for machine bands or harness, but is well adapted for boots and shoes, especially for nailed soles and heels, and for inner soles. It promises to be an important branch of economic industry in utilizing a very abundant waste material. — *Mechanics' Magazine.*

SUPPLY OF FRESH MEAT.

Fresh meat has of late years become more and more costly, notwithstanding the improvement in the breeds of cattle and in the manufacture of artificial food; so that the laboring classes, the bone and sinew of the country, find it difficult to obtain, in sufficient quantity and of good quality, the animal food which experience shows to be necessary for the daily performance of hard work in temperate and cold climates. Cattle-plagues, the devastation of war, the increase of population, and the greed of man, have all combined to produce this unfortunate result. The public naturally look to scientific men for the remedy.

Much attention has been given to the relative heat-giving and work-sustaining properties of nitrogenous and carbonaceous substances, in the matter of food in the abstract; while the chemist and the meat-curer have devised many methods for preserving meat both for home and foreign consumption. The perishable nature of animal food has been a serious obstacle in the way of bringing it from distant points in a fresh condition, and the unavoidable difficulties in the way of securing proper food, water, air, and rest, render cattle thus transported more or less diseased, and their flesh unwholesome. Among the processes for preserving meat may be mentioned that of Baron Liebig for the manufacture of "Extractum Carnis," described in the "Annual of Scientific Discovery," for 1866–67, pp. 90–93. By this the nutritive properties of meat are condensed into a portable form, highly concentrated, of reasonable price, and extensively used in the preparation of soup, especially for armies and hospitals. Eight small cans will hold the concentrated alimentary matter of a whole ox, sufficient for 1,000 basins of good strong soup, at about 2 cents a basin. Morgan's process (see "Annual of Scientific Discovery," 1865, pp. 52–3) is based on forced infiltration, and makes use of the circulatory system for introducing the solution of brine and nitre, instead of the usual method of applying salt outwardly. In the process of McCall and Sloper ("Annual of Scientific Discovery," 1866–67, p. 94) bisulphite of soda is used; and in that of Medlock and Bailey ("Annual of Scientific Discovery," 1868, p. 80) the bisulphite of lime; both used by injection. Chemical preservative operations have not as yet inspired much confidence in the public, and, by all, the natural flavor of the meat must be more or less impaired.

The most valuable as well as the simplest system is the one ordinarily practised in this country, namely, of packing the meat in tin cases, varying in weight from 1 to 6 lbs. As practised by McCall in England, after the raw meat is tightly packed in the cans, a little water is added and the lids closed, a small hole being left in each. A considerable number are then placed, in such a manner as to leave the upper part exposed, in a boiling solution of chloride of calcium. While the contents of the cans are boiling, the water escapes as steam through the holes in the lids. When the air is expelled, the holes are soldered up, and the tins transferred to a bath at 260°, when, should any be imperfectly soldered, they begin to leak. After boiling for some time the meat is in a fit state for being kept any length of time. In order to ascertain if the air has been perfectly excluded, the cans are placed in a dry chamber at about 90°, and there left for a time. If, on a light tap at the upper end a hollow sound is emitted, indicating a space below, the workman is satisfied that there is a vacuum and that the can is perfect; if the sound be dull, as if the meat were in contact with the lid, the can is set aside.

Without going to the river Plate, we have in our plains of Texas and the new States and territories west of the Mississippi, an inexhaustible storehouse from which to draw our supply of first-quality meat, to be preserved on the spot by the last-named simple process, and to be brought to the north and east to supply the demand for animal food, which, at present, for the reasons above named, is too expensive for the subsistence of the laboring classes, who most need its life-sustaining properties. Establishments of this kind, conducted by competent and trustworthy persons, could not fail to be highly remunerative for years to come.

PROCESSES FOR PRESERVING MEAT.

At a recent meeting of the Boston Society of Natural History, Prof. Gamgee, of London, offered some remarks on antiseptics for the preservation of meats. He stated that the insufficiency of the supply of animal food in the markets of Great Britain had led him to investigate the various groups of maladies affecting cattle in the Old World, especially those which spread with such frightful rapidity from one country to another through the lines of transit of cattle trains; but efforts in that direction proving only partially successful, and the price of many kinds of meat having risen from 30 to 40 per cent. in 17 years, he had commenced in 1865 a series of experiments on preserving meats in bulk, without the use of salt or desiccation.

The conclusion was early reached that the tissues of the animal should be fixed previous to its death. Ingredients containing tannin were first used, and the carcasses, which were packed in fat, remained in good condition for a great length of time; this failed, however, in the case of one animal, which persistently refused to partake of the drug; and as herds of cattle could not readily be induced to feed on tannin, some other expedient was necessary. Having proved the antiseptic effects of carbonic oxide gas by its tendency to expel oxygen, animals were made to inhale the gas, and the result showed that decomposition took place only when the carbonic oxide disappeared. To effect the complete removal of the oxygen, the use of sulphurous acid gas, well known as an expedient for curing hams for exportation, was resorted to; by itself, the acid could not prove successful, as it would remain in contact with the oxygen for an indefinite length of time without material change in either. The carcass was therefore placed beneath the air-pump, the sulphurous-acid gas introduced, and charcoal, platinized by the use of chloride of platinum, passed up through a column of mercury. The sulphurous acid gas was thus oxydized and the atmosphere entirely destroyed. Simple carbon was subsequently found equally efficient, and the plan was finally simplified by the introduction of a small quantity of carbon in which sulphurous acid was condensed. In this way the measurement of definite quantities became an easy matter.

The process now consists in causing the animal to inhale carbonic-oxide gas until it loses consciousness, when it is killed and bled; the carcass is quickly dressed, and while still warm placed for a short time beneath an air-pump. The small quantity of air which this process fails to exhaust is destroyed by the introduction of sulphurous acid gas in charcoal. The meat will then keep for months, and perhaps years, in any temperature, without putrefaction, even though it be filled with the maggots of flies. It is not believed that the sulphurous acid, which is neutralized by the alkalies of the meat, could have any injurious effect on the tissues.

The tests of this method thus far applied have been attended with success. Beef killed in London, in March last, was sent to New York in June, and as late as the middle of July was shown to a prominent butcher in Fulton Market, who did not discover that it was other than ordinary beef, and expressed the opinion that it had probably been killed about 2 days. One piece of beef, kept for 10 days in a can surrounded by water at a temperature of 90° to 100°, came out perfectly fresh. The process, in the opinion of eminent chemists, does not injure the meat in the least, which is an advantage very difficult of attainment, even in the case of transportation of live stock, which is liable to the bad effects of confinement and the length of the journey. Among the beneficial results of the adoption of this scheme would be a better supply in our markets of wholesome meat, and at a desirably cheaper rate.

In the "Scientific American" is mentioned another preservative for animal substances, not very different from the *eau hemostatique*, or blood-staying water, presented to the French Academy. It is composed of alum, benzine, and water, and is said to cover the substance to be preserved with a sort of filtering cuticle, excluding the decomposing animalcules, according to Pasteur, while admitting pure air and allowing free evaporation. That air has in itself no tendency to promote decay accords with common experience, though not with the common impression. The butcher keeps his meat in a current of dry, pure air, and a carcass hung up in the elevated atmosphere of some of our Rocky Mountain regions will dry perfectly sweet and sound throughout, without other curing. Putting these facts and Pasteur's discovery together, is there not probably a practicable principle which may be applied to the preservation of fruits and meats, and even of the human body, without the aid of a vacuum?

UTILIZATION OF WASTE FOOD.

The utilization of the waste food of South America, if it could be accomplished profitably, would be the greatest possible boon to the poor. In the vast prairies of America, extending from the Mississippi to the Missouri, bisons roam freely in droves too large for the eye to compass, but certainly numbering many hundred thousand beasts. In the pampas of Buenos Ayres the wild oxen are at present slaughtered at the rate of 400,000 annually for their hides and skins, the flesh being an absolute waste, civilization having not yet arrived, in these regions, at the simple process of cutting the flesh into long slips, and then drying it in the sun, in which form it comes from the River Plate to the Southern States of America, and is there eaten by the negro population in the form of jerked beef. In Moldavia and Wallachia there is an abundance of ox flesh wasted, the immense herds of this quarter of Europe being slaughtered simply for their fat and horns. Some of this beef, and some also from Australia, has come over to this country in hermetically sealed cases; and capital food it is, much better than the salt junk upon which we used to feed our navy; but it has not yet made a footing among our population, although it can be sold in London at sixpence a pound.

Mr. Simmonds, in a paper contributed to the "Journal of the Society of Arts," in speaking of the vast sources of unutilized food that exist in different quarters of the globe, states that the quantity of animal matter wasted in the Newfoundland cod-fishery is 120,000 tons annually. Surely, if none of this can be secured for food, it may be made available for some other useful purpose. Prof. Way has, we understand, prepared a manure from refuse fish, which contains a very high percentage of ammoniacal salts and phosphate of lime. We are told, indeed, that the guano islands will be exhausted by the year 1888, or thereabouts; and if in the mean time we have not brought our own sewage into use, our agriculturists will be sorely pressed for a powerful fertilizer. The enormous number of horses in Buenos Ayres renders them of little commercial value; but it is certainly odd to hear that the number of mares slaughtered in that country merely for their hides and grease is so great that it is found economical to light the city of that name with gas made from the fat of these animals. Again Mr. Simmonds tells us, that from 18,000 to 20,000 elephants are killed annually to furnish the ivory used by the Sheffield manufacturers. Elephants' flesh is very good; and the late Mr. Gordon Cumming spoke rapturously in his volumes on African travel about the delicacy of elephants' feet; not that we think it likely that the flesh of this animal will ever come into use among ourselves, or that we shall ever benefit by the superfluity of green turtle to be found in the bays of the Bonin Islands, where they are so numerous "that they quite hide the color of the shore, and many are from 3 to 4 cwt. each;" but there is no knowing what science may do for us even with respect to preserving this superabundant flesh and fat. — *London Quarterly Review.*

UTILIZATION OF SEWAGE.

In a recent report of M. Dumas, of Paris, the following process is recommended for the useful application of sewage: It is collected in reservoirs, and precipitated by a solution of sulphate of alumina. The cost of the precipitant is stated to be one centime to the cubic metre of sewage, or less than half a farthing to a cubic yard. The precipitate is quickly deposited, and contains all the phosphoric acid and nine-tenths of the nitrogen and organic matters of the sewage; it is, therefore, a valuable manure. The weight of dry precipitate obtained is 6 kilogrammes per cubic metre. The supernatant liquor is limpid and odorless, and may be run into a stream without fear of dangerous consequences.

THE LIME LIGHT FOR DWELLINGS.

The principle of the lime light is the same as that known as the "Drummond" light; oxygen, hydrogen, and lime are concerned in its production. According to the "London Scotsman," they are used as follows: A jet of hydrogen being lighted, a jet of oxygen is turned on to mix with it, and the solid incombustible lime, exposed to the intense heat, emits a very pure and powerful light. As the method of using and lighting the jet is the same as with a common gas-burner, no special knowledge or instruction is necessary for its management. With a consumption of the gases of 1½ feet per hour, the light produced is equal to 4 gas-lights, each burning 5 feet per hour; 3 feet per hour give a light equal to 15 gas-lights, each burning 5 feet per hour; and 6 feet per hour are equal to 300 feet of gas. The two gases are easily produced, and a very small main would be sufficient to convey them through the streets to dwelling-houses, for which this light is singularly well-fitted, as its products of combustion are innoxious and have no tarnishing effects; it exercises also no changing influence on colors, every tint being as distinctly observable as in sunlight. It is believed that the lime light will, in many cases, supersede the use of gas both in a small way and on an extended scale.

PRESERVATION OF WINES.

According to the new process of Mr. Dumesnil, the cask of wine, uncorked, is placed under an iron bell and the air exhausted; after two hours the noise occasioned by the exit of the air ceases.

A vacuum being created, the gases contained in the wine are released from atmospheric pressure, and, as they are essentially elastic, expand sufficiently to break the cells of vegetable fibrine enclosing them and escape. These gases are dissolved to such an extent that the withdrawal of 30 or 40 litres of gas occasions no sensible decrease of liquid. The theory of the decomposition of grape-juice and other organic substance rests on a very elementary fact, namely, on the power of double decomposition. Gaseous products of the fermentation do not remain inert, but energetically induce the fermentation or decomposition of free bodies. These products are the most active in inducing decomposition; they alter wines indefinitely when enclosed in the fibrine cells, which M. Pasteur calls mycodermes. White wines owe their great superiority in preservation over red wines to their different condition as regards this point. Under the treatment by the vacuum, fermentation does not occur, or, if in progress, entirely ceases. — *Chem. News.*

AIR TREATMENT OF WINE.

Mons. R. D'Heureuse, the patentee of the new process by which new wine is ripened in a few *weeks*, instead of, as in the old method, *years*, gives us the following resumé of his method. He says: —

In all "must" are certain nitrogenous substances, the cause of fermentation, if called into action by some impulse. The contact with air, and the germs of fermentation therein constituting the impulse, causes in "must" the vinous fermentation, — generally termed "the fermentation,"— which eliminates a portion of the deleterious substances by oxidation in shape of yeast. To prevent later fermentation and diseases of the wine inherent therein, all the nitrogenous substances have to be eliminated. This can be done slowly, tediously, expensively, and imperfectly, by frequently drawing the wine from cask to cask for years, or it may be done in a few weeks, thoroughly, easily, and economically, by impelling the air into the "must" or young wine. The air it is, which in either case acts, oxidizing and eliminating the nitrogenous substances, and the wine is constant and sound only when free from all these substances, which also carry with them all that bad or earthy taste which vitiates nearly all American wines.

An air-pump is used by M. D'Heureuse for the purpose. In some cases it is desirable that the air be previously heated. The heater has a pipe and faucet, and the heated air may be mingled with that of ordinary temperature at will in a reservoir arranged for the purpose.

From this the air is passed through a cotton filter of simple construction, and then conducted through some pipe or rubber hose to which a perforated mouth-piece of tin, copper, or gutta-percha is attached. This mouth-piece, mostly in shape of a pipe or pipes to suit the vat, is sunk to the bottom of the ferment-vat, and requires frequent cleaning from anything adhering, to prevent souring.

Air being the necessary agent for fermentation, the impelling of it into the "must" is commenced at once. A slow current of air will generally prove sufficient. The temperature of the air is to be kept low as a general thing; only exceptional cases may require it exceeding 70° F.; 55° to 60° to be considered the average.

It is impossible here to lay down a general rule for the duration and quantity of the impelled air; it depends on the kind of "must," the weather, and locality. However, it is certain that a deviation from the precise quantity of air, for the production of the very best wine, will be of less injurious consequence to the product than the incorrect *guess* as to the termination of the usual fermentation. It will also be preferable, toward the end of the process, to impel the air not continually, but to allow some intervals, during which the manner of clarification will permit an accurate judgment whether the process is finished or not.

By this plan, it is claimed, a given quantity of wine may be worked with a smaller number of vats and in far less time than by the usual method. The losses by various accidents, which, when the time is prolonged, are liable to occur, are a yearly offset against the cost of pump-apparatus, which will last for years.

It was formerly supposed that air should be excluded from wine; and this was done in the face of the fact known to all, that it was improved by occasional changing from cask to cask. About 25 years ago Liebig proposed that the casks be left open. This did not answer the purpose, because the air came in contact with the surface only of the wine. Mons. D'Heureuse says that upon the first announcement of his plan it met with no encouragement. He has now an ally in Mr. C. H. Frings, a well-known German expert, who gives it as his opinion that this method is the only one suited for American wines. The patentee considers the method as adapted also to the treatment of cider, beer, and all fermented liquors. — *Mining and Scientific Press.*

PRESERVATION OF WOOD.

Mr. Sigismund Beer, of New York, at a recent meeting of the American Institute, explained his new process for preserving wood. The following are extracts from his patent: —

"Wood freshly cut is full of sap, composed of hygroscopic and very perishable organic substances. Heretofore, the idea has been, in seasoning and preserving wood, to wash out these substances, or to chemically combine and convert them into more durable compounds. Washing by steam only removes matter having great affinity for water, and soluble therein, leaving those that coagulate by the action of steam to fill the pores and stop further action. The chemical conversion of these substances is commonly produced by metallic salts, which combine with them, forming insoluble compounds of more durability. But this action is necessarily limited to the exterior, as deep impregnation is stopped by the newly formed products. Moreover, the cost is high, and the salts more or less injuriously affect the wood substance.

"My discovery consists in simply treating the wood with a boiling solution of borax in water, which easily and effectually dissolves and removes all those perishable substances, without injuriously affecting the wood fibre, which, on the contrary, becomes harder, impregnable to water, vermin-proof, perfectly indifferent to the moisture or dryness of the atmosphere, and almost incombustible.

"The process and operation are as follows: In a tank, of wood or iron, I prepare a saturated or nearly saturated solution of borax in water, sufficient to cover the wood. I then raise the temperature, by steam or otherwise, to the boiling-point, and keep it there from 2 to 12 hours, according to the porosity and thickness of the wood. I then repeat this operation in a freshly concentrated solution of borax in water, but immersing the wood only half as long as before. The wood is then taken out, and, as soon as dry, it is ready for use, if its hardness and discoloration are not objectionable; or it may be several times washed in boiling water, which will extract the absorbed borax in connection with the colored matter, and restore its former color and appearance, more or less, at will.

"It is not necessary to use a very strong solution, but I prefer it on account of the facility for re-using it.

"Simple as my process is, it may be advantageously altered in some cases. When thick lumbers are to be treated, it is well to steam them thoroughly in the ordinary way, and place them in the tank while still warm and wet. The denser and heavier liquid of the borax solution will more quickly penetrate the pores of the wood, and shorten the operation considerably.

"If it be desirable to impregnate the wood with tar, coal-oil, or like substances, they are easily applied after the wood has been thoroughly dried.

"If it be desirable to make the wood perfectly water-tight, shellac, or other gum, or resin, or substance soluble in a boiling solution of borax, and insoluble, after drying, in cold water, may be added to the liquid of the second operation."

WOOD-HANGINGS FOR WALLS.

At a recent meeting of the Massachusetts Institute of Technology, was exhibited an extensive series of specimens of the "wood-hangings" recently introduced as substitutes for paper on the walls of houses.

The machinery used in preparing this wood is that used in cutting veneers, but the sheets cut are much thinner than any veneers, some of them being as thin and delicate as tissue paper, 2 to 300 thicknesses to an inch, though the common thickness is from 110 to 120 to the inch. The logs are steamed before they are cut, and the knives are long or short according to the direction in which the logs are cut, some of them being 10 feet long. In cutting round a log, shavings of very great length are made. A length corresponding to 8 rolls of paper, of 8 yards each, can be cut by the present machine in 2 minutes.

By saturating the wood in glycerine and other fluids, the harder woods, like hard maple, are rendered soft and pliable, so that they can be carried, without breaking, round corners and over beads in the same way as paper. A strong sizing of glue is first applied to the wall, and then the hangings are put on with common flour paste in the same way as with paper; the grain is then filled in and finished with a varnish or a mixture of oil and wax, the last being the best and the cheapest. The prices of the common woods are 1½ cents per square foot, equal to 54 cents for an 8-yards roll of paper; the more expensive woods, such as mahogany, bird's-eye maple, etc., 2 cents per square foot, equal to paper at 72 cents a roll.

It may be put on plain, panelled, or ornamented in various ways. The sections are so thin that they dry completely in 24 hours, and, if they come off at all, will do so at the end of that time; heat does not affect them any more than paper, and they have withstood without change the great changes of temperature, dryness and moisture, in kitchens in this vicinity, for a period now reaching 9 months. These hangings can be put on, finished and fitted, at an expense of 2 dollars a roll, presenting the appearance of the solid wood, and, it is claimed, permanent and capable of being washed without injury to the texture or lustre.

CHROMO-LITHOGRAPHY.

Chromo-lithography is the art of picture-printing in colors, and, although not a very recent invention, it has been greatly modified and improved of late years; it might, with propriety, be called mechanical painting, as the colors are laid on one after another, mingling the different tints and shades until the picture is complete, in a manner analogous to painting with a brush; and, provided the men who undertake the work are skilful artists, there is no reason why a chromo-lithograph should fall short, in point of expression or delicacy, of the original painting which it is designed to imitate.

A few words on ordinary lithography will first be necessary in order to give the reader a clear idea of the chromo process. Briefly, then, a lithograph is a chemical drawing upon stone, — the drawing being made with a greasy or oily ink upon the peculiar quality of limestone found in the quarries of Solenhofen, Bavaria. All other processes of engraving are mechanical rather than chemical, as in wood or type work, where the impression is obtained from a raised design, or in copper or steel plate, where the design is made by deep incisions, into which the ink is rubbed. In the lithographic process, however, there is neither *relievo* nor *intaglio* design; the operation is dependent simply upon the chemical affinity existing between the greasy matter employed in the ink and that upon the stone, and the antagonism which this matter has for water, with which the stone is, in all cases, dampened before pulling an impression.

In chromo-lithography the process is identical, except that a different stone is required for every color employed, and the ink used is a species of oil color, similar to that adopted by artists for painting. The number of stones used depends upon the number of colors required, usually varying between 10 and 30, and the time necessary to prepare these stones for an elaborate piece of work extends over months, and sometimes years; but the number of colors in any given picture is not always an indication of the number of stones employed, as the colors and tints are multiplied by combination in being printed one over another; thus, in an engraving where 25 stones are used there may be upward of a hundred different shades of color obtained by this means. The amount of labor and detail involved in drawing the different parts of the design upon so many stones is almost inconceivable to one who is uninitiated. The *modus operandi* is as follows: —

Upon the first stone a general tint is laid, covering nearly the whole picture, and as many sheets of paper as there are to be copies of the pictures are printed from it. A second stone is then prepared, embracing all the shades of some other color, and the sheets already printed with the first color are worked over this stone. A third, fourth, fifth, and sixth follow, each one repeating the process, and adding some new color, advancing the picture a step further, until the requisite number of colors have been applied. The printing of so many colors, and the time required for drying each before the application of a succeeding one, involves months of careful and anxiously watched labor. Great care and skill are required to perfect what is technically termed the "registering," or that part of the process which provides that the paper falls upon every stone in exactly the same position relatively to the outline. To attain this end, stout brass pins are fixed in a frame surrounding each stone. These pins penetrate the paper in making the first impression, and, the holes thus made, being carefully placed over the pins in all subsequent impressions, insure the certainty of the outline on every stone always falling into the same position on every sheet. At last, however, it leaves the press to be sized, embossed, varnished, mounted, and framed. The embossing is that part of the operation necessary to break the glossy light and soften the hard outlines, a broken structure being given to the print by being passed through the press in contact with a roughened stone.

Of course the chromo-lithographer and the printer must be artists, in feeling at least, or they never can attain any degree of competency; and this requisite, combined with the necessity of long study and training, is the reason why so little is done in this branch of the business in this country. The number of successful chromo-lithographers, even in Europe, is yet very limited; therefore the efforts of American houses are all the more praiseworthy, in view of the degree of perfection which has been attained in their work. — *New York Tribune.*

PROCESS OF SUGAR-MAKING IN MAURITIUS.

There is no department of manufacturing industry in which more progress has been made during the last ten years than in the production of sugar. It is equally true that there is none in which so much remains to be done. The extraction of white sugar direct from the juice of the cane and beet, without refining, is now an accomplished fact. At the great Exposition in Paris beautiful specimens from three estates in Mauritius were exhibited and took gold medals.

M. Poulin, one of the planters who received the gold medal as before stated, gives the following simple statement of the process employed: —

"The canes are crushed in very powerful steam mills, the cylinders of which turn extremely slow, so as to squeeze out all the juice. The juice is received in troughs, and a certain quantity of sulphate of soda (neutral and anhydrous, that is, without water) is added to it. After this first operation, the object of which is to prevent the juice from fermenting in the defecating troughs, it is saturated with lime (the quantity varying according to the quality of the juice), and it is then drawn off into an apparatus called an '*appareil à triple effet*,' which is a set of vacuum pans, 3 in number. It is then boiled at a very low temperature in these vacuum pans. When the syrup is concentrated to the granulating point, it is left to cool. When cold it is put into a turbine or centrifugal, which is made to perform 700 revolutions per minute. The sugar is 'clairced,' or clarified, by having thrown upon it a 'clairce,' that is, a syrup, which is ladled out of a jar or tub, and thrown upon the revolving mass of sugar by a workman.

"The clairce is simply a syrup of sugar, or molasses, into which has been previously introduced a certain quantity of water, so as to reduce the syrup to a density of 35 degrees (Baumé's hydrometer, called also a *pèse syrop*). As the workman pours in the clairce the sugar becomes white, and when the cleansing process is thus accomplished a jet of dry steam is let into the turbine. This jet is sent directly into the centre of the turbine.

"A jar or tub for the claircing or clarifying syrup is attached to each turbine and bears a fixed proportion to its capacity. The workman pours this syrup upon the revolving sugar with a large iron ladle, about three-fourths of a pint; so that the contents of the turbine are clarified by a single jet of the syrup, and in from 3 to 4 minutes. The syrup usually employed in turbining the sugar is obtained from that part of it which flows from the turbine.

"In Mauritius the syrups from the turbine are usually reboiled a second and third time, so as to extract from them every particle of crystallizable sugar. The residuum of the third boiling is generally sent to the distillery and used for making rum.

"By means of this process canes cut in the morning may furnish sugar perfectly ready for packing and shipping by evening of the same day. The success of the claircing in the turbine depends in a great degree on the skill of the workman in charge of the ladle; and this skill is the result of practice and observation. So also in regard to the jet of steam sent into the turbine, and *which must be dry*, that is, heated to a degree where it ceases to be moist, as moist steam would cause the sugar to melt in the turbine, instead of drying, as happened in the beginning in Mauritius, where the planters began by using condensed steam, which is very bad.

"The very large and splendid crystals shown in some of the samples are easily obtained; but they cost more and are inconveniently slow in melting. Those samples in the Exposition were made simply to show what can be done; but they would be unsuitable for general use, as they would take a good half hour to melt in water.

"Let any one, desirous of ascertaining the relative qualities of European-made and Mauritian-made sugars, dissolve the latter in a glass of water, and observe its delightful perfume. But in order to have this fine odor, the sugar must not have undergone fermentation, nor have been subjected to refining by bone-black. All the Mauritian sugars made by this process have this perfume, and all are, strictly speaking, raw sugars; that is, they are purified by a mode of fabrication from the juice, which is not refining, and which makes no change in their natural savor." — *Scientific American.*

THE INVENTION OF VULCANIZED RUBBER.

After long years of effort and disappointment, Charles Goodyear stood apparently as far as ever from the attainment of his object; until, one day, while in earnest conversation regarding his proposed invention, he emphasized an assertion by flinging away at random a piece of rubber combined with sulphur that he held in his hand. The fragment fell upon the stove, was subject to a higher heat than that to which he ever ventured designedly to subject the material; and when it was recovered, it was found to possess the qualities for which he had sought so long; cold did not harden and heat did not soften the water-proof and elastic mass. And thus sprang forth the germ of an invention that has built up a new branch of manufacturing industry, given employment to thousands of operatives, and added in myriad forms to the conveniences of life. — *American Artisan.*

NEW LAMPS.

A lamp has recently been invented in France, the flame of which is said to be as brilliant as the oxy-hydrogen and lime lights, while it is much less costly. Coal gas, intimately mixed with air, is urged with gentle pressure along a tube, and made to pass through a metallic plate pierced full of minute holes. A vast number of jets is thus obtained, which, after being driven through a fine tissue of platinum wire, are lighted in the usual way. The platinum soon acquires a white heat, and gives out so brilliant a light that it cannot be endured by the naked eye. About 1 metre of gas is consumed per hour. It is called the "Bourbouze" lamp. — *Oil Trade Review.*

Submarine Lamp. — Oil lamps, as ordinarily employed for this purpose, require the use of a pump to force in air for combustion through long rubber tubes, and are not only inconvenient, but give little light. Electric lamps are too expensive for common use. MM. Léauté and Denoyel have constructed a lamp fed by compressed oxygen, enclosed in a reservoir below the lamp; it thus carries its own gas with it, burns without communication with the outer air, and is portable and inexpensive. The gas, under a pressure of 5 atmospheres, is fed to the lamp by a tube with 2 annular crowns, one external and the other internal to the wick, both pierced by numerous small holes. The wick can be regulated from the outside, and the jet of gas modified by a cock; the lamp is surrounded by a cylinder of thick, well-annealed glass, covered by a brass plate. The flame is bright and steady, and will endure for three-quarters of an hour. Numerous successful experiments have been made with it in the River Seine, at Paris. A man in costume of a diver recently descended into the sluice opposite the Mint to the depth of 8 feet; the lamp burned beneath the water, and at the distance of 2 yards from him the diver was able to inscribe with a diamond on a piece of glass the date and hour of the experiment. The lamp burned for three-quarters of an hour in the water, and when it was brought to the surface it was still burning, and the flame as bright as ever. Not only will this invention prevent the danger of explosions from fire-damp, but it will enable search for drowning persons, or for property lost by shipwreck, to be pursued with the utmost facility. — *Comptes Rendus,* 1868.

WATERING STREETS.

In one of the principal streets of Glasgow, workmen are laying down pipes, which are to be connected with the water-mains, for watering and cleansing the highway, — an invention of Mr. Sim. The pipes are of malleable iron, about 3 inches in diameter, and are laid down immediately outside the pavement on one side of the street only. The water is to escape by openings one-sixteenth of an inch in diameter, drilled about a foot apart. By this arrangement, Mr. Sim expects to be able to lay dust at a much cheaper rate than by the old water-butt process; and he will use it in cleansing in conjunction with the scavenger's broom. — *Journal of Franklin Institute, June,* 1868.

ON GALVANIC DEPOSITION OF IRON IN COHESIVE FILMS.

A German chemist of eminence, Dr. F. Varrentrapp, of Brunswick, comes to the conclusion that there are no reasons why deposits of almost any thickness of metal in cohesive coats may not be obtained from solutions of iron by means of the galvanic current, with as great a facility as from those of copper, if only certain precautionary rules be attended to, which follow: —

From a watery solution of iron in which a plate of metallic iron, serving as, and connected with, the copper cylinder of a simple Daniell element, and the plate to receive the deposit connected with the zinc cylinder are immersed, both plates being of about the same size, a coating, though thin, will be obtained, but it will remain so, and usually there will very soon set in a strong evolution of gas. In order to avoid this, it is sufficient to insert in the current close to the iron plate a spiral of iron wire, thus enlarging the surface of this metal as compared to that of the one which is to receive the coating, and upon this change the process will go on for days in perfect regularity. The iron coating has the tendency of forming warty aggregations near the edges. It is exceedingly brittle, and of a hardness resembling non-hardened steel under the file. After passing the fire, however, it becomes soft and flexible, and may be rolled into a narrow cylinder.

The tank must be of such dimensions that there may remain a space of at least 4 to 5 inches between both plates. It is of advantage to arrange in front of the iron plate a pane of glass, not quite reaching to the sides of the vessel, as this will prevent the particles from being carried on to the surface of the plate.

Metallic types and blocks are most readily coated in this manner, as much so as with deposits of copper; they may be easily separated by having a previous coating of silver, which has been allowed to become yellow in an atmosphere of sulphuretted hydrogen, but which must not be too heavy, since in that case it would cause the iron coating to become loose and reflexed, as soon as it acquires about the thickness of paper. The latter also takes place on casts of wax or gutta-percha made conductive by means of plumbago, in case the coating cannot be made to grow beyond the edges. Any bubbles of air which may adhere to the object will prevent a correct deposition, and must be removed by immersing in alcohol previous to placing in position, or by blowing over it atomized spirits.

Since the iron solution is rarely quite neutral, and generally to some extent oxidized, it is well to receive the first deposit on a spare plate of copper, to remain in the bath for an hour. When the battery is fresh, or must be renewed, it is well also to add some sulphuric acid to the strong solution of copper. The water for the amalgamated zinc should contain only short of 3 per cent. of sulphuric acid.

In the beginning of the operation the formation of bubbles cannot always be avoided altogether, and it will be found best to remove the plate or object after 5 minutes of action, to rinse it in a current of water, and, after replacing, repeat this several times on the first day, and on the following days only once or twice. Sometimes — when the basic-iron compound has commenced to make its appearance, but only if the tank be sufficiently deep to allow the deposit to remain undisturbed — the bubbles may be removed by slightly tapping the plate.

The concentration of the bath is not of primary importance, but one consisting of sal-ammoniac 3 pounds, copperas 4 pounds, and water 30 pounds, has been found practically a good one. Since a deposit also forms in absence of the ammonia, it is proved that it is not composed of nitride of iron, though it be much more readily formed in presence of the salt.

To obtain a good polish, the coating when completed is rubbed with a little oil, which must again be removed, always entirely by polishing. When thin the lower surface is quite smooth, but with increasing depth it assumes a granular, or somewhat velvety appearance. A deposit 2 millimetres in depth may be easily obtained in a fortnight. — *Dingler's Polyt. Jour.*, II., *January*, 1868.

Some recent experiments by M. Klein, of St. Petersburgh, are thus alluded to in the "Scientific American": —

"His starting-point was the known process of covering engraved copper plates with a coating of steel, which is quite successful in a bath composed of the chlorides of ammonium and iron, to which he added a minimum quantity of glycerine. Nevertheless, all who have attempted coating with steel must have observed, when endeavoring to give greater thickness to a very thin and brilliant layer of steel, that the surface cracks, and the deposit detaches itself from the cathode in very brittle spangles. Other baths, composed in a uniform manner, and capable of being employed under the same conditions, must therefore be used. They may be classed under two categories, comprising baths composed of sulphate of iron, and sulphate or chloride of ammonium. The first bath consisted of a solution of the double salt sulphate of iron and sulphate of ammonium; the second was composed of an admixture of the concentrated solutions of each of these two salts, in the proportions of their equivalents; the third bath, which distinguished itself meritoriously from the others, was obtained by taking a solution of sulphate of iron, precipitating the iron by carbonate of ammonium, and dissolving the precipitate in sulphuric acid, thus avoiding all excess of acid. For the preparation of the baths in the second category, he either mixed solutions of chloride of ammonium and sulphate of iron in the proportions of their equivalents, or dissolved in a solution of sulphate of iron, at a temperature of about 15° Réaumur, as much chloride of ammonium as it would take. All these baths were as highly concentrated and as neutral as possible. For an anode, plates of sheet iron were used, presenting a surface nearly 8 times as large as that of the copper cathode. Upon the employment for decomposition of one of Daniell's cells, there were formed upon all the cathodes, in the course of 24 hours, irregular deposits full of cracks, which, on the slightest attempt to remove them, broke into a thousand pieces.

"A continuation of the experiments for several days produced no better results, the solution not improving by use, as is often the case with copper solutions used in electrotyping. An employment of a weaker battery improved the results, but still left much to be desired. An examination of the bath showed an increasing acid reaction, owing to the deposition of iron upon the cathode more rapidly than it was dissolved from the anode. To augment the solubility of the anode, a plate of copper was plunged in the bath and combined with the iron.

"The result of this combination was most surprising; not only did the baths in the first category become re-neutralized in a few hours, but the deposits became much smoother, their color a dull gray, and adhered perfectly to the cathode without forming bubbles or cracking in any part. Their surfaces remained quite smooth during the first 24 hours, after which there began to form, in several places, the characteristic cavities, corresponding, so to speak, with those mammillary bubbles so often seen in the electro-deposition of copper. By reducing the energy of the current, either by reducing the strength of the solution or increasing the resistance in the solid parts of the circuit, so as to render the evolution of gas imperceptible, the formation of these bubbles ceased entirely. M. Klein found the strength of the solution should vary with the material of which the cathode was made. In all cases the cathode was required to be perfectly clean and smooth.

"Galvanic iron, when first taken out of the bath, is as hard as cast steel, and very brittle, but when annealed at a temperature of dull redness it loses much of its harshness and hardness: when further annealed to red heat it is malleable, and may be engraved as easily as soft steel.

"When made under favorable conditions, and annealed uniformly, and with the proper precautions, electro-deposits are not subject to twist, bend, or blister. There is no contraction, but, on the contrary, an almost imperceptible dilatation. This is of importance where the complete similarity of blocks is required, as their dimensions should receive no sensible alteration on being annealed. The specific gravity of this iron before and after annealing has not been yet determined.

"It appears that galvanic iron has no permanent magnetism, but will receive magnetism like soft steel."

THE COLORING OF BRASS.

Some interesting details have lately been published respecting this very practical subject in a German cotemporary, illustrating the methods employed in obtaining a color of any required tint. An orange tint, inclining to gold, is produced by first polishing the brass and then plunging it for a few seconds into a neutral solution of crystallized acetate of copper, care being taken that the solution is completely destitute of all free acid and possesses a warm temperature. Dipped into a bath of copper, the resulting tint is a grayish-green, while a beautiful violet is obtained by immersing it for a single instant in a solution of chloride of antimony and rubbing it with a stick covered with cotton. The temperature of the brass at the time the operation is in progress had a great influence upon the beauty and delicacy of the tint; in the last instance it should be heated to a degree so as just to be tolerable to the touch. A moire appearance, vastly superior to that usually seen, is produced by boiling the object in a solution of sulphate of copper. According to the proportions observed between the zinc and the copper, in the composition of the alloy, so will the tints obtained vary. In many instances it requires the employment of a slight degree of friction, with a resinous or waxy varnish, to bring out the wavy appearance characteristic of moire, which is also singularly enhanced by dropping a few iron rails into the bath. There are two methods of procuring a black lacker upon the surface of brass. The one, which is that usually employed for optical and scientific instruments, consists in first polishing the object with tripoli, then washing it with a mixture composed of 1 part of nitrate of tin and 2 parts of chloride of gold, and after allowing this wash to remain for nearly a quarter of an hour, wiping it off with a linen cloth. An excess of acid increases the intensity of the tint. In the other method, copper turnings are dissolved in nitric acid until the acid is saturated; the objects are immersed in the solution, cleaned, and subsequently heated moderately over a charcoal fire. This process must be repeated in order to produce a black color, as the first trial only gives a deep green, and the finishing touch is to polish with olive oil. Much pains is taken abroad to give brass objects "an English look." For which purpose they are first heated to redness, and then dipped in a weak solution of sulphuric acid. Afterward they are immersed in dilute nitric acid, thoroughly washed in water, and dried in sawdust. To effect a uniformity in the color, they are plunged into a bath consisting of 2 parts of nitric acid and 1 part of rain-water, where they are suffered to remain for several minutes. Should the color not be free from spots and patches, the operations must be repeated until the desired effect is produced. — *The Engineer.*

SILVERING GLASS MIRRORS.

The process we propose to describe has for its author Prof Henry Draper, of this city, and may be divided into 5 operations, namely, the cleaning of the glass, the preparation of the silvering solution, the warming of the glass, the process of silvering, and the polishing. The description is for a 15½-inch mirror.

1. Rub the glass plate thoroughly with aquafortis, and then wash it with plenty of water and set it on edge on filtering paper to dry; then cover it with a mixture of alcohol and prepared chalk and rub it in succession with cotton flannel.

2. Dissolve 560 grains of Rochelle salt (tartrate of soda and potassa) in 2 or 3 ounces of water, and filter; dissolve 800 grains of nitrate of silver in 4 ounces of water. Take an ounce of strong

ammonia of commerce and add nitrate solution to it until a brown precipitate remains undissolved. Then add more ammonia and again nitrate of silver solution. This alternate addition is to be carefully continued until the silver solution is exhausted, when some of the brown precipitate should remain in suspension. Filter. Just before using, mix the Rochelle salt, and add water enough to make 22 ounces. The vessel in which the silvering is to be performed should be a circular dish of ordinary tin plate and coated with a mixture of equal parts of beeswax and resin. At opposite ends of one diameter 2 narrow pieces of wood are cemented to keep the face of the mirror from the bottom of the vessel.

3. The glass is slightly warmed by putting it in a tub or other suitable vessel and pouring in tepid water to cover the glass; then hot water is gradually stirred in.

4. Carry the glass in the silvering vessel, into which the silvering solution has been poured, place the whole apparatus before the window, and keep up a slow rocking motion. Leave the mirror 20 minutes or half an hour in the liquid, and wash with plenty of water.

5. When the mirror is perfectly dry, take a piece of the softest buckskin, stuff it with cotton, and go gently over the whole silver surface to condense the silver. You may use some of the finest rouge. The best stroke is a motion in small circles; rub an hour. The thickness of the silver thus obtained is about one two-hundred-thousandth of an inch. — *Scientific American.*

CRYSTALLIZATION UTILIZED.

A very curious discovery has recently been made by M. Auguste Bertsch, and turned to practical account by M. Kuhlmann, the celebrated chemist. Who is there that has not, during cold winters, stopped to admire the beautifully symmetrical and yet fantastic figures of leaves and flowers depicted on the window-panes of a well-heated room, the air of which is charged with aqueous particles? M. Bertsch has found that Epsom salts (sulphate of magnesia) dissolved in beer, together with a small quantity of dextrine (artificial gum), and in this state applied to a pane of glass with a sponge or brush, will, on crystallizing, produce the identical designs above alluded to, hitherto considered peculiar to water; with this improvement, however, that the liquid may receive any color whatever, at the option of the operator. The ephemeral productions of frost may thus be easily perpetuated; but M. Kuhlmann, on being apprised of the fact, conceived the idea of going a step further, and transferring those fairy-like creations to stuffs and paper. For this purpose he first got the crystallizations on sheets of iron, on which he afterwards laid one of lead. By means of a powerful hydraulic press the minutest details of the figures in question were durably imprinted on the soft metal, and a copy of them in relief was then obtained by galvanoplastics. But here another difficulty arose: in the impression of cotton stuffs the pattern must be continuous; whereas in M. Kuhlmann's plates the lines at one end would clearly not coincide with those at the other, so that disagreeable interruptions would be caused in the printed designs. This obstacle, however, has been overcome in a most ingenious manner by effecting the crystallization on the cylindrical surface of a roller. A slight rotary motion imparted to it will prevent the liquid from accumulating at any particular point before it has evaporated.

MICA SPECTACLE-GLASSES.

As made on the recommendation of Dr. Cohn, of Breslau, the mica spectacle-glasses are curved somewhat in the shape of watch-glasses; they not only protect the eye in front, but their brass frames fit closely on the osseous circle round the eye-sockets, so that no chips can enter the eye from any part, and still the eyelashes do not touch the glasses. The frame is made of thin brass wire, which can easily be bent by hand into any shape. As hinge-joints would have caused too much expense, the side parts are soldered on to the frame. The thickness of the mica is about one-twenty-fifth of an inch. Only the purest kind of mica being used for this purpose, these spectacles are just as transparent as real glass ones. They impart, to be sure, a slight pale gray tint to the objects, but they do not in the least weaken the optic nerve of the eye. For blacksmiths and foundrymen such a gray tint is rather an improvement, and for other metal workers it is not in the least objectionable. Now, these mica spectacles, besides protecting the whole eye, have the following advantages: First, they cannot be broken; heavy blows with a sledge-hammer only squeeze them flat, without breaking the glasses. They may be thrown to the ground with full force without being damaged in the least. Red-hot metal poured on the mica does not make any impression on it. The shower of pointed particles of iron which issues from lathes, etc., only rebounds from the perfectly elastic mica glasses. Secondly, mica spectacles are almost twice as light as glass spectacles; a pair of French watch-glass-shaped spectacles weighs 13.9 grammes; mica spectacles only 7.5 grammes. Thirdly, mica spectacles keep the eyes of the workman cool, mica being a very bad conductor of heat. Fourthly, mica spectacles are very much cheaper than glass spectacles, especially watch-glass spectacles, which are the only ones that protect the whole eye. The mica spectacles are sold at Breslau for about eight pence, English money, apiece. They would be, of course, a few pence dearer in this country, as carriage, duty, commission, etc., would add to the expense. But, at all events, their cost would be exceedingly trifling when compared with the very serious expense, loss of time, and pain, that are caused to iron-workers by the frequent accidents to their eyes. No doubt there will soon be established an agency for the sale of mica spectacles in this country, and we shall then hear more about them. As it is, we strongly recommend our metal-workers to look into so important a matter. — *Mechanics' Magazine.*

THE USES OF PAPER.

There are very few articles applied to so many useful and ornamental purposes as paper, and although it may be remarked that we are behind some of the Oriental Nations, China and Japan, for instance, in such application, yet, judging by the progress we have made within a few years, we may be expected soon to be in advance of those semi-civilized people whom we seem to be copying after. The opinion has been expressed that, at no very distant period, houses, and even large ships, may be made in greater part or wholly of paper. Japan produces excellent waterproof clothing from paper, and with proper treatment this material may be rendered sufficiently tenacious, and, imbued with water-proof qualities, may be a better covering for naval purposes than the wooden planks or iron sheets now used.

In looking over the uses which the Orientals have made of paper, we find that, besides serving for books and writing material, it is employed in the fabrication of screens and partition walls, for trunks, boxes, cases, clothing, handkerchiefs, twine, etc. It is fabricated to resemble leather, and is so used for saddles.

We have imitated those nations in some of our applications; for instance, since the price of leather has been so much enhanced, paper has become to some extent a substitute in the manufacture of travelling trunks, and forms so good an imitation that the deception is almost complete.

An establishment in Massachusetts is now engaged in the manufacture of paper belting as a substitute for the leather machine belts formerly used, and it is stated that one paper belt, 75 feet long and 8 inches wide, has been in use for several months, and shows good service. As substitutes for wood we find that paper has been for some time used in roofing, for boxes, and table-tops; and more recently for pails, buckets, and barrels, which are claimed to be superior in many, if not in all respects, to the material they displace, and are represented as resisting wear and tear, and the action of the elements, better than wood or iron.

The high price and also scarcity of cotton, not long ago, induced us to follow out an Oriental idea, and we had quite a passable twine, with which to tie up parcels contained in paper wrappers, made of the same material as the wrapper itself. A chemical preparation gives us a paper that takes the place of parchment, which it so strongly resembles that it takes the name of "parchment paper."

In lieu of cloth, we have used ornamental paper for tapestry and carpets, for curtains, and in our clothing we employ it in cuffs, collars, bosoms, and buttons, hats and bonnets, and it has been gravely proposed to substitute it in the manufacture of shirts, skirts, hosiery, and other under-clothing. It has also entered into the manufacture of boots and shoes.

In building houses it has become a common practice for the builders to buy the doors and windows already made. It is now proposed to supply them in like manner with the walls and ceilings, in the form of slabs, to be used as a substitute for lath and plaster. These slabs are made of cane fibre, — a cheap material obtained from the cane of the Southern canebrakes, by disintegration effected by the explosive force of steam, and costing about $10 a ton, mixed with clay, resin, size, and other cheap materials. The cane fibre is also made into paper of various kinds.

The following advantages are claimed for this new building material: In a few hours all the walls and ceilings of a house can be put up by nailing them to the ordinary battens upon which the laths are nailed. The work can be done as well in winter as in summer time, and no drying is required. The fibrous slabs do not warp, crack, break, peel, shell, crumble, nor decay; and they keep out damp, heat, and cold, better than lath and plaster. They are somewhat similar, but asserted to be superior to the panels or wainscoting found in many palaces and mansions in England. Their cost is said to be less then half the cost of common lath and plaster. It is proposed to make them fire-proof and water-proof,that they may serve for the roofs and outer walls of houses better than clapboards and shingles.

According to estimates which have been made, the cost of an ordinary cottage house will be very much less than the present cost of a frame house of the same size; and it is claimed fibrous slab houses can be erected in less than one-fourth of the time now required to erect other houses.

One of the late uses of paper is its application in the manufacture of pails, wash-basins, pans, spittoons, etc.; and, strange as it may seem, it is nevertheless true that the above articles — as made by the American Papier Maché Manufacturing Company of Greenpoint, L. I., from a chemically prepared paper — are superior in many respects to any others before made. The paper from which these articles are manufactured is rendered impervious to the action of water or acids; the utensils can be placed in an oven till water will boil in them; placed in the sun at the hottest season, or exposed to the severest cold, without the slightest effect on them. Where wood would rot and iron rust, these articles are unaffected, and with proper usage would be as good as new. In pails, there is an advantage that water will not taste of the material and will never soak, and they will not fall in pieces; they are lighter than the wooden pail, and, being a non-conductor of heat, will keep water cool. The articles are coated with a vegetable composition which, even if it does wear off, does not affect their durability, and does not injure them except in appearance. — *American Artisan.*

Walter Brown of Portland, the "Argus" says, has brought home a new paper boat, of the Waters' patent, from a model of his own. This boat is 31½ feet long, 12 inches wide, and weighs but 22 pounds. The lightest wooden boat ever built of similar dimensions weighed 41 pounds. The most singular part of the matter is that the boat is more than four times stronger than one of wood. All of it, save where the sculler sits, is gas-tight, so that in the event of a race sufficient gas may be taken into it to reduce its weight to 8 pounds. The displacement of water by such a craft will be very much less than that of a wooden boat, and the same exertion will propel it proportionately faster. Its strength is also a great advantage.

SULPHURIZED PAPER.

This invention as patented by Charles F. Crehore, of Newton, Mass., consists in subjecting the paper to the action of sulphur, preferably to immersing it in a bath of boiling or melted sulphur. the temperature of which is to be regulated by the required hardness of the finished material. The action of the sulphur has the effect of rendering the paper hard, semi-elastic, and water-proof, as well as compact in body, and with a susceptibility of high finish, if desired. Among the various instances of application of which the invention is susceptible, so far as the experiments made have proved it a success, a particular one is its use as press-paper for cloth printers' use, as well as for those of ordinary printing, the advantages of which will at once manifest themselves to persons skilled in the craft. For book-binders' use the requisite amount of rigidity may be obtained with great reduction in bulk and weight, and, as a consequence, in cost, as compared with the material now in use.

NEW CEMENTS.

Few things are in more constant demand among mechanics than cements, and it must be admitted that most of those in common use are open to improvement. We have recently met with some recipes in the French and German journals, which we put together for the information of our readers: 1. The first is an iron cement, which looks likely to be useful. It is made by mixing from 4 to 5 parts of dry clay, 2 parts of iron filings, 1 part oxide of manganese, half a part of salt, and half a part of borax. When the cement is wanted for use, this mixture is made with water into a paste, which is applied immediately to the pieces to be joined. It is then allowed to dry gradually, and is subsequently heated to whiteness. After this the cement will resist water, and of course heat. 2. Another, said by Stinde to be a very useful cement, is made by mixing equal parts of oxide of manganese and oxide of zinc, and making them into a thinnish paste with the solution of silicate of soda of commerce. This paste must be applied quickly, as, no doubt, it sets very rapidly. It is not calculated to resist heat and water; the latter, at all events, not for any length of time. 3. Another recipe we find is for a strong liquid glue. To make this the inventor puts 3 parts of glue with 8 parts of cold water, and lets them stand for several hours to soften the glue. He then adds half a part of muriatic acid and three-quarters of a part of sulphate of zinc, and heats the mixture to 185° F., for 10 or 12 hours. The mixture remains liquid after cooling, and is said to be very useful for sticking wood, crockery, and glass together. — *Mechanics' Magazine.*

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.

Zinc Cement. — We have before mentioned Soret's cement, which is formed by making oxide of zinc into a paste with a solution of chloride of zinc. This paste quickly sets into a hard mass, which may be applied for stopping teeth and a variety of useful purposes. Dr. Tollens gives a cheaper form of the same cement, which may be used for stopping cracks in metallic apparatus, and cementing glass, crockery-ware, and other materials. He mixes equal weights of commercial zinc-white and very fine sand, and makes the mixture into a paste with a solution of chloride of zinc having the density 1.26. The mixture sets rapidly, but allows plenty of time for its application. As it resists the action of most agents, it will be very useful in the chemist's laboratory. — *Mechanics' Magazine.*

Metallic Cement. — A very strong and durable metallic cement, we read in a German "Mechanics' Journal," is formed when a mixture of equal parts of oxide of zinc, sulphate of lead, peroxide of manganese, and oxide of iron is made into a paste of proper consistence with boiled linseed oil.

Impermeable Cement. — A cement impermeable by air or steam, superior to any in use for steam and gas pipes, is made by mixing 6 parts of finely powdered graphite, 3 parts of slaked lime, and 8 parts of sulphate, with 7 parts of boiled oil. The mass must be kneaded well until the mixture is perfect.

A NEW INK FOR PRINTERS.

A new ink for printers has been invented by Prof. Dr. Artus and Mr. Fleckstein, a master-printer at Lichtenhain, near Jena, which ink is said to be a complete success. The composition of it is as follows: —

"Venetian turpentine, 4½ ounces; fluid soap, 5 ounces; rectified oleine, 2 ounces; burnt soot, 3 ounces; Paris blue (ferro-cyanic acid), one-half ounce; oxalic acid, one-fourth ounce; distilled water, one-half ounce."

The mixing process of this new, beautiful, and cheap ink is described as follows: —

"Gradually warm the turpentine and the oleine together; put the soap on a marble plate, and gradually add, continually rubbing, the mixture of turpentine and oleine; when well mixed, add the burnt soot, which must be well powdered and sieved before; then add the Paris blue, dissolved in the oxalic acid, continually rubbing the composition on the stone, the Paris blue and the oxalic acid having been mixed before with water in the above-given proportions. A solution of soda in water is sufficient to thoroughly cleanse the type."

PAINTS AND VARNISHES.

Aniline Black Varnish.—An aniline black varnish, of recent Parisian production, is the following: In a litre of alcohol 12 grammes of aniline blue, 3 grammes of fuchsine, and 8 grammes of naphthaline yellow, are dissolved. The whole is dissolved by agitation in less than 12 hours. One application renders a white object ebony black; the varnish can be filtered, and will never deposit afterwards. The 3 colors are not destroyed, for each can be separated by analysis with the characteristic properties.

Black Varnish for Iron Works.—Dr. Lunge distils gas tar until nearly all the volatile products are got rid of, the residual pitch being then dissolved either in the heavier oils, or, if a quick-drying varnish is required, in the light oils or naphtha. The advantage of varnish so prepared over the original tar is, that by the above process we get rid of the ammonia, water, carbolic acid, and other constituents that give to tar its disagreeable odor, and make it so long in drying.

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.

Silicate Paint for Stoves and Ovens.—Black-lead certainly has its recommendations, but it can hardly be said to be ornamental, while it entails an immense amount of labor on servants. In Germany, where a stove and sort of kitchen range is continually to be found in the common sitting-room of a respectable family, the unsightliness seems to have been felt, and a suggestion has been made to do away with the black-lead, and paint the stoves and ovens. Oil paint, of course, cannot be employed, but waterglass (silicate of potash), colored with pigment to match the paint of the apartment, is the material recommended. Before this is applied the iron must be thoroughly cleaned from grease, and all rust-spots must be rubbed off with a scratch brush. Two or three coats of the paint may then be put on and allowed to dry, after which the fire may be lighted without fear of injury to the color, which may, indeed, be heated to redness. Grease or milk spilt over the paint has no effect upon it, and it may be kept clean by washing with soap and water. Dutch-ovens and like utensils may also be coated with the same materials, and the labor spent in polishing be saved. A good coating of the paint, the author says, will last a year or two.

To make Paint adhere to Zinc.—Dr. Bottger claims to have succeeded in this difficult process. He makes a solution of 1 part of chloride of copper, 1 part of nitrate of copper, and 1 part of chloride of ammonium, in 64 parts of water and 1 part of commercial hydrochloric acid. This solution acts as a mordant. It is put on with a wide brush over the zinc, which immediately becomes of a deep-black color, forming, according to him, a basic chloride of zinc, and what he calls an amorphous brass. The black color changes in the course of 12 or 24 hours to a gray, and upon this gray surface any oil paint will dry and give a firmly adhering coat. The zinc is by this completely protected both against summer heat and winter rain.

VEGETABLE HAIR.

This invention of M. W. Staufen, of Paris, consists in the manufacture of a species of vegetable hair from the fibrous material which grows through and proceeds from the bark situated near the foot of the palm known as *Levistonia* or *Latania Chinensis*. The fibrous material and adherent bark, as imported in the rough state, being first disintegrated by an opening machine, is boiled in an alkaline lye composed of from 5 to 10 lbs. of soda or potash dissolved in 100 gallons of water. This operation, which lasts from half an hour to 2 hours, according to the strength of the lye, is continued till the gummy, resinous, and ligneous matters adhering to the fibres are completely removed. Thus cleansed, the material is exposed to the action of a mordant, preparatory to its removal to the dyeing-vat charged with the required color, to which is added 1 to 4 lbs. of oil soap for every 100 lbs. weight of fibre. The dyeing completed, the mass is dried either in the open air or artificially, and is then submitted to the action of ordinary opening and combing machinery, by which the filaments are glazed and divided to the requisite degree of fineness. This material is applied to the different purposes for which horse-hair, bristles, and other kinds of hair have hitherto been employed.—*Mechanics' Magazine.*

INDELIBLE ANILINE INK.

An indelible marking ink may be prepared from aniline by mixing the two following solutions: —

1. Cupreous Solution:

Crystallized chloride of copper,	8.52	grammes.
Chlorate of soda, ...	10.65	"
Chloride of ammonium, . .	5.35	"
Distilled water, ...	60	"

2. Aniline Solution:

Hydrochlorate of aniline,	20	grammes.
Distilled water, . .	30	"
Solution of gum-Arabic (1 of gum to 2 of water),	20	grammes,
Glycerine, ...	10	grammes.

By mixing cold 4 parts of the latter with 1 part of the former, a green liquid is obtained, which can be used immediately for tracing characters upon linen; the marks are at first green and gradually become black. The solutions must be kept separate until required for use; the mixture may be diluted so as to flow easily from a pen, without diminishing the intensity of the tint. Heat causes the black color to appear immediately; a steam heat is sufficient, and is better for the fabric than a hot iron. The linen is afterward to be washed in warm water with soap. This ink is not affected by acids or alkalies, and is remarkably permanent. — *Chemical News.*

NEW ANILINE DYE.

Geranosine is prepared by making first a solution of 1 kilogramme of any salt of rosaniline in 1,000 litres of boiling water, which is then allowed to cool to 45° C. Another solution is made by first mixing 4½ kilogrammes of binoxide of barium with 35 litres of cold water, and then adding 10 kilogrammes of sulphuric acid. The two solutions are then mixed. The mixture immediately becomes lemon-yellow in color, but in a short time nearly colorless. The sulphate of baryta is then separated by filtration. The filtered solution is then gradually heated, and, as the boiling-point is reached, assumes a red color, reaching its greatest intensity after 2 minutes' boiling, and is then ready for dyeing. The shade of color is that known as *ponceau*, almost as brilliant as the same shade produced by cochineal. Acid brightens, and ammonia discharges it. It is evidently an oxidized product of rosaniline. When precipitated from its solution, the new compound is soluble in alcohol, and partially so in acids.

SUMMARY OF IMPROVEMENTS IN THE MECHANIC AND USEFUL ARTS.

Aluminium Bronze. — M. Evrard, in making this bronze, does not combine the copper and aluminium directly, but makes use of a pig iron containing aluminium. This is slowly heated to fusion, when copper is added to the melted mass. Having more affinity for copper than for iron, the aluminium abandons the latter and combines with the copper. After it has been well stirred it is allowed to cool slowly, so as to permit the bronze, which is denser than iron, to find its way to the bottom of the crucible. The same process may be employed to obtain a bronze of silicium; indeed the affinity of copper for silicium is energetic enough to induce M. Evrard to try this method for separating silicium from pig iron by adding a proper quantity of copper. — *American Artisan.*

Very Hard Alloy. — By melting together 500 parts of lead, 300 parts of tin, and 225 parts of cadmium, a very hard alloy may be made, fit for stereotype plates and for backing up electrotypes. It is said to be harder and better for the above purposes than that made with bismuth, and it is also cheaper. An objection to it is that, when remelted, some of the cadmium will be volatilized, and thus the composition and properties of the alloy will be to a certain extent changed; by melting, however, at as low a temperature as possible, and by adding a small quantity of cadmium, the composition may be kept sufficiently uniform.

Useful Alloys for Table Use. — Oreide consists of 80 parts of copper, 13.5 parts of zinc, and 6.5 parts of nickel. A beautiful white metal, very hard, and taking a fine polish, is composed of 69.8 parts of copper, 19.8 nickel, 5.5 of zinc, and 4.7 of cadmium.

Method of Cutting Glass. — A speedy method is practised in some of the large establishments of France. A jet of highly heated air is directed from a tube on the vase or other object to be cut, which, while made to revolve on its axis, is brought close to the nozzle of the tube. The object being then cooled suddenly, the glass divides at the place operated on with extreme accuracy.

Extraction of Indigo from Rags. — A French inventor places the rags, cotton or woollen, which have been dyed with indigo, in a boiler provided with a double bottom, and saturates them thoroughly with a solution of caustic soda of 1° Baumé. He then keeps them under the action of steam at 45 lbs. pressure for 5 hours. By this treatment the indigo is reduced and dissolved, and may be precipitated from the solution and collected. The indigo thus recovered is said to be as pure as the best commercial. The process will be useful to paper-makers, requiring no more careful sorting of the rags than is usual in paper-mills.

Bronze Powders. — These colors, according to Dr. Wagner, are really metallic, and not mixtures colored with organic pigments, like carmine and indigo. The metals employed are, for the most part, copper and zinc, an alloy of the two being reduced to an impalpable powder. The proportions are given as follows, in Dingler's "Polytechnic Journal:" for a bright yellow shade, 83 parts of copper, and 17 of zinc; for an orange shade, 90 to 95 of copper, and 5 to 10 of zinc; for copper red, 97 to 99 of copper, and 1 to 3 of zinc. Tin, silver, and nickel are not used.

Hair-cutting by Machinery. — M. Nabat has invented a mechanical razor, in principle something like a lawn-mower. A helix, with steel blades tangent to a comb, is made to rotate by means of a flexible chain worked by a lever. One man works the lever, while the operator moves the comb over the body of the animal, regulating the length of hair to be left by the inclination of the comb. It works well on horses and oxen, and may be modified to act on the human head.

Fire-proof Flooring. — The method found successful in France consists of first spreading upon the planks a layer of clay about an inch thick, and running upon this a layer of asphalte about half an inch thick, — useful in warehouses and granaries.

Steel Billiard Balls. — Billiard balls are now frequently made of steel instead of ivory; they are very elastic, and not liable to crack like ivory balls.

Liquid Glue. — This useful article, for mending porcelain, glass, etc., is best made as follows: 3 parts of glue, in small pieces, should be covered with 8 parts of water, and left to stand for some hours; one-half of chlorhydric acid and three-fourths of sulphide of zinc must then be added, and the whole heated from 81° to 89° C. during 10 or 12 hours. This compound does not gelatinize; if simply allowed to settle it is ready for use. — *Chemical News.*

New Glue Preparations. — A German chemist has discovered that if glue or gelatine be mixed with about one-quarter its weight of glycerine, it loses its brittleness, and becomes useful for many purposes for which it is otherwise unfit, such as dressing leather, giving elasticity to parchment or enamelled paper, and for bookbinding.

Water-proof Glue may be made by boiling 1 pound of common glue in 2 quarts of skimmed milk. This makes an excellent glue for articles which are exposed to the action of the weather.

Bromo-iodized Rubber. — The following process of treating rubber and other gums without the use of sulphur has lately been patented by J. B. Newbrough and E. Fagan, New York City. By adding to iodine one-half its weight of bromine, proto-bromide of iodine is formed, and this, when combined with rubber, or equivalent gum, will produce a composition which will harden on being subjected for about an hour to a heat of 250° F. Owing to the volatile properties of proto-bromide of iodine it cannot be applied without difficulty to practical purposes. To obviate this difficulty, we treat both the bromine and iodine, prior to combining the same, with oil of turpentine, or similar oil, which has previously been mixed with about one-fourth its weight of sulphuric acid, to prevent the formation of an explosive composition.

The pasty mixture, produced as above described, is combined with caoutchouc, or equivalent gum, in the proportion of about 3 ounces of the paste to a pound of gum, the proportion of gum being increased if a more elastic product is desired. After the gum and paste are thoroughly incorporated, the composition may be hardened by subjecting it to a dry heat (of from 200° to 320° F.), for from 10 minutes to 1½ hours, the time being lengthened to increase the toughness of the product.

The product thus obtained may be applied to many useful and ornamental purposes, and any desired color may be imparted to the material by combining with the composition, before it is hardened, any suitable mineral or earthy coloring matter. — *Scientific American.*

Sponge for Textile Fabrics. — A. Paraf, of Mulhouse, France, has lately obtained a patent in this country, in which we find the following: —

"The best quality of sponge is gathered in the Mediterranean Sea; but an excellent quality, as well as an inexhaustible quantity, is found upon the rocks of the Bahamas and the coast of Florida. The sponge, when torn from the rocks to which it adheres, appears at first as a heavy, black-looking mass, having a strong and offensive odor. In order to clean the sponge it is buried in the earth for some weeks, at the end of which time all the organic matter will be decomposed, only the pure fibrous skeleton remaining.

"The sponge, when purified, is liable to become exceedingly hard, and, therefore, unfit to be used as a material for weaving cloth. To obviate this, I first take the purified sponge, and immerse it in water containing from 10 to 20 per cent. of glycerine, then squeeze it dry, after which it will be entirely soft and elastic. It is then cut into small pieces and put through the carding process, and then felted. Only certain qualities of sponge are capable of being spun. One of them is the kind known as 'chipoul,' which has comparatively a long fibre. The felted sponge may be used for hat bodies, carpets, etc.; the sponge-cloth for clothing, etc.

"Sponge thus prepared may be worked in the preparation of fibrous and textile fabric, with or without the admixture of other ingredients or fibres; for instance, it can be used to advantage in connection with woollen and other similar substances." — *Scientific American.*

Composition Fuel. — The mixture of tar, coal-dust, sawdust, tan bark, peat, and other inflammable refuse stuff, and the pressing the same into blocks, for the purposes of fuel, is very common, and several patents have been issued for varieties of such mixtures. Washington Stickney and Nathan B. Chase, of Lockport, N. Y., have lately obtained one of these patents, and they say: —

"The coal consists of screenings and other fine portions, which accumulate in great abundance in coal-yards, and hitherto have been considered comparatively valueless. The tan bark used (commonly called spent tan bark) is also comparatively useless and very abundant. These, with other ingredients, hitherto considered of little or no value, are so combined as to form a cheap and convenient fuel, and may be compressed, by mechanical power, into blocks convenient for use. The coal tar cements the whole, making a solid mass, which may be readily ignited, and is well adapted for common fuel, especially for summer use.

"The above ingredients are combined in the following proportions, to wit: Coal, 3 parts; tan bark, 2 parts; sawdust, 2 parts; peat, or other fine woody or vegetable matter, 1 part; coal tar or pitch, 1 part, or sufficient to cement the whole; or they may be combined in a greater or less proportion of either, securing substantially the same result. The whole mass may be easily ignited with shavings or paper, or more readily by the application of a small quantity of benzine and a match." — *Scientific American.*

To render Paper and Paper-hangings Water-proof. — Rischer recommends to size with a thin paste of glycerine and starch (equal parts), with which for colored paper at the same time the paint is applied, and afterwards with a solution of Japanese wax in 5 or 6 times its bulk of alcohol. About a scruple of wax is said to be sufficient to give a water-proof coating to a sheet of paper.

Tobacco Paper. — This article is manufactured by a Hamburg firm as a substitute of the expensive "leaf" of fine cigars, and has acquired considerable reputation abroad. The composition, aside no doubt from a variable amount of flavoring substances, is given as: —

Woody fibre + moisture, ...	91.69	per cent.
Aqueous extract, incl. albumen, gum, veget. acids, . .	7.63	"

Resin, sol. in alcohol, ...	0.05 per cent.
Chlorophyll and nicotianin, ...	0.32 "
Nicotina, ...	0.31 "

To Remove Paint. — To remove paint of white lead or zinc-white which has become dry and hard, and cannot be removed by benzine, ether, or the bisulphide of carbon, a little chloroform may be used successfully. The odor, so disagreeable to many persons, will quickly disappear by warming the fabric before the fire, or by the application of a moderately hot smoothing iron.

Uses of Paper. — Esparto grass is radidly growing in use for making paper. It is stated that a large proportion of British paper is now made from it. The London "Times" is printed on paper made of this material, as is also the fine thin paper on which the circular conveying this information is printed. Fifty thousand tons are annually exported from Spain and Portugal to England, at a cost of about 35 dollars a ton.

Machine belting is manufactured of paper by Messrs. Crane, at Dalton, Mass., and is in use in several New England mills. One of these paper belts measures 75 feet long and 8 inches wide. The article promises to become the subject of much importance.

Improvement in Generating Illuminating Gas. — Ferdinand King, of Richmond, Va., in his patent, says: "I take of the oil that runs from the gas tar produced at gas or coke works about 2 parts, and crude petroleum about 1 part, and mix them together, forming a compound oil. From this compound oil I generate gas by treating it in any oil-gas generator, in the same way that other oils are treated for the same purpose. It makes a superior illuminating gas, at a very small expense, and will be found of great value for lighting private houses and single buildings or establishments which cannot be supplied by public gas works."

Minargent. — A new substitute for silver, which is said to possess nine-tenths of its whiteness, malleability, ductility, tenacity, sonorousness, and density, while it has a superior metallic lustre, wears better, is less likely to be acted upon by sulphur in its various forms, and is less fusible than silver. The chief features of this alloy consist in the introduction of pure tungsten and aluminium, also the considerable proportion of nickel which the inventors have been enabled to alloy with aluminium, notwithstanding its known want of affinity therewith. Minargent is composed of 1,000 parts copper, 700 parts nickel, 50 parts tungsten, and 10 parts aluminium. The first three elements are melted together, then run off in a granulated form, and again melted, adding the aluminium and about 1½ per cent of a flux composed of 1 part borax and 1 part fluoride of calcium; these proportions of borax are reduced as the fusion proceeds.

Improvement in Fire-proof Safes. — Edward H. Ashcroft, of Lynn, Mass., in his patent says: "I place in the inner perforated compartments of a safe, metallic tubes or vials filled with a liquid acid (sulphuric acid, for instance), one or both ends of such tube or vial being stopped with an easily fusible alloy. I surround this by, and place in immediate contact with it, bicarbonate of soda.

I then put into the compartments a large proportion of carbonate of ammonia, or other volatile salts.

"When the safe becomes heated to about 212° F., the above mentioned fusible alloy melts, thus opening the vial; the acid runs out, and, coming in contact with the surrounding bicarbonate of soda, immediately eliminates carbonic-acid gas, which fills the safe and is non-combustible. The evolution of this gas having ceased, if the safe is still longer heated, the carbonate of ammonia or other volatile salt vaporizes slowly, and, being also non-combustible, protects the contents of the safe."

Bleaching of Sugar. — It has been found by experiment that a stream of electricity from a powerful electro-magnetic machine, driven through a solution of brown unrefined sugar, will bleach it, electricity being thus made to perform the function of charcoal. One of Wilde's electro-magnetic machines, driven by a 15 horse-power engine, has been set up for this object in a sugar refinery in Whitechapel.

Composition for Coating Wood, Iron, Paper, etc. — Antonio Pelletier, of Washington, D. C., says, in his patent: —

"I take the pulp of any fibrous matter, preferring that from bamboo, sugar-cane, cornstalks, or other similar substances, prepared as for the making of paper, soapstone, or any mineral substance of a similar nature, and silicate of soda, in a liquid or any suitable state, in about equal quantities by weight, and thoroughly mix and incorporate the whole mass until it becomes soft and plastic. To this mixture, when desirable, a small quantity of red lead and litharge, in about equal proportions, may be added, the two together making about one-eighth or one-ninth of the whole mixture.

"The composition thus made, with or without the red lead and litharge, or similar substances, while in its plastic state, I apply, with any suitable instrument, to the surface of any kind of wood, whether green or dry, or to the surface of paper, pasteboard, cloth, leather, brick, stone, or other fibrous or porous materials, which I desire to make water and fire proof, or to iron or other metal surfaces that I desire to protect from the action of fire. When this coating is about half dry, I treat it with coal or common tar. This tar may be either hot or cold. I prefer to use it hot, as it is then thinner and works easier. This tar may be applied with a brush or any other suitable instrument. Before it becomes dry, I cover it with as much powdered steatite, talc, or other similar refractory substance, as it will hold, rubbing it well in with a roller or any suitable instrument. This done, the cement will be found completely water and fire proof.

"My composition I also make into sheets of any size that may be desired, either for immediate use in the vicinity where made, or in convenient size for transportation, having made them fire and water proof, as above described. In this form, my composition can be very conveniently used for roofing purposes of all kinds, whether for houses, railroad cars, locomotives, decks of steamboats, etc., etc., or for covering marine boilers, or lining wood or other surfaces exposed to the action of water or fire."

Coating of Cast Iron. — Herr W. Lieke, of Hanover, has made a series of practical experiments upon the various processes for covering cast iron with a protecting varnish. The author's observations were made with the view of discovering some new method of protecting cast-iron objects from oxidation or rust when exposed to the damp atmosphere. In the first place, he observed that "zinc dust," which is now extensively produced as a waste product of zinc furnaces, can be applied with considerable advantages. Half an ounce of this zinc dust mixed with 1 ounce of oil varnish, and rubbed several times upon 1 square foot of cast iron, will, he finds, preserve the metal from rust in a variety of circumstances; but it is not entirely satisfactory when the iron is subjected to soap water or other alkaline liquids.

To be effective against the action of these solutions, the iron must be coated with 2 parts of water-glass (silicate of soda), employed in solution, marking 20° Baumé, and 1 part of zinc oxide intimately mixed together. This material, laid on as a thick varnish, gives the iron a kind of enamelled appearance, and the protective coating will not yield to soap water. — *Scientific American.*

Improvement in Water-Wheels. — Mr. James P. Collins, of Troy, N. Y., enamels all portions of any water-wheel exposed to the action or force of the water with some suitable material, or combination of materials, thereby giving a smooth and glazed surface, over which the water flows with greatly diminished friction; of course adding proportionally to the efficiency of the wheel. All chemical action of the water must be entirely prevented by such a coating.

The Durometer. — At the Paris Exposition an instrument was exhibited designed for testing the relative hardness of steel rails. This "durometer," as it is styled, is virtually a small drilling machine, working by hand or machine power, which registers the number of revolutions of the drill spindle, and also the amount of feed, the latter being given by the application of a known weight to the back of the drill spindle. The friction of the machine and the state of the cutting edges are supposed to be constant quantities, and, as such, are thrown out of the calculation. The hardness of any rail is considered to be inversely proportionate to the depth of feed obtained with a given number of revolutions.

Drilled vs. *Punched Holes.* — A large number of specimens of steel plates were recently tested at Chatham Dockyard, to determine the difference in strength between steel plates with punched and drilled holes. Although the pieces were so prepared that they should break at the smallest part, they all, without exception, fractured at a place where two small holes had been punched. But when the holes were drilled, and in the largest sectional area of the steel, they as uniformly broke in the smallest part, exactly the reverse of the previous trial. From this and other experiments, the advantage in tensile strain, gained when the holes are drilled rather than punched, was calculated to be 22.5 per cent.

Immense Machines. — The largest planing machine in the United States, if not in the world, has just been completed at the government workshop at Charlestown. It has been several years in building. It will plane a mass of iron 40 feet in length, 20 feet in width, and 20 feet in height. One of the bed-pieces weighs over 40 tons. It is an elegant piece of workmanship, and reflects great credit upon American skill. Among other new and expensive tools in the machine-shop, there is also a boring-mill, which will bore 12 feet in diameter, and will turn 24 feet in diameter.

Recently, in the shop of the Boston Machine Company, on First Street, South Boston, a gigantic slotting-machine was put in motion for the first time. It is a ponderous piece of mechanism, weighing a little over 60 tons, and was made for the government machine-shop at the Charlestown Navy Yard. When removed to its destination it will be placed next to the mammoth planer, lately added to the Navy Yard works, and, like the planer, is the largest machine of its class in the United States. It is intended to perform the heavy slotting work on marine engines, is after an improved plan, and possesses immense power.

Differential Motion. — At a recent meeting of the Massachusetts Institute of Technology, Mr. Henry F. Shaw, of Roxbury, exhibited several models of machinery, in which differential motion is applied with remarkable effects, obtaining by the use of two wheels, of which the inner has an eccentric motion, as great a result as by the ordinary train of several wheels. By varying the excess of the number of teeth in the outer wheel, he obtains different velocity as required. In addition to the simplicity of this arrangement, as several teeth of the wheels are always in contact, there can be no retrograde motion unless by the same slow process by which the forward motion is produced; there can be no slipping, however great the load, the apparatus being self-sustaining. He exhibited his invention as applied to a windlass, elevator, pulley, lathe, planing machine, and ship-steering apparatus.

Manufacture of Steel. — At a recent conversazione of the London Institute of Civil Engineers, a process for manufacturing steel by friction was explained. By the aid of machinery, pig iron is ground to powder by a rapidly moving cutter. The great amount of friction generated produces a heat so intense that the iron is set on fire, and, after scintillating, falls down as reddish-brown dust, the combustion having caused the riddance of the superfluous carbon. The dust is collected, put in a crucible, melted, and when cooled, is found to form ingots of steel of superior quality.

Large Chilled Roll. — At Pittsburgh, Pa., has recently been cast a chilled roll, by Messrs. Bollman, Boyd, & Bagaley, of a diameter of 28 inches. This is by far the largest chilled roll yet made. It is to be used in rolling copper.

Large Armor Plate. — An armor plate has been made at Sheffield, England, which was, before rolling, 20 feet long, 4 feet broad, and 21 inches thick, weighing 420 cwt. The final rolling reduced the thickness to 15 inches. Two hundred and fifty tons of coal were consumed, and the labor of 200 men required for its production.

The Albert Medal.— This medal, which was instituted to "reward distinguished merit in promoting arts, manufactures, or commerce," has this year been awarded by the Council of the Society of Arts, to Joseph Whitworth, of Manchester.

Mosaic Gold. — Bisulphuret of tin forms gold-colored, translucent scales, of a peculiar soapy feeling. It is largely employed in bronzing wood. The following is a description of its mode of preparation from tin scraps: Put the scraps in glazed pots, cover them with muriatic acid, and when the tin is all taken up, transfer the liquid into another vessel. Should it yet contain free acid, add new scraps. Then immerse copper plates in the liquid; the tin will thus by galvanic action precipitate upon them as a spongy mass. Collect the tin, wash it with water, dry it and mix it intimately with equal parts of sulphur and sal-ammoniac; put the mixture into glass retorts, and heat them up gradually on a sand blast. The bronze is obtained partly as a sublimate, partly at the bottom of the retort.

A NEW VESSEL OF WAR.

Mr. John Elder, of the firm Randolph, Elder, & Co., in Glasgow, has recently patented a most original form of iron-clad ram for coast defences and attacks on sea fortifications. Mr. Elder's vessel is formed below the water-line as a segment of an enormous sphere, say 25 feet deep and 200 feet in diameter, of the circular water-line. This corresponds to a small piece of a sphere, of which the versine over a chord of 200 feet is 25 feet long. Over the water-line the armor-clad sides are a short truncated cone, and in the centre of this circular deck a high castle or tower, carrying 3 or 4 tiers of guns, is arranged. This vessel, being perfectly circular in plan, has neither bow nor stern, nor anything of the steering attributes of ships now in existence; it bears, in fact, the same relation of outline and form to the ordinary ships as the form of a crab bears to that of a fish. The power of locomotion is given to this craft by the reaction propeller. The reaction-wheel — probably Mr. Randolph's improved water-jet propeller — is placed in the centre of the vessel, at the lowest point of the spherical segment, and the ejection of water can be effected through 4 openings placed at 4 equidistant points in the circumference, so as to command the direction of propulsion without any steering arrangement by forcing the water through 1 or 2 of the passages which command any one of the 4 quadrants enclosed by them. There are, however, steering or deflection-boards fitted to the end of the passages through which the water is ejected; and, by using these boards, a rotary motion can be given to the "crab." By ejecting the water from 2 opposite passages, or from all 4 passages simultaneously, and placing the steering-boards in a corresponding position, the total engine power of the vessel can be made available for setting the ship into a revolving movement round its own vertical axis. The velocity which the ship is capable of attaining under these conditions, measured at the outer circumference, is very great, since there is no other resistance to this motion except the skin-friction. Mr. Elder proposes to make use of the great momentum which this high velocity of movement will afford for ramming purposes. The whole circular edge of his vessel, which is of a sharp angle in section, represents, so to say, the edge of a circular saw or revolving disk-wheel, and the accumulated momentum of the rotary movement can be used for producing a destructive effect upon the sides of any vessel with which this revolving turret-ship would come into contact. The circular form allows of a very large stowage-room as compared with the ordinary form of ships, and it produces a base of such stability as to allow the erection of a tower of great height in the centre, so as to obtain better facilities for attacking objects on shore. Mr. Elder has carried out some experiments as to the resistance to propulsion in a straight line offered by his form of vessel compared wlth the ordinary forms. He made two models representing equal tonnage, one of the "Black Prince" shape and the other of his spherical form, and the resistance of these two models was measured by an apparatus which afforded a simple mode of comparing the relative proportions of these resistances. The result was only about 10 per cent. in favor of the "Black Prince" model; and this seems to indicate that the new vessel would be capable of attaining a fair speed under steam. The advantages offered by this form are of different kinds, the most prominent being a maximum of internal accommodation or stowage room, with a minimum of exposed surface, a circular or turret-shaped armored side, and an extraordinary facility of manœuvring in an action; last, but not least, the total absence of any exposed points of weakness, such as most iron-clads at present possess. — *Engineering.*

A NOVEL GUNBOAT.

A boat named the "Staunch," built for the Admiralty upon the proposition and plans of Mr. Rendel, has just been tried off the Tyne. A correspondent gives us the following account: "This vessel, though wholly insignificant in appearance and cost, represents some very novel principles. She is only 79 feet long, and 26 feet beam; her draft of water when loaded, 6 feet, and her displacement, 150 tons. She has twin screws driven by 2 pairs of condensing engines of 25 horse-power (nominal) combined, giving her a mean speed of 7½ knots. Such being her dimensions and power, it is hard to suppose that she can be in the least degree formidable. She carries, however, as heavy a rifled gun as any in the navy, and to all appearance carries it most efficiently. The gun, a 12½ ton 9-inch Armstrong, is mounted in the fore part of the boat, in a line with the keel, and fires through a bulwark or screen over the bow, which is cut down and plated something like that of a monitor. Thus placed, it is easily worked in a rolling sea, and its change of position by recoil does not appreciably affect the trim of the vessel. At the same time, to provide for heavy weather, it is made capable of being lowered into the hold, so as to relieve the little vessel of its deck-load, and enable it to carry the weight as cargo. Machinery is also employed for the purpose of working the gun, by which means more than half of the ordinary gun's crew can be dispensed with. It is in these mechanical arrangements that much of the interest of this vessel lies. The operation of lifting and lowering is performed by simple but powerful machinery. During the trials, the gun, with its carriage and slide, and the platform carrying them, — weighing in all, 22 tons, — was raised and lowered in a rough sea, with the boat rolling 11° each way, in from 6 to 8 minutes. When the gun is lowered the gun-well is closed and the deck left perfectly clear, but in a few minutes the gun can be again brought up ready for action. During the trials the 12½-ton gun was easily handled by 6 men, and fired with extra charges of 56¼ lbs. of powder, and 285 lbs. shot. It must be observed that very little, if any, training is requisite with the gun of the "Staunch." The vessel is so small as to be a sort of floating gun-carriage. Her twin screws enable her to turn rapidly in her own length. Her helmsman is placed just behind the gun. The gun, therefore, can be laid by rudder, right and left, with far more ease and speed than any gun of similar weight, otherwise mounted. During the recent trials, with the engines driving reverse ways, the vessel made the full circle, in her own length, in 2¾ minutes. With both engines going full ahead, she made by the helm a complete circle of 75 yards diameter in 2¼ minutes. The "Staunch" is wholly unarmored. Her strength and security lie in her great gun and her diminutiveness; and she must be considered as one of a flotilla of similar vessels. Sixty such could be built at the price of a single armor-clad frigate, and 10 of them, acting from different points, doubling in their own length, escaping into shallows, sheltering under forts, would drive off or render a good account of any hostile vessel venturing to attack our harbors. Primarily they are intended for harbor defence; but the power of lowering the gun and carrying it as cargo, would afford great security for these vessels at sea, and enable them to be sent from harbor to harbor with safety. — *Pall Mall Gazette.*

AMERICAN ORDNANCE.

Whatever representations or misrepresentations may have been made on either side of the Atlantic with regard to the performances of American ordnance, it is certain that it comes out very creditably in this respect in the report of the U. S. Chief of Ordnance, General Dyer, just issued. The official facts contained in this report are at once interesting and instructive, and General Dyer demonstrates that the American heavy smooth bores are "the cheapest and most effective gun possessed by any nation."

The report states that the 20-inch gun has been fired with a charge of 200 pounds of powder, and a shot weighing 1,100 pounds, and the general states that this may be the regular charge for this gun. The range at 25° elevation was more than 4½ miles. The 15-inch gun, about the performance of which, at Shoeburyness, we in England know something, has been fired as follows: 7 times with 40 pounds of powder, and a shell weighing 350 pounds; 5 times with 50 pounds of powder, and a shell weighing 350 pounds; 70 times with 50 pounds of powder, and a shot weighing 434 pounds; 59 times with 55 pounds of powder, and a shot weighing 435 pounds; once with 60 pounds of powder, and a shot weighing 434 pounds; once with 75 pounds of powder, and a shot weighing 434 pounds; once with 80 pounds of powder, and a shot weighing 434 pounds: once with 90 pounds of powder, and a shot weighing 434 pounds; and 125 times, with 100 pounds of powder, and a shot weighing 434 pounds. The mean range obtained with 100 pounds of powder, at an elevation of 32°, was 7,732 yards. The mean initial velocity of the shot, with the same charge, was 1,510 feet per second. Ten rounds were fired in 35 minutes, which was as rapidly as the gun could be fired with 100 pounds of powder, and a solid shot. An examination of the gun has failed to detect any enlargement of the bore, from firing; neither has the metal been cut away by the powder. In fact, the gun is reported to be serviceable in every respect.

If the performances of the 15-inch gun are thus proved to be in every respect satisfactory, no less so are those of the 20-inch gun. This formidable weapon has been fired with 200 pounds of powder, and a shot weighing 1,100 pounds, the range at 25° elevation being more than 4½ miles. This gun and its charge are difficult things for us to realize, but here they are, and here are their results, and. what is more, General Dyer has no hesitation in assigning this heavy charge as that which may be regularly used in this gun. — *London Mechanics' Magazine.*

ENGLISH ORDNANCE.

At the last anniversary meeting of the British Institution of Civil Engineers, Mr. C. H. Gregory, the President, delivered an address, from which the following are extracts: —

"Irrespective of breech-loading, which has been abandoned in this country for heavy guns, and of rifling, in which the original mode has been to a great extent superseded by larger grooves to guide soft metal studs fixed on a hard metal projectile, the gun now generally manufactured for the service has undergone considerable structural changes, the most material one being the diminution of the number of parts, and the substitution of outer coils of fibrous Staffordshire iron for coils of the best Yorkshire iron, tough steel being still maintained for the lining, as best resisting surface wear. In the former type of gun there was a forged breech-piece over the breech end of the steel lining tube, and, according to the size of the gun, a greater or less number of coiled tubes, carefully and successively fitted on. The pattern at present in use for all guns consists of only 4 pieces, namely, 1st, the steel barrel, or lining; 2d, a coiled tube over the barrel, extending from the muzzle nearly to the trunnions; 3d, the breech coil, consisting of 3 coils in alternate directions, welded together, with a trunnion welded on, the whole piece shrunk on over the breech of the barrel, and lapping over the front coil; 4th, the cascable. It is considered by the present authorities that the diminution in number of parts leaves the gun less liable to injury by accident, and less dependent upon perfection in manufacture, and that practically an equal amount of strength is obtained; while it is held that a fibrous iron is to be preferred, as more workable for coils, and as giving out its greatest strain over a greater distance than the best Yorkshire iron, which, while strong statically, is considered not to yield so far before fracture. It is stated that this change has diminished the cost of production by 35 or 40 per cent.

"The heaviest projectile thrown by any gun in the service, prior to 1854, was the 200-lb. shell of the 13-inch mortar.

"The largest Armstrong gun hitherto constructed is an experimental one, which has a calibre of 13.1 inch, weighs 23 tons, and throws a shell of 600 lbs.

"It is intended that future 12-inch guns shall have a weight of 25 tons.

"The 11-inch gun lately constructed weighs 23 tons, and the weight of the several parts are as follows: The steel barrel, 5 tons 5 cwt. in the rough, 2 tons 16 cwt. finished; the muzzle-coil, 2 tons 15 cwt. in the rough, 1 ton 16 cwt. finished; the trunnion and breech coil, 22 tons 6 cwt. in the rough, 17 tons 17 cwt. finished; the cascable 14 cwt. in the rough, 11 cwt. finished.

"Two guns of Mr. Whitworth's, of 9-inch calibre, and weighing 15 tons, are about to be delivered for trial.

"Prior to the mechanical improvements which have led up to the present rifled guns, the greatest distance to which a projectile was ever thrown from a smooth-bore gun was not much over 6,000 yards, and the limit of bombarding range at high elevations, with the 13-inch mortar was 4,500 yards. With the modern ordnance, projectiles have been thrown with greater precision to a range exceeding 10,000 yards; the guns of the service make good practice at 6,500 yards, — in fact, much better practice than was formerly attainable at 3,000 yards.

"At 1,000 yards the mean error of range of round shot from smooth bores may be taken as 43 yards, and that of rifled shot 19 yards; the mean error of direction (referred to the mean direction of all the shot) with round shot may be taken as 4.1 yards, and with rifled shot as 0.8 yard. At 2,000 yards the mean error of range of round shot may be taken as 60 yards, and that of rifled shot 21 yards; the mean error of direction with round shot 10 yards, and with rifled shot 21 yards. In other words, — the accuracy being inversely as the products of the errors, — the rifled gun is in one case more than 11 times, and in the other more than 13 times, as accurate as the smooth bore."

AN IMMENSE AIR-GUN.

One of our most successful inventors and engineers has lately patented, and the specification has been published, of an enormous air-gun of 32-inch bore, to throw a 6,000-pound shot. The bore of the gun is to be upwards of 30 feet long, and the inventor asserts that he can compress and retain air at a working pressure of 10,000 lbs. per square inch. The sectional area of a 32-inch bore is 804¼ square inches, and the total initial pressure would thus be 8,042,400 pounds, or nearly 3,600 tons. It would, of course, be next to impossible to pump in air fast enough at this enormous pressure to keep up the velocity of the shot, so the high-pressure air is to be contained in a huge casing or jacket formed around the bore of the gun, and having the same capacity of, say, 165 cubic feet. Thus, instead of the pressure being reduced almost to nothing at the muzzle, the air would have been expanded but twofold on the discharge of the shot; and if we disregard the influence of rarefaction, and consequent cooling by expansion, and its effect on the pressure, we should have 5,000 pounds per square inch still left. If we take the average pressure at 7,500 pounds, throughout the length of the bore, we shall have 2,400 tons exerted through 30 feet, or say 72,000 foot-tons, and this, were the air to follow fast enough, would send a 6,000-pound shot at a rate of more than 1,300 feet per second. As no ordinary valve could be opened quickly enough to admit air under such pressure, and in such quantities, the shot itself forms the valve. The high-pressure air in the air casing or jacket enters the chamber of the gun through ports, like those by which steam enters a steam-cylinder. The shot — a short cylinder, with hemispherical or pointed ends — is so packed as to close these ports while the jacket is being pumped full. To discharge the gun a little high-pressure air is separately pumped in behind the shot, so as to start it on and past the ports, when the stored-up air does the rest of the work.

Although there may be certain practical difficulties in carrying out this scheme, it possesses great interest, and we shall look with much curiosity to its practical realization. — *Engineering.*

HAND AND SHOULDER GUNS.

Mr. Charlesworth read a paper, at the last meeting of the British Association, on the substitution of hand for shoulder guns. He exhibited a gun, invented by himself, its peculiarity consisting in its being used in the hands, extended from the body, instead of being rested against the shoulder. The first hand-gun he had known was a stick-gun, invented by Mr. Hubbard about 45 years ago, but the difficulty which could not be overcome in respect to that weapon was the recoil. The principle he had applied to the hand-gun was what he termed the elevation, — a handle which screwed into a strong piece of iron on the lower portion of the barrel. This gave the sportsman sufficient control over the recoil, and enabled him to use the gun with greater quickness and as much dexterity as could be obtained in the case of a shoulder-gun. Lately he had met with a breech-loading apparatus, which he found was applicable to his gun.

In the ordinary stick gun the support is given by merely resting the barrel on the left hand. Now, this additional support is, in the present invention, considerably augmented by giving the other hand something to grasp in the shape of a perpendicularly attached stock. This brings the gun within the grasp of both hands, and thereby renders the recoil controllable, which is the real advantage of the gun itself. It is, moreover, probable that an accident with any of these rifles, in the case of exploding, for instance, would not have the same disastrous effects as with the ordinary weapon, the seat of the explosion being somewhat more distant.

ON THE PROPER FORMS OF PROJECTILES FOR PENETRATION THROUGH WATER.

At the last meeting of the British Association, a paper was read showing the result of experiments that had been made by Mr. Whitworth with three descriptions of projectiles. The iron plate used was 50 inches long, 13 wide, 1.2 inch thick, and was immersed in water 39 inches deep. The gun used was the one-pounder, from which all the former experiments were made previous to the first penetration of 4-inch armor-plate from a 70-pounder rifled gun in October, 1858. The angle of depression of the gun was 7° 7′; the distance which the projectile passed through the water from the point of entering to the bull's eye 80 inches. No. 1 projectile was Whitworth steel, and of the form always advocated by the author for use at sea. It was not deflected by passing through water. No. 2 shot, with hemispherical form of head, was deflected, and struck 9½ inches above the bull's eye. No. 3 projectile, of white cast iron, commonly called the Palliser, or chilled shot, struck 19 inches above the bull's eye, its conical form of head causing it to rise quickly out of the water. The advantages of No. 1 projectile are, first, its power of penetration, when fired, even at extreme angles, against armor-plates; secondly, its large internal capacity as a shell; thirdly, the capability of passing through water, and of penetrating armor below the water line. The No. 3 projectile is advocated by Major Palliser, on account of the cheapness and its power of penetration, which latter quality, however, depends upon its being fired at a near approach to right angles against armor-plates.

The objections to this projectile are, first, that when it is fired at any considerable angle against an armor-plate, its form induces it to glance off, and the brittleness of the metal causes it to break up; and it is to be observed that in naval actions oblique fire is the rule, and direct fire is the rare exception; second, that the brittleness, and consequent weakness of the metal, necessitates a greater thickness of the sides, and reduces its internal capacity as a shell; and, third, that its form renders it useless for penetration under water.

GREEK FIRE.

True Greek fire is simply a solid, highly combustible composition, very similar to "Carcass Composition." What is now commonly called Greek fire consists of a solution of phosphorus or of sulphur and phosphorus in a very volatile liquid, the bisulphide of carbon, to which is sometimes added a mineral oil with the view of increasing its incendiary powers. When this liquid is thrown on to any surface exposed to the air, the solvent evaporates, leaving a film of the phosphorus or sulphide of phosphorus, which will then inflame spontaneously, but will not very readily set fire to wood or combustible materials. The proper mode of extinguishing the flame is to throw upon the burning surface a quantity of wet or damp sand, ashes, sawdust, lime, or other powder, wet sacking or carpeting, — any material, in short, by which the flame can be stifled by exclusion of air. No attempt should be made to remove the covering for some time after the flame has been extinguished; the place should afterward be thoroughly scoured by a powerful jet of water.

ARMSTRONG GUN.

This was the result of an idea of Sir William Armstrong; namely, that of enlarging the ordinary rifle to the standard of a field gun, and using elongated projectiles instead of spherical balls. It is made by twisting bars of wrought iron round a steel core, and welding them together while white-hot. Over this tube another cover of twisted bar, but with an opposite turn of the spiral, is put; another, and sometimes a fourth, follows, till the requisite strength is obtained. The power of the gun, as compared with those formerly in use, may be roundly stated thus: for the same weight of projectile the Armstrong gun is only half the weight, requires only half the charge of powder, and sends the shot or shell 3 times as far.

PEABODY SYSTEM OF BREECH-LOADING FIRE-ARMS.

The Peabody rifle in its form is compact and graceful, and the symmetry of its lines is nowhere infringed upon by unseemly projections, which, besides being offensive to the eye, are often prejudicial to the comfort of the soldier on the march, or in the performance of its necessary manipulations.

This symmetry is preserved while performing the operation of loading, as the whole movement of the breech-block is performed within the stock, the end of the trigger-guard falling but little more than an inch, whereas, in most breech-loaders, the guard must describe a curve of 90 degrees, and assume a position at a right angle with the line of the barrel, while the breech-block itself drops below the stock.

No movement of the barrel or any other parts, except those immediately connected with the breech-block, is required in the performance of any of its operations. These operations are performed in the simplest manner, and without infringing upon the strength and durability of the arm, which is equal, in these respects, to the best muzzle-loader.

The simplicity of the mechanism is such as to relieve it from the possibility of being impeded by the effect of friction, rust, or exposure to the influence of dust, rain, or continued service.

The position of the breech-block, when the guard is drawn down, is such as to form an inclined plane, sloping towards the breech of the barrel, and the groove on its upper surface corresponding precisely with the bore of the gun, facilitates the entrance of the cartridge, so that it slides directly into its proper position.

The removal of the empty cartridge is effected by the action of an elbow lever, which throws it out with certainty the instant the guard is lowered, and this lever derives its power simply from the action of the breech-block itself, and cannot become deranged, as it is not dependent upon any spring, and is of such strength as to prevent the possibility of breakage or derangement by any service to which it can be exposed.

The breech-block itself is of such strength, and is so firmly secured in its position, as to insure its perfect safety, as has been proved by the severest tests.

The gun cannot be discharged till the breech-block is in its proper position, and when not loaded it cannot be injured by being snapped.

The rapidity with which it can be loaded and fired is believed to be equal, if not superior, to that of any single loader, and in continuous firing, to that of any repeater.

This arm was fired at the Springfield trial of breech-loaders 20 times a minute, and was the only gun, out of 65 presented, which, after being subjected to the fullest tests applied by the committee, was uninjured and in perfect condition for use.

The hammer is at the side in the position most convenient for use.

The weight of the carbine is but 6½ pounds, and that of the infantry arm not greater than an Enfield or Springfield musket.

In force, accuracy, and general efficiency, it is equal to any other gun of similar dimensions, and the peculiar construction which constitutes its claim to excellence is applicable to any form of barrel or size of calibre which it may be considered advisable to adopt.

It has received marked attention and high commendation from many military men in our own and various foreign countries. A board of army officers, which was convened at Springfield a few months since, by order of the secretary of war, selected this from among 65 guns presented for their examination, as "undeniably the best for the use of troops."

Some of the distinguishing points of the converted arm are, the small amount of metal required for the breech mechanism, combined at the same time with great strength; the small number of parts; the easy manner of taking out the breech-block; using a whole stock; retaining the ordinary permanent guard, and the regulation lock. The compactness of the breech mechanism is also particularly noticeable, none of it swinging out of the gun, except the tail-piece of the breech-block, which rises only three-fourths of an inch, and is back of the hammer, which serves to protect it. Cocking the hammer and closing the breech can also be done by the same operation.

The joint-pin can be taken out, and the breech-block removed, without the aid of any instrument.

The alteration of muzzle-loading guns to breech-loading, by this system, adds but one quarter of a pound to the weight.

The ammunition is put up in such form that no change of weather will effect it; and dampness, or even complete immersion in water, will do it no injury. The powder and explosive fulminate are both deposited in a metallic shell, the ball is entered, and the shell closed tightly around it, a blow being necessary to ignite the fulminate in the rim of the cartridge-shell. By this means, the powder is preserved from any action of the weather, and the cartridge is at all times ready for use, while it can be transported with entire safety.

The Peabody gun is meeting much favor abroad, particularly in those countries whose people are skilled in the use of fire-arms. The Providence Tool Company supplied 15,000 of these arms to the Swiss government, and we give below a very satisfactory statement of the result of their use. The company is now engaged in filling a similar order for another European government. The Swiss "Sharp-shooters' Gazette," of June 19, says: —

"*The Peabody Gun.* — Last Sunday the Feldschützenverein of the district of Thallwell held their first meeting this year. Since all the riflemen were to fire with the Peabody gun, which is now in the hands of the sharp-shooters, except two who had the ordinary field-rifle, great interest was manifested in the result of the shooting. The success of the gun was surprisingly complete. Fifteen sharp-shooters fired 20 shots each, together 300 shots, at distances respectively of 300 and 400 paces. A shot in the breast of the figure of a man which formed the target, counted 3, in the head or legs 2, and for the target 1. In these 300 shots 560 points were made, being 93 per cent. hits. Had the marksmen been more accustomed to the trigger, which was somewhat stiffer than their own guns, 96 per cent. would have been obtained, — a result which has never yet been attained by the usual field-rifle.

"All the sharp-shooters, including those who, using the arm for the first time, regarded it with some distrust, were afterwards enthusiastic in praise of its precision, rapidity of fire, and simple manipulation. One of the marksmen fired 4 shots in 24 seconds, making at 400 paces 2 breast hits, and 1 to the right, and 1 to the left. Consider the terrible effects of one battalion even, armed with this weapon, and skilled in its use!

"The guns fired not having any hair-trigger, and a stock a little too straight, they were in this respect not so convenient as the field-rifle; but one soon gets accustomed to this. These little drawbacks are far more than outweighed by the many good qualities of the Peabody. The ammunition, of Swiss manufacture, was excellent; not one shot of 300 missed fire, so that in this respect also we can be perfectly satisfied, and Switzerland may congratulate herself upon her possession of her 15,000 American-made Peabody guns."

NITRO-GLYCERINE.

From a paper read a short time ago by Edward P. North, C. E., before the American Society of Civil Engineers, of New York city, we make the following extracts on the properties and uses of nitro-glycerine: —

"The effect of nitro-glycerine differs from that of powder in consequence, I suppose, of its greater force and quickness of explosion, in that, that powder, when fired, when the line of least resistance is a vertical one (the bore also being vertical, and the rock homogeneous), will form a tolerably uniform crater, with the sides sloping according to the hardness of the rock. When the line of least resistance is a horizontal one, and not too long, the rock being solid, the blast will throw out what is before it, leaving the back uncracked, and no sign of action below the bottom of the hole.

"Nitro-glycerine, on the contrary, in the first case, will form a well, and, if the rock is not too hard, the bottom diameter will be greater than the top. Nor, as far as I have seen, will the action ever be concentrated on the line of least resistance, but will extend back from the hole and downward to a greater or less distance, according to the hardness of the rock. I think that this action of nitro-glycerine, in connection with the fact that its explosive force is uninfluenced by the presence of water, will tend to its being the only explosive agent used in all subaqueous operations; for, with any depth of water, it will be unnecessary to drill holes, but only to sink a flask of nitro-glycerine on the rock and fire it."

Its advantages are: —

"1st. That, being of greater strength, there is a great saving in drillers' wages, as fewer holes have to be made, and the charge of nitro-glycerine can be put into the rock much more compactly. For instance, if, to break up a certain rock, 1 foot of depth in the bore-hole was required with nitro-glycerine, 13 feet would be required with powder, which would necessitate 6 feet of additional drilling if but 1 hole was used; but 13 feet of powder could not be exploded in a 2-inch or 2¼-inch hole so that it would be effective, on account of the slowness with which it burns, so that additional holes would have to be drilled, with in each an allowance of at least two-thirds of the depth for tamping. With gun-cotton there would not be so much difference.

"2d. That nitro-glycerine is not injured, either permanently or temporarily, by water or moisture, which enables us to use water tamping, a great saving of time and risk of life, impossible with either of the others; and it can be stored in damp cellars, or under water, without the necessity of drying it before using, as in the case of gun-cotton, or having it ruined, as with gunpowder.

"And, lastly, the difficulty of exploding it renders it the least dangerous to human life."

DYNAMITE.

M. A. Nobel read, at the last meeting of the British Association, a paper on "Dynamite, a recent preparation of the nitro-glycerine as an explosive agent."

"It is nothing but nitro-glycerine absorbed in highly porous silica; and if I have given it a new name, it is not by way of disguise, but that its explosive powers are so much altered as fully to warrant a new denomination.

"Dynamite consists of 75 per cent. of nitro-glycerine and 25 per cent. of porous silica. Hence it appears to possess only three-fourths of the power of nitro-glycerine, the specific gravity of both substances being very nearly the same. But practically there is no advantage in the greater concentration of power of nitro-glycerine. It cannot, or at least ought not to be poured direct into the bore-hole, since it easily causes accidents by leakage into crevices, where it explodes under the miners' tools. It must, therefore, be used in cartridges, which leave considerable windage; whereas dynamite, being somewhat pasty, easily yields to the slightest pressure, so as completely to fill up the sides of the bore-hole and leave no windage whatever. For this reason a given height of dynamite charge in a hole will contain quite as much nitro-glycerine as when the latter is used in its pure, liquid state.

"Besides the security derived from its solid form, dynamite has over nitro-glycerine other special advantages. Its sensitiveness to concussion is, as I have already stated, reduced in a very high degree, and, since fire does not cause it to explode, it offers great security for transportation and stowage. Besides, it is quite natural that miners should prefer, as more practical, a solid to a liquid explosive. Dynamite is now generally sold in ready-made cartridges, and nearly all the workman has to do is to put them in his bore-hole and fire.

"It would be a great drawback on advantages here set forth, if, as has been sometimes asserted, the fumes of nitro-glycerine or dynamite were of a noxious nature. The best answer, perhaps, to those who maintain that opinion is, that a great number of mines are daily using it for underground work, and that the miners do not at all complain. The truth is, that when nitro-glycerine is allowed to leak into the crevices of a bore-hole, it does not all explode, and, being dispersed in the atmosphere, causes a severe headache. It is, however, easily remedied by using cartridges, which prevent leakage, and, in the case of dynamite, which is a solid, that inconvenience falls away entirely."

The following is from an English paper: —

Dynamite, which resembles coarse, dark-brown sand, is a solid granular explosive, for which is claimed force of a remarkable degree, and a harmlessness, under ordinary circumstances, that cannot fail, if fully confirmed, to make it one of the most popular and desirable of explosive agents. The causes which render gunpowder and nitro-glycerine so dangerous to handle, or convey by the common modes of transit, have no effect upon it. Nitro-glycerine explodes at 240° F.; gun-cotton at 400 degrees; gunpowder at 600 degrees; a common fire at 1,200 degrees; but a much higher temperature than this is required to ignite dynamite, which must be placed somewhere between 1,400 and 3,280 degrees. A thin deal box containing 10 pounds of the compound was placed over a raging fire; the box was consumed, but there was no explosion, and the dynamite mingled harmlessly with the ashes. It was in other ways placed in immediate contact with fire, with the same results. Gunpowder was exploded near it without effect. The superiority of the material over the dangerous explosives as to which concussion would be certain destruction was acknowledged by several practical persons present, connected with the carrying trades. Ten pounds of dynamite were enclosed in a second deal box, and hurled from the top of a cliff. It fell 60 feet upon the rocks below, with no more signs of explosion than would be caused by the fall of a brickbat. Equally striking were the illustrations given of its deadly strength. A cartridge filled with dynamite was placed upon a 2-inch oak plank. A fuse with a strong percussion-cap was attached to it and fired, and the plank was split in several places, and had a hole knocked through it. The percussion-cap is the explosive agent, and it is claimed that nothing else, so far as is known, will do the work. In this instance the work was done most effectually, although the cartridge, which was about the size of a man's finger, was laid loosely on the plank. A large block of granite, about a yard cube, was shivered by like treatment. A block of wrought iron, with an inch bore-hole, but without either plug or tamping, shared the same fate, as did a wrought-iron cylinder with a charge laid loose on the top. The rocks were bored 15 feet deep, and fired, with an effect that startled the quarrymen present, not because of the loudness of the report, so much as the immediate and extensive character of the blasting. Other experiments demonstrated the great velocity imparted to fragments of shells charged with dynamite, and its adaptability to distress signals.

Of the properties of this substance, Nobel mentions the following: It burns in an open space, or, as commonly packed, without explosion; in burning in the air it evolves some nitrous fumes, while in exploding, the products of combustion are carbonic acid, nitrogen, and water,— all innocuous gases,— and no smoke, and it leaves some white ashes. Moisture does not injure it; it is somewhat poisonous, but by no means in the same degree with nitro-glycerine. In a closed space, with considerable power of resistance of the walls, it is exploded by the spark, and in all cases only by artificial heat.

Its advantages over the ordinary blasting powder are saving of half the labor and time, and cost of material; for, although the cost of the material is 4 times that of blasting powder, its effect is eightfold; it is entirely free from danger, and does no injury by the products of its decomposition. Into the wet drills the material is introduced in sized paper-cartridges; in some cases, as in coal-mines, it is employed loose. The first is provided at the point with a peculiar percussion-cap, and inserted in the cartridge, reaching about an inch deep into the powder; the whole is covered with loose sand.

As precautions against accidents, it must be avoided to raise any dust with the dynamite, on account of its poisonous nature, and the cartridges should be filled out of spoons, and both for the sake of economy and safety, to reduce the calibre of the boring.

The price of this substance, as sold by Nobel, is 42 cents per pound (gold), in 50-pound kegs, and 35 cents for 100 percussion-caps.

Should the statements of Mr. Nobel be confirmed in practice, there is no doubt that this new agent will take rank as the only and best blasting agent in existence; for, if it be true, that the substance is not injured by moisture, the possibility of poisoning may be avoided by moistening the powder sufficiently to prevent dusting. — *Polytechnisches Centralblatt.*

Late California papers contain accounts of the prodigious power of this powder, as shown in some experiments tried in that State. They recommend it highly, as being vastly more explosive, and requiring much less drilling or preparation of the rock, than gunpowder.

EXPLOSIVES, ETC.

Anthracite Gunpowder.—According to Mr. Ehrhardt, the inventor, "The powder is composed of nitrate of potash and chlorate of potash mixed in proper proportions with mineral carbon. Powder thus compounded is less liable to accidental explosion, inasmuch as it does not explode when ignited in the open air, but burns slowly, something like common gunpowder when wet. But when confined, as in a gun, or in a blasting hole in a rock, it explodes with even greater force than ordinary gunpowder. It is not much affected by dampness, and generates but little smoke in burning.

"To make this powder, the several ingredients must be finely pulverized and then intimately mixed together. The more finely they are pulverized the better. They require no other preparation. When the ingredients are well mixed the powder is ready for use. The proportions of the ingredients may be varied for different kinds of work. For use in coal mines, I prefer to take 1 part by bulk of chlorate of potash, 4 parts of nitrate of potash, and 5 parts of mineral coal. For blasting granite or other hard rocks, I prefer to take 1 part of chlorate of potash, 2 parts of nitrate of potash, and 3 parts of mineral carbon.

"The mineral carbon may be either bituminous coal or anthracite, but I prefer to use the anthracite known as 'red ash.'

Wood charcoal may be used instead of mineral coal, but it is not so good. Nitrate of soda may also be used in place of the nitrate of potash."

Picric Acid. — In a lecture delivered before the Society for the Encouragement of National Industry in France, Dr. Calvert spoke of a curious application which has been made of the explosive property of the salts of this acid. During the last few years, the picrate of potassium has been employed in great quantities by Mr. J. Whitworth, for charging the bombs for destroying the iron plating of ships. When the projectiles thus prepared strike the iron masses, the enormous force with which they are expelled from the gun is instantaneously converted into heat, and to such an extent that the ball becomes red-hot, the heat decomposes the picrate of potash, and a violent explosion ensues, owing to the enormous quantities of vapors and gases which are thus produced in an instant of time.

Nitro-glycerine. — The London "Chemical News" says that when nitro-glycerine is dissolved in 2 or 3 times its bulk of methylated spirit it is quite inexplosive, and when required for use, the addition of water will precipitate the oil, the layer of water and spirit merely requiring decanting off. The nitro-glycerine, separated in this way, possesses explosive properties quite as active as the original oil, which, indeed, is frequently rather improved than otherwise by the treatment.

Penetration of Cannon Balls. — The fact has been satisfactorily demonstrated at the Shoeburyness trials, that a cannon-ball will penetrate a target with much greater ease with a range of 200 yards than with a range of 70 yards. The supposed explanation for this fact is that the shot "wobbles" a little on leaving the gun, and requires time, and consequently space, to settle down to a steady whirl. The fact that the holes made at 70 yards are larger than those made at 200 yards, supports this hypothesis.

Gatling Gun. — It appears that the Gatling revolving gun, decribed in "Annual of Scientific Discovery" for 1868, pp. 115, 116, is to be very generally introduced into European armies. According to the Augsburg "Gazette," the agents in Carlsruhe have received orders for 1,000 of these guns. Of this number, 400 are designed for France, and 200 for Russia, the remainder being equally distributed between Austria, Italy, Belgium, and Holland.

SUBMARINE DRILL.

The improved submarine drill, recently perfected in New York, for use in removing obstructions at Hell Gate, is acknowledged by experts to be the best ever invented. The machine is in the shape of a "mushroom anchor," or half of a sphere. It is about 7 feet in diameter at the bottom, and weighs 5 tons. Inside of the iron frame, which is water-tight, are placed 2 engines of about 5 horse-power. They are supplied with steam by means of a flexible tube, which is attached to a boiler on board a tug. The "anchor" is surmounted by a steel frame-work, supporting the drill. The bit is of concave form, over an inch in diameter, and studded with about 18 black diamonds. The bit is attached to an iron tube 9 feet long, worked by a screw, and having over 300 revolutions to an inch. The diamonds are arranged so as to grind the rock as fine as sand at the rate of an inch a minute. Several experiments have been made on Maine and Quincy granite, all of which have been successful. It is claimed that with this drill submarine blasting can be done with less diving and more rapidly than by any other process. The "anchor" will be lowered from a tug, which will supply the engines with steam. The weight of the apparatus will lower it in spite of the strongest tide, and keep it firmly on the bottom. A smooth hole can be drilled 5 feet deep in an hour.

REFINING IRON WITHOUT PUDDLING.

The following is taken from the "Cleveland Herald": —

"We referred a day or two ago to the excitement produced among iron manufacturers by the discovery of a means of dispensing with puddling, now in practical operation at the Shoenberger Junta Works, in Pittsburgh. The process consists simply in combining, mechanically, oxides of iron with melted crude metal. If the mixture is thoroughly effected, the result is instantly a malleable iron superior to the best puddled balls. It is then only necessary to heat it as blooms are heated, and put it through the machinery, to produce the best quality of horse-shoe bars from materials which, if puddled, would yield only common iron, and at much less cost than puddled iron. The method employed at the Shoenberger Works is to take the melted metal direct from the blast furnace (they have 2 large stacks) and run into a large kettle of a capacity of 5 tons. Thence it is poured, in a stream about a foot wide, into a circular trough 12 inches wide and 10 inches deep, revolving on a radius of 7 feet, or 14 feet diameter. Pulverized iron ore, Lake Superior, Champlain, or Iron Mountain, is used as the converting agent. The ore descends from a hopper into a revolving trough, and covers the melted metal as fast as it is poured in. The continuous revolutions of the trough produce alternate thin layers of hot metal and raw ore, and effect the combination in a very satisfactory manner. The machinery which accomplishes this is moved by steam and hydraulic power, and is so well planned that one man, standing with his hand on valve-levers, can manage the whole operation. When the trough is full, and before the iron cools, it is broken up into slabs of suitable size for the heating furnace."

NATURAL PHILOSOPHY.

ATOMECHANICS.

THE discovery of the existence of pantogen, which may be regarded as the primary chemical principle, as gravitation is the primary mechanical principle, is due to Gustav Hinrichs, of Copenhagen. In 1856 and 1857 he communicated memoirs on atomechanics, or chemistry considered as mechanics of the panatoms, or atoms of pantogen, to various learned men and academies of Europe. He referred frequently to the subject in several papers between 1860 and 1866, and in 1867 published a complete outline of the new science, illustrated by elaborate diagrams.

Though as yet in its infancy, and only a first step in a boundless realm, it furnishes subjects for thought of great interest. He concludes, from the analogy between the history of astronomy and that of chemistry, that there exists some general principle which will transform modern chemistry into a mechanics of the atoms, as astronomy has become a mechanics of the heavenly bodies. As the basis of this celestial mechanics is but a hypothesis, so a similar hypothesis may be pronounced with regard to the chemical atoms.

Let us suppose that the atoms of the chemical elements differ only in regard to quantity, that is, in regard to the number and relative position of the atoms of some one primary matter, just as the planets differ only according to the number of pounds of ponderable matter they contain, and its distribution around their axes. Since everything would thus be composed of this one primary matter, he calls it pantogen, and its atoms panatoms. This is a hypothesis; but even universal gravitation is only a hypothesis; and, as this hypothesis is the fundamental principle of theoretical astronomy, so the hypothesis of pantogen explains the numerical relation of the atomic weights, and gives a simple, comprehensive, because natural, classification of the elements, so that the chemical, physical, and morphological or crystallographic properties of the elements and their continuations may be calculated just as the orbit of a planet is calculated.

The panatoms, or atoms of pantogen, are necessarily equal; they must be considered as simple and material points, totally devoid of all occult properties. When combined they are at certain fixed distances from each other. Three combined necessarily form an equilateral triangle, as this is the only position of stable equilibrium of three equal material points. More panatoms combining herewith in the same plane will continue this geometrical law, thus forming hexagons, etc., divisible into regular triangles. According as the figures thus formed, or atomares, are composed of equilateral triangles or squares, the elements are divided into two orders, trigonoids or metalloids, and tetragonoids or metals. According to the geometrical outline of the atomare these orders are subdivided into genera; the species or elements correspond to given values of the variables expressing the geometrical form of the genus. — *London Mining Journal.*

WEIGHT VS. SPECIFIC GRAVITY.

Dr. Lewis Feuchtwanger gives the following table for ascertaining the weight of a cubic foot of any mineral ore, metal, earth, or any other substance, either native or artificial, from its specific gravity.

1,728 inches comprise 1 cubic foot, and 1 cubic foot of water weighs at a temperature of 60°F., 62½ pounds avoirdupois. By ascertaining the specific gravity, and multiplying with 62½ pounds, the exact weight of 1 cubic foot is obtained.

	Sp. gr.	Pounds avoirdupois Cubic foot weighs.
Anthracite coal,	1.5	94
Antimonial copper, tetrahedrite, or gray copper,	5.0	300
Antimonial silver,	9.5	600
Antimony ore, gray sulphuret,	4.5	279
Antimony metal,	6.5	400
Apatite, or phosphate of lime,	3.0	186
Arsenical iron pyrites, mispickel,	6.0	370
Asbestos,	3.0	186
Asphaltum, mineral pitch,	1.0	62
Baryta sulphate,	4.5	310
Baryta carbonate, Witherhite,	4.0	248
Bismuth,	9.7	600
Bituminous coal,	1.5	90
Black lead, graphite,	2.0	125
Black jack blende, sulphuret of zinc,	4.0	250
Bog iron ore,	4.0	250
Brown hæmatite,	4.0	250
Building stones, — granite, gneiss, syenite, etc.	3.0	186
Calamine,	3.3	190
Chromic iron,	4.5	260
Copper pyrites,	4.0	260
Derbyshire spar, fluor spar,	3.0	186
Feldspar,	3.0	190
Flint,	2.5	110
Loose sand,	—	95
Franklinite,	5.0	310
Galena,	7.5	465
Gold (20 carats),	15.7	1000
" pure,	19.2	to 1200
Gypsum,	2.3	130
Iron — cast iron,	—	450
" magnetic ore,	5.0	310
" spathic ore,	3.0	200
" pyrites,	5.0	310
" pyrrhotine, or magnetic pyrites,	4.5	280
" specular iron ore,	4.5	290

Iron, wrought,	—	487
Limestone, hydraulic,	2.7	150
" magnesian,	2.5	130
Manganese, binoxide of,	4.8	294
Malachite,	4.0	248
Mica,	2.8	160
Novaculite, or whetstone,	3.0	186
Ochre,	3.5	217
Platinum, metal and ores,	16 to 19	1116
Porcelain clay,	2.0	140
Pyrites, iron,	4.5	280
Quartz, pure, compact,	2.6	155
" loose, angular, and round sand,	—	100
Trap,	3.0	186
Vitreous copper, copper glance,	5.5	341
Wood tin, stream tin,	7.0	434
Zinc, sulphide or blende,	4.0	248
Zincite, red zinc ore,	5.5	331
Zinc carbonate,	4.4	268
Zinc silicate,	3.4	200

ATOMIC MOTION.

Prof. J. F. Walling, of Lafayette College, of Easton, Pa., read a paper at the 1868 meeting of the American Association for the Advancement of Science, on Atomic Motion.

After making the general statement that all the physical phenomena of the universe were made up of motions of matter, Prof. Walling went on to unfold a new theory of force and the constitution of matter based upon the fundamental idea of one grand primary universal force. He deemed it necessary, in order to avoid the difficulties and inconsistencies of existing hypotheses, to commence with strict definitions of force and matter. These were given as follows: Force is that which when associated with matter causes motion. Matter is that which can be moved. Its sole properties, *per se*, are quantity (synonyms, weight, inertia) and position.

The theory of Boscovich, a Russian philosopher of the last century, supposed atoms to be alternately attracted and repelled at minute distances, according as their distance varied. That of Prof. Norton, of Yale, supposed material atoms to be surrounded by atmospheres of one or more ethers, whose atoms repelled each other but attracted those of matter.

A new theory had been suggested by Sir William Thomson, of Edinburgh, in which vortex atoms were supposed to constitute the different kinds of matter. The kind of motion which he supposed to take place is seen in the well-known smoke rings which we sometimes see issuing from the muzzles of guns, the stacks of locomotives, etc.

This attempt of Thomson is based upon the mathematical discovery of Helmholtz, that a vortex motion, or wirbelbewegung, as he calls it, when once instituted in a perfect fluid, would continue forever. Such a theory is a step in the right direction, as it removes one of the absurdities of the old theories, namely, that of solid atoms. He then proceeded to show that, by his hypothesis, all unnecessary assumptions were avoided, and all the properties of matter explained upon dynamical grounds. His hypothesis is as follows: Force exists independently of matter, every position in space being traversed by lines of force in every possible direction, each line of force being infinite in quantity. This force produces gravitation as follows: A single atom in space would be acted upon in all directions alike, and no resultant motion would ensue, but when two atoms were introduced, a mutual interception of the force lines would take place, and force would become associated with the atom, and they would be impelled toward each other. Atomic attractions are simply gravitations of atoms towards each other, and are referable to the same cause.

No such thing exists in nature as attractions and repulsions, in the usual meaning, which implies that they are inherent properties of matter. Repulsions of atoms, like the separative motions of celestial bodies, are due to momentum or excess of associated force over gravitation. Heat, the great repulsive force of nature, is simply the momentum of atoms. The three distinctive conditions of matter, namely, the solid, liquid and gaseous or vaporous conditions, he then attempted to show to depend on the relations of the two opposing forces of gravitation and momentum. When the former is greater the atoms are held together in the solid condition. In the liquid condition they are equal, and in the gaseous state excess of motion produces virtual repulsion. This hypothesis explains the polar force of crystallization in a simple and beautiful manner.

The law of Mariotte, that at equal temperatures the volume of a gas is in inverse proportion to the pressure, was shown to be a direct consequence of this hypothesis; — also the law that specific heat is in inverse proportion to the atomic weight, and the principle of equal gaseous volumes of chemical atoms, simple or compound. Some other correspondences of theory with fact were pointed out, and the nature of the transformation from one condition of matter, by the addition or abstraction of heat or momentum, was traced in detail. Ampère's theory of the identity of magnetism with electricity could be well illustrated by the same models which exhibited the motions of atoms in this hypothesis, and the polarization of light into vibrations in different planes accounted for. Finally, all the phenomena of nature could be accounted for when they were properly understood, by referring them to the one universal force assumed.

PERMEABILITY OF CAST IRON TO GASES.

Graham discovered that iron at a red heat will absorb 4.15 times its volume of carbonic oxide. Observers are not agreed whether the gas thus absorbed would pass inward toward the fire in a stove, or outward into the atmosphere. The porosity of cast iron is a well-known fact; many years ago Mr. Perkins forced water through thick plates of it, and it is not, therefore, surprising that gases pass with ease. Indeed, it may be considered as conclusively proved that cast iron at a red heat is permeable to carbonic oxide and certain other gases, even when devoid of any discernible fissures or pores, and when quite impervious to common air. This fact was first made known by the French chemists, Deville and Troost, in a communication to the Academy of Sciences toward the close of 1863. In April, 1865, Dr. Carret, the Surgeon-in-Chief of the Hospital of Chambery in Savoy, presented to the Academy, through M. Velpeau, a paper describing a very peculiar epidemic, which had made its appearance on the introduction in that neighborhood of cast-iron stoves in place of the old stoves of tile or porcelain, and announcing the belief that this malady was caused by carbonic oxide escaping into the air. This memoir was read without calling forth any suggestion of its important bearing upon the previous experiments of Deville and Troost.

The Swiss surgeon continued his investigations, gathering fresh proofs of the truth of his previous induction, and toward the close of 1867 addressed a memoir to the Minister of Agriculture and Public Works, in which he distinctly affirmed the conclusion that the cast-iron stoves allow carbonic oxide to pass out into the air through their walls.

The attention of the Academy was thus recalled to the subject, and Deville and Troost were invited by General Morin, the distinguished physicist and engineer, to make the proper test-experiments, with a stove of the corps de garde, which he placed at their disposal. These chemists did their work thoroughly; Deville added similar experiments with the stoves of his lecture-room at the Sorbonne, and the result of all these trials, communicated to the Academy on the 13th of January last, was a confirmation of Dr. Carret's views in regard to the passage of the gases through iron, and thus, for the first time, the attention of scientific men was emphatically called to the sanitary bearing of facts already known to them, but of which they had overlooked the application.

Without admitting the conclusion of Dr. Carret as to the production of the epidemic observed by the escape of these gases, there is no doubt that hydrogen, carbonic acid, and carbonic oxide do actually pass through the walls of a cast-iron stove, at a dull as well as at a bright red heat. The fact is worth knowing, for such stoves are often used, and most frequently in ill-ventilated apartments. The amount of gases which pass is certainly not large, but carbonic oxide is an exceedingly poisonous agent, and most of the discomfort experienced in rooms heated by these stoves is no doubt attributable to that gas. The subject deserves the attention of manufacturers, who might devise a tile or clay-lined stove that would diminish this inconvenience, and at the same time economize fuel.

There is also no doubt of the actual leakage of noxious gases through the joints and cracks of stoves, and it is well known that carbonic oxide will transude through a crack which will not allow common air to pass.

Experiments show that hydrogen will pass through cast iron at the ordinary temperature. M. Cailletet took an iron flask with a long, curved neck, exhausted the air from it, and placed the mouth under mercury. The body of the flask was then set in a vessel of dilute sulphuric acid. The outer surface was attacked by the acid and hydrogen evolved, some of which passed into the interior of the flask, and, driving out the mercury, escaped in bubbles from the trough. Hydrogen passes into metals with most remarkable facility, and Mr. Graham believes is liquefied with them.

EARTHQUAKE WAVES.

One of the most striking of the phenomena attending earthquakes is the effect produced on the sea by these convulsions, especially when the earthquake is near the shore. In an earthquake there is an undulation of the solid crust of the earth, and the influence of the earth wave being communicated to the sea, causes the latter to swell and retire from the beach, and the great wave rolls in upon the shore. This is frequently the case in the immediate locality of the earthquake; but it sometimes happens that the influence of the disturbing agencies upon the sea extends to a considerable distance from the place where the earthquake occurs. The late terrible earthquake furnishes some curious and highly interesting facts bearing upon these points. In this earthquake the sea was terribly agitated along the whole western coast of South America; and along the northern coast of the same side of the continent, as well as on the shores of the Sandwich Islands, the disturbance of the ocean consequent on the subterranean convulsions was sensibly experienced. In Peru several of the ports were submerged by mountain waves rolling in from the Pacific with terrific violence, sweeping away everything before them. On the southern coast of Chili, at Talcahuano, a whaling station, distant fully 1,400 miles from Arica, at about 11 o'clock on the night of the 13th of August, — that is, about 6 hours after the catastrophe in Peru and Ecuador had taken place, — a great tidal wave swept into the bay, submerging a greater part of the towns of Talcahuano and Tome.

But, more remarkable still, tidal phenomena of a similar character to those which appeared on the southern side of the continent, showed themselves on the coast of California, at a distance of nearly 4,000 miles from Peru. A letter appears in the "Los Angelos Star," from Mr. E. Hewitt, describing a tidal phenomenon witnessed at Wilmington, Southern California, on the 14th of August, at about 7 o'clock on the morning of that day. He says, "The tide was observed to be running in with unusual velocity for about 15 minutes, and then to suddenly turn and run out for about the same length of time with the same unexampled rapidity. It is now 9 o'clock in the evening, and the same running in and running out, at intervals of from 15 to 25 minutes for each direction, has been going on since it was first observed this morning. Capt. Polhamus, of the steamer Cricket, informs me, that in crossing the bar to-day he observed the water fall 5 feet in 8 minutes, and to immediately rise the same number of feet in the same space of time. Another unexplainable peculiarity of this tidal freak is, that the water from the sea would run up to one side of the channel and down the other side at the same time."

The same day irregularities in the tides in the Oakland Creek were noticed by several persons. The tide alternately rose and fell, and it was observed, at the foot of Washington Street, in Oakland, that, while drift-wood floated towards the mouth of the creek, the water was gradually rising. On the morning of the 13th, according to a telegram from San Francisco, which appeared at the time in the "Tribune," a series of waves commenced flowing upon the coast off San Pedro, causing the tide to rise 63 or 64 feet above the ordinary high-water mark, which was followed by the falling of the tide an equal distance below the usual low-water mark. The rise and fall occurred regularly every half hour for several hours. Thus it appears that the tidal upheaving produced by the earthquake travelled nearly 4,000 miles in about 36 hours.

An earthquake wave which followed the recent eruption in the Sandwich Islands was transmitted to the Pacific coast, and recorded on the government self-registering tide-gauges at San Francisco and Astoria, in about 6 hours.

The great tidal wave from Hawaii reached this coast, distant over 2,000 miles, in 5 hours, and was observed along a stretch of shore over 13 geographical degrees in length. These earthquake waves appear to have moved with a velocity of about 400 miles an hour.

The papers have lately announced the terribly destructive force of waves of the sea, produced by earthquakes in the West India Islands. Prof. Brocklesby, in his "Elements of Physical Geography," states some facts of an interesting character in reference to the velocity of these waves. On the 22d of December, 1854, immediately after an earthquake, the sea rolled in upon the town of Simoda, in Japan, in a wave 30 feet high, overwhelming it in an instant. After the wave fell, there were only 4 feet of water in the harbor. Four or five similar waves followed at intervals, completing the destruction of the town.

Prof. Bache, by observations made on the tide gauges at San Francisco and San Diego, which registered all changes in the sea-level, discovered that these earthquake waves at Simoda travelled across the Pacific. The distance from Simoda to San Francisco is 4,527 geographical miles, which was traversed by the waves in 12 hours and 28 minutes, or with a velocity of 6 miles a minute. At San Diego, which is 4,917 miles distant from Simoda, the waves arrived an hour later, the velocity being sensibly the same. The curious fact is stated, that the breadth of a wave, its velocity, and the depth of water in which it travels, have been found by Prof. Airy to have a relation to one another. For example, a wave 100 feet broad, travelling in water 100 feet deep, has a velocity of 15 miles an hour; while a wave 10,000 feet broad, travelling the ocean with a depth of 10,000 feet, advances with a velocity of 154 miles per hour. So that, given the velocity of a wave and its breadth, the depth of the water may be calculated. Prof. Bache, from these data, calculated a depth of the Atlantic, and found it to be on an average of 22,000 feet, a result corresponding with soundings made.

The force of ocean waves has been calculated. During a storm on the western coast of Scotland, in March, 1845, the force of the waves was estimated at 6,000 pounds per square foot. It would seem that the immense wave, which, like a wall 30 feet high, moving with resistless velocity, struck the ship-of-war "Monongahela" broadside, in the harbor of St. Thomas, and drove her from her moorings, forcing her over the tops of the warehouses, and leaving her, when the wave receded, high and dry on the coral reefs of the island, must have had a force even greater than 6,000 pounds to the square foot.

FORCE OF WATER.

According to the Abbé Moigno, —

							Per second. M.
Wet soils	begin to be transported by water, moving at the rate of						0.07
Soft clays	"	"	"	"	"	"	0.15
Loose sands	"	"	"	"	"	"	0.30
Gravel	"	"	"	"	"	"	0.60
Pebbles	"	"	"	"	"	"	0.61
Broken flint stone	"	"	"	"	"	"	1.22
Agglomerated pebbles, soft pudding stones, and stratified rocks	"	"	"	"	"	"	1.83
Hard rocks	"	"	"	"	"	"	3.65

RETARDED EBULLITION.

Krebs has continued an investigation, begun some years ago by Dufour, on some of the phenomena of retarded ebullition. The experiments were made in a retort connected with an air-pump, the water having previously been boiled several times to get rid of air in solution. After connection with the pump, the water is again brought to the boiling-point, and then the heat is withdrawn, and the pump set to work. When a vacuum of 11 inches was obtained, and the temperature of the water had fallen to 167° F., it was found necessary to pump with caution, as at that point the ebullition is likely to be violently reproduced. But that stage being passed, it was found possible to get a perfect vacuum, and allow the temperature of the water to sink to 86°, or 104° F. without any ebullition. At this low temperature and pressure, however, violent ebullition can be set up by several means. Among these, he mentions two which he thinks may afford explanations of some boiler explosions. One is a sudden application of heat; the other is a shaking of the liquid. The latter seems unlikely to be realized in a large boiler; but the former, we think, may happen when, for example, after a fire has been banked for some time, and the temperature and pressure allowed to fall, a violent stir has been given to the fuel, and a torrent of flame sent through the flues; and we rather think explosions have really occurred under such circumstances. — *Mechanics' Magazine.*

MOLECULAR INFLUENCE UPON LIGHT.

At the closing meeting of the Royal Institution, Dr. Frankland brought forward some new experiments upon light, of a very interesting character, proving that external pressure, acting upon the ponderable molecules, which throw out waves of light, exerts considerable influence in modifying the character of the resulting luminosity. The exceedingly minute ultimate atoms, composing what is called solid matter, utterly beyond the ken of the most powerful microscope, are believed by Messrs. Stewart, Tyndall, Thompson, and other philosophers of the same high school, to be in a state of incessant motion, of a true or modified vibratory character. This motion is what is commonly called heat. The less the vibratory motion of the solid, the lower is the temperature. There is a point at which atomic motion would cease; but such a degree of cold has never yet been produced by man.

The atoms in moving throw out waves. A fluid infinitely finer than air, the "interstellar ether," is believed to fill all space, and to permeate all solid bodies, bathing the vibratory particles. The explanations, given by philosophers, of the causes of all the phenomena of optics and the undulatory theory of light, rest upon the assumption of the reality of this ether. The atoms, then, cannot move without throwing the ether into waves; neither can the ether move without altering the motion of the atoms. The waves thrown off by moving atoms differ in length; most of the shorter waves being what is known as light, and the longer waves being called radiant heat. Hence there is no difference between radiant heat and radiant light but that of "wave-length." That our senses convey to us the impression that there is a very great difference between heat and light is caused by the short range of action of our senses, not by any great difference in the phenomena. The hand is sensitive to the long, slow waves of heat, but is practically insensitive to the quick, short waves of light. The eye is very sensitive to the short, quick waves, which we call light, but, according to Tyndall, is very insensitive to radiant heat. Thus most of the waves emitted by all ordinary sources of light are invisible, as may be proved by throwing the spectrum of the electric light upon a screen. In the spectrum, all the rays in light are unrolled, so to speak, in regular order, the longest waves at one end and the shortest at the other. The shorter waves, at one end, are visible to us, beginning with the violet and ending with red, the last being the longest and slowest which can be seen by the eye. But when the red is reached, we have only reached the middle of the spectrum; beyond the red, another length of separated rays falls upon the screen, invisible to the eye. That there are rays there, we know from the delicate little thermo-electrometer, which proves that the spectrum of the electric light is twice its visible length, and that the invisible portion of it contains 8 or 9 times more heat than the visible length.

Dr. Frankland's experiments deal with the effects upon light of pressure made to act upon luminous sources. After pointing out that the more the pressure of the outside air is increased, the more luminous will it make the flame of the common spirit-lamp, he showed how to make the oxyhydrogen flame luminous; as the flame continued to burn within a strong iron cylinder, under a constantly increasing pressure, produced by the the tension of the gaseous products of combustion, the light grew brighter, till, at a pressure of about 150 pounds to the square inch, the light was nearly as bright as that of a common candle. He showed that external atmospheric pressure increases the luminosity of flames. Common gas gives out a little more light when the barometer rises, and decreases in luminosity as it falls. Some flames, as that of burning metallic arsenic in oxygen, are very brilliant, though they contain no solid particles, and their brightness increases with the density of the gases or vapors burning, or produced by the combustion. He also proved that the spark from the secondary wire of an induction coil is brighter in proportion to the density of the gas by which the spark is surrounded. He gives the following relative densities of gases and vapors: hydrogen, 1; ammonia, 8½; water, 9; air, 14½; oxygen, 16; hydrochloric acid, 18¼; carbonic anhydride, 22; sulphurous anhydride, 32; chlorine, 35½; phosphorus, 62; mercury, 100; phosphoric anhydride, 142; arsenic, 150; arsenious anhydride, 198. — *Mechanics' Magazine.*

CHEMICAL RAYS OF THE SUN.

Most of the waves travelling to the earth from the sun have no power to act upon the organs of vision, but convey only the sensation of heat. About eight-ninths of the rays reaching the earth from the sun are too long and slow to make their presence known to our eyes, and these waves are those whose powers and qualities have been largely examined and investigated by Dr. Tyndall. But there are other waves at the other side of the solar spectrum, too short in length and too rapid in motion to excite the organs of vision; neither are they sufficiently powerful to make their presence known in the shape of heat.

These excessively short waves coming to us from the sun have been thoroughly examined by Prof. Stokes, Secretary of the Royal Society.

Some of these chemical rays are visible to the eye, and some of them, as already stated, are invisible, and extend beyond the violet end of the spectrum.

If a slice of light from the sun or electric lamp, after passing through a slit in an opaque screen, be received upon a glass prism, and then be brought to a focus upon a white screen by means of a lens, the prism will "unroll," so to speak, the line of white light, and spread out all its rays upon the screen in the order of their wave-length, the short waves at one end, and the long waves at the other. Only the waves in the centre of the spectrum will be visible to the eye, in the order of violet, indigo, blue, green, yellow, orange, and red. Beyond the violet end, where nothing is to be seen by the eye, many chemical rays fall, and beyond the red end are many other invisible waves, noted for their great heating properties. The chemical rays extend from the green or blue divisions through the violet and indigo portions, and a considerable distance beyond. Thus some of the chemical rays are visible to the eye, but the rest cannot be seen.

They are called chemical rays, because they act upon and tend to set up decomposition in some chemical compounds, wherein the affinities of the atoms for each other are weak. Chloride of silver is one of these substances, and the chemical rays will change this white salt into finely divided black metallic silver, or into sub-chloride of silver, a portion of the chlorine being driven off. The whole art of photography depends upon the action of the chemical rays of light upon unstable chemical compounds.

There are certain substances which, when placed in these feebly luminous rays, become apparently self-luminous, and shine out in the partial darkness of the room with strange brilliancy and beauty. When most of the luminous rays of white light are cut off by sheets of manganese glass, by cobalt glass, or by a trough filled with ammonia-sulphate of copper, rays scarcely visible to the eye may be made to pass through the room. Then, when slabs of uranium-glass are placed in the path of these rays, they appear to be self-luminous, and glow with unearthly beauty. When uranium glass is the recipient of the rays it glows with a yellow color like the moon when illuminated with the blue rays of the spectrum; but the nearer the color of the incident light approaches to violet, the greener and the more ethereal is the glow of the uranium glass.

The chemical rays are usually supposed to end in the blue part of the spectrum, but bromide of silver, unlike the other salts of silver, is sensitive also to some of the green rays.

THEORY OF DOUBLE REFRACTION.

At the 1868 meeting of the British Association, Mr. Alfred R. Catton read a paper on this subject. His view was that the double refraction of light is caused by the action of the material molecules on the ethereal medium, and he believed this to be a direct and not an indirect action. He adduced a number of physical facts, with the object of showing that the optical properties of crystals are a function of the arrangement of the material molecules in space, and not of the matter of which these molecules were built up. It might be stated as a physical law, notwithstanding apparent difficulties, that a body of definite chemical constitution always crystallized in the same form, under the same physical conditions, and therefore he believed that the chemical constitution of the molecule did not affect the optical properties directly, but only intermediately, through the fact that a definite chemical constitution produced a definite crystalline form; that is, a definite arrangement of the material molecules in space. The so-called cases of dimorphism were considered by the author in connection with his views, and he denied the possibility of dimorphism in the ordinary sense of the term. It might be accounted for in every known case by the differences in chemical constitution produced by impurities. For instance, arragonite is never pure carbonate of calcium, but is always associated with variable quantities of the carbonates of lead, strontium, and manganese.

INDEX OF REFRACTION.

At a recent meeting of the Royal Institution, Dr. Gladstone stated that the indices of refraction of liquids are lowered by increase of temperature; he showed, by means of a glass prism filled with oil of nutmeg, that the more the oil was heated the less could it bend a ray of light from the electric lamp out of its primary direction. This law holds good with all liquids. Solids, on the contrary, have their power of refraction very slightly increased as they are heated, with the exception of crown glass, which is not influenced in its optical properties by temperature, and fluor spar, which, like a liquid, has its power of refraction diminished by an increase of heat.

The specific refractive energy — or the refractive index, minus unity, divided by the density — is common to the solid, liquid, and gaseous conditions of bodies. A general law discovered by him is, that the refraction equivalent of any substance is the sum of the refraction equivalents of its constituents. The specific refractive energy multiplied by the atomic weight of the substance gives its refraction equivalent. He expressed the opinion that the double refraction of Iceland spar may be caused by the crystal being in a state of unequal tension in different directions, so as to permit light to pass more freely in one direction than in another.

NEW POLARIZING APPARATUS.

This apparatus, made by M. Hempel, from a suggestion by M. Plucker, of Bonn, similar in the majority of its parts to one already known, is made up as follows: 1, A black glass, usually horizontal, but capable of being inclined, upon which the incident ray is polarized rectilineally by reflection; 2, a disc or ring, to carry and maintain in the path of the reflected polarized ray the transparent plate which is to exhibit chromatic polarization; 3, a convex lens which renders the ray leaving the transparent plate parallel or convergent; 4, (the addition which gives to the instrument a perfection scarcely expected), a parallel glass silvered on the exterior surface, and fixed in a support at such an inclination that it leads to the vertical, the doubly reflected and transmitted ray, which it directs to the Nicol's prism, serving as analyzer. — *Chemical News.*

SOURCE OF LIGHT IN FLAMES.

According to Prof. Frankland, the light of a gas flame, and of luminous flames in general, is not due, as has been generally believed since the time of Sir Humphry Davy, to the presence of solid particles. There are many flames possessing a high degree of luminosity which cannot possibly contain solid particles, — as the flame of metallic arsenic burning in oxygen, — or of carbonic disulphide vapor in oxygen, or nitric oxide gas, or of phosphorus in oxygen. He believes that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapors, when carbon is present.

THE ELECTRIC LIGHT.

According to M. Felix Lucas, the luminous distance at which the electric spark is visible is greater than that of a permanent light, the apparent intensity of which would be 250,000 times that of the spark. The light actually employed in modern light-houses gives a brilliancy equal to 125 carcel lamps. An electric spark possessing the illuminating power of the two-hundredth part only of a carcel burner is superior in its power of projecting light, showing the advantage of a warning light composed of intermittent flashes of the electric spark from a powerful Leyden battery. He stated that, in a laboratory experiment, 2 apparatuses were established, 1 voltaic battery equal to 125 carcel lamps, and a spark battery equivalent to only the one-two-thousandth part of a carcel lamp; the photometer showed a marked superiority in favor of the spark.

In Holmes's machine each revolution develops 16 currents in opposite directions; hence the light produced is not continuous, being extinguished and relighted as many times. As there are 500 revolutions per minute, the intervals of darkness are exceedingly small. Though unable to demonstrate the intermittence, M. Jamin recognized that the light of the luminous arc was less bright than that from the charcoal points, which he attributes to the interruption of the current. We have, therefore, in this not the discontinuous electric light, but that of the carbon poles heated to intense whiteness, and giving a nearly uniform light. The light of this machine is less blue and poorer in chemical rays than that from a lamp excited by a battery, and therefore better adapted for light-houses.

The dioptric system of Fresnel as applied to the lanterns of light-houses has been recently described by Mr. Chance before the English Institution of Civil Engineers. It consists of a structure of segments of glass enveloping a central flame, whose focal rays are parallelized in a horizontal direction and deflected in the case of fixed lights in meridian planes only, while in revolving lights the rays are gathered into a number of cylindrical beams, which are made to pass successively before the observer by the rotation of the apparatus. The instrument consists of 3 main divisions; an equatorial belt of the sphere of light proceeding from the flame is acted upon by refraction, but the rays above and below this belt are deflected by local reflection. The relative illuminating values in the horizontal plane of these divisions of the part of the luminous sphere acted upon are in the proportion of, upper reflectors, 20; refracting portion, 70; lower reflectors, 10. It is important to send toward the sea horizon the brightest sections of the flame.

The machine for the production of the electric light consists essentially of 6 brass wheels, with 16 bobbins of insulated copper attached at equal distances to the circumferences of each wheel; inside each bobbin is a hollow core of soft iron; the wheels are all fixed upon a shaft, which is driven by a steam engine. In turning, every core of each wheel is brought at the same instant between the opposite poles of two magnets, which pair of poles it also quits at the same instant. The core of every bobbin has its magnetism thus reversed by the revolution of the wheels 107 times per second. This reversing of the magnetism induces a current of electricity in the bobbins; the combination of the currents produces one of sufficient intensity to give a powerful light. The bars of the lantern are best fixed obliquely, as by this means the least amount of light is stopped by it.

USE OF ZIRCON IN THE OXYHYDROGEN LIGHT.

M. Caron has published a memoir on a new material to be substituted for the magnesia cylinders, serving for the oxyhydrogen light. He found that these cannot resist, indefinitely, the intense heat produced by the combustion of ordinary coal gas mixed with oxygen. This volatilization of the magnesia may be due to the formation of reduced magnesium. After trying silica, alumina, and various refractory substances, he resolved to try zircon, which, according to Berzelius, has the property of being infusible and giving out a light of dazzling brilliancy in the flame of a blowpipe. This he found to be true, and he has employed the same crayon in the flame of the oxyhdrogen jet, without the least sign of wear, volatilization, or even partial reduction. This is very important, for the incandescent matter must remain always at the same distance, and, if the pencil wore away, the distance would increase and the light diminish. In addition to its being unalterable, the light is superior to that of magnesia in the proportion of 6 to 5. Though at present rare, zircon exists in many volcanic sands, and in great abundance in the zirconean rocks in the environs of Ilmensea, at the foot of the Ural Mountains. He has found a simple way of economizing this substance, by applying it only to that portion of the crayon exposed to the flame; the rest can be made of magnesia or refractory clay. By compression, the zircon adheres to the other substances, and burning adds to the solidity of this adhesion. The crayons are made in the same manner as those of magnesium.—F. MOIGNO, *in Journal of Franklin Institute, August*, 1868.

THE MAGNESIUM LIGHT.

The light emitted by a magnesium wire one-thousandth of an inch in diameter, is equal to that of 74 stearine candles, of 5 to the pound; 3 feet of it are burned per minute, or a quarter of an ounce per hour, the cost of which, at the present price, would be about 2s. 6d. Seventy-four stearine candles would, however, in the same time consume 2 pounds of stearine, which would cost 2s.; 40.4 cubic feet of 12 candle coal gas would be required to produce the same effect, and would cost about 2¾d. The dearness of magnesium arises from the dearness of sodium required in obtaining it. Magnesium gives off 265 times less heat than gas. Gas and candles vitiate the air by the production of watery vapor and carbonic acid. Magnesium is free from this objection, but it has an inconvenience of its own: a large quantity of calcined magnesia is thrown off as a fine powder, which soon renders the atmosphere of a room intolerable. This is also objectionable in photography, though used for very short periods. At best, magnesium can be only an imperfect substitute for sunlight; its light has been found to be only the 4.525th of that of the sun on a bright November day, but at the same time its chemical effect was ascertained to be the 1.36th of that of the sun.

CARBURETTED COAL GAS.

At a recent meeting of the Massachusetts Institute of Technology, Mr. C. P. Sykes exhibited, in operation, his apparatus for carburetting the ordinary street gas, thereby, as he claimed from his experiments, diminishing by about 40 per cent. the amount consumed, and at the same time increasing the light nearly one-half. The carbonator is a strong sheet-iron box, with apartments arranged so as so compel the gas to travel a considerable distance to take up the vapor of the hydrocarbon, which fills it, and with a stuffing of shavings of wood, such as are used in making the so-called "Excelsior mattress." The light hydrocarbons of petroleum, of about 71 gravity, are employed in the apparatus. As no air can gain admission to the boxes, which are securely locked, the hydrocarbon vapor cannot become explosive. He stated that 1 gallon of the hydrocarbon will carbonize 1,000 feet of gas; the cost of the apparatus, exclusive of the lead pipe and change of burners, is from $15 to $20 for an ordinary dwelling-house; as the amount of gas consumed is much less with than without the hydrocarbon vapor, the burners are reduced in size one-half, and yet the amount of light is increased. He stated that the incrustations which form in old gas-pipes, sometimes diminishing their calibre one-third, are rendered soluble by the hydrocarbon vapor, and run off by the drip as compounds of coal tar.

A method of increasing the illuminating power of gas was devised some years ago in England, by Mr. Bowditch, which at the time attracted attention by its claim to superior cheapness and safety. It consisted in placing over the burner a vessel containing naphthaline or other hydrocarbon, vaporizing at a comparatively high temperature, and connecting the upper part of the vessel with the jet-pipe, so that soon after the ordinary flame was lighted the vapor would be supplied, and mingling with the gas would greatly increase the illumination. The arrangement was perhaps inelegant, especially for dwellings, but appeared to have claims to attention, as one of the processes for economical lighting, now so frequently discussed.

PLATINIZED MIRRORS.

The diathermanous properties possessed by various substances are precisely analogous to those of transparency and translucency with which they are endowed, except that the former refer to rays of heat and the latter to those of light. Although in some degree the two descriptions of rays may be confounded, yet they are in reality separate, and the actinic rays of the sun are perfectly distinct from the luminous ones.

It might be supposed that the substances which showed great power of translucency would also evince similar capabilities with respect to diathermancy; but experience has proved this assumption to be perfectly erroneous. If we select chloride of sodium in its crude condition, common crystal, and alum, they will be found nearly all equal in their power of transmitting light; but a wide discrepancy will be found in the manner in which they transmit heat. Their diathermanous capabilities are in the proportion of 9, 62, 93. It is quite possible to modify these proportions of bodies so as to produce quite contradictory and almost apparent paradoxical results. Thus a mirror can transmit light, and a perfectly translucent surface is capable, under certain conditions, of reflecting it.

By coating upon one side an ordinary plate of glass with an extremely thin layer of platinum, Mr. Dodé obtains a mirror with direct reflection, which may also, curiously enough, be employed as a common window-pane by turning the coated surface outside. A slight tinge is imparted to the objects beheld through this medium, but otherwise the vision is clear, aud the outlines of the objects well defined.

As all rays of light and heat must be disposed of by reflection, absorption, and transmission in different proportions, it is manifest that when a transmission and absorption accompany a reflection, there is a loss incurred when the end in view is to bring into play the reflective powers only of the body. To prevent this, it is the practice to cover the non-platinized surface of the mirror with a slight coating of varnish. In this condition they are, of course, not translucent, but when they are intended to be manufactured in the form of kitchen and domestic utensils the varnish is omitted. They are, moreover, covered with a variety of designs, produced by corroding the surface of the glass and platinizing the engraved portions, which, therefore, are rendered alone transparent. Very beautiful and elaborate designs can be produced in this manner. One of the distinguishing features characterizing the light transmitted by glasses platinized in the manner described, is its peculiar softness and tone. M. Leroux was the first to notice this particular attribute of the light, and stated that it might be turned to good service in shielding the vision when engaged in regarding any intense source of heat, such as the sun, smelting or gas furnaces. When the natural sight is weak or temporarily deranged, these platinized glasses might be advantageously substituted for the tinted or colored ones usually employed, which are supposed to possess powers of neutralization that in reality rarely belong to them. They have already been replaced by the former in some astronomical instruments, to modify the intensity of the solar rays. All that is necessary is to place one of the glasses before the object-glass of the telescope, by which means a large proportion of the rays are reflected, and only a sufficient number pass through to enable the observer to study the aspect of the luminous body, without fatigue or annoyance to the eye. This property of subduing and softening rays of ardent light is not confined to platinized glass. The same effect is produced by the application of different metallic substances. If a pale-blue glass be simply covered with a piece of gold leaf, the light transmitted is instantly endowed with a peculiar soft tone. A slight characteristic tint is also imparted to the light, which depends upon the nature of the metal employed. Thus, if pure gold be used, the tint is of a light-greenish hue, while the ordinary or jeweller's gold, which always contains a certain proportion of silver, gives a bluish shade, varying in depth of color with the amount of alloy in the gold. The effect of thin sheets of metallic substances upon light has been known for a long period, and M. Foucault has proposed to silver the object-glasses of telescopes employed solely for taking observations of the sun. He himself made the experiment upon the lens of a large telescope in the French Royal Observatory, and found that the image lost none of its clearness or sharpness, and the plan was greatly superior to the ordinary one of interposing a colored medium before the eye-glass of the instrument. — *Mechanics' Magazine.*

WHAT ARE BRAZILIAN PEBBLES?

They are nothing but pure crystallized silica without a flaw, and are not necessarily all Brazilian; but as they have been found plentifully and very perfect in that country, a trade has sprung up for the supply of the London and Paris lens manufacturers. Spectacle lenses were formerly all made of common glass, but they have been found to be much less pure, and at the same time to be more inflaming to the eyes, than the pure and cold natural product of the caverns of the earth. An examination with the tourmaline tongs, or "pebble trier," shows common glass to be almost dark, where the rock crystal is luminous; and, on touching them both to the tongue, there is observable at once the most marked difference as to temperature. Brazilian pebble glasses cost the manufacturers 10 times as much as the ordinary glasses, yet the price at which they are sold is only 4 times that of the latter, namely, \$6 and \$1½ respectively. It is certainly unwise economy that would submit so delicate an organ as the eye to the use of imperfect or irritating glasses.

CEMENTATION.

"Under this head I desire to make a few remarks upon the cementing together by a transparent substance of two surfaces of glass, such as the component parts of an achromatic lens, or covering a transparency or opaltype with glass so that the two shall be in optical contact, and the junction therefore invisible. The advantages of cementing lenses are increased brilliancy and rapidity from the destruction of two internal reflecting surfaces; among the advantages accruing from the cementation of transparencies being perfect protection from the atmosphere, and in the case of a painting, such as a slide for a lantern, greater transparency and beauty, arising from the brush marks and its other surface irregularities in the paint no longer interfering with the perfect transmission of the light. The best cement for effecting the union is Canada balsam, which, if too thick, should be thinned with a little turpentine, benzole, or ether. It is of importance that no air-bubbles be present, as they prove a source of annoyance. Let it be assumed that the object to be cemented is a lens, (and it may be observed that the instructions for effecting this apply equally to a transparency or an opaltype). Having thoroughly cleaned the surfaces to be brought in contact, lay the flint glass, previously made warm, down on a table suitably covered to prevent the under surface from being scratched. Now, by means of a peg of wood or otherwise, convey a drop of the balsam to the centre of the lens, and then gently lower down upon it the lens to be placed in contact, also previously made slightly warm. Now apply a slight pressure, and the dark disk in the centre, indicative of optical contact, will rapidly increase in size, until at last the balsam reaches the margin and begins to ooze out at the edges, if the balsam be present in excess. By means of a piece of soft string passed crosswise over the lenses tie the two together, and place them in a stove, an oven, or before a fire, for a short time, until the balsam at the edges shall have become hard and dry. Let the string then be removed and the lens freed from all external traces of balsam by means of benzole, ether, or even old collodion. The above directions, modified to suit circumstances, apply to the cementation of transparencies or opal pictures." — *Humphrey's Journal.*

NEW MICROSCOPE.

In a letter from M. Moigno, in the "Journal of the Franklin Institute" for August, 1868, is described a novel and ingenious microscope, invented by M. Caselli, of Rome. It consists of a magnifier, one of whose sides is silvered by precipitation with the aid of organic substances. If an object be placed in front of this lens, at a proper distance, a well-magnified virtual image is obtained. Two convergences and one divergence contribute to produce the magnifying power: 1. The convergence of the rays entering the lens. 2. The divergence of these rays by the silver concave mirror at the back. 3. The convergence of these rays on quitting the upper surface of the lens.

The mirror-lens is placed horizontally, or slightly inclined, so as to keep at a distance the image of the object. Above it, and fastened to the same pillar, is the horizontal diaphragm on which the object is placed; this is furnished with a screw and rack-work, so as to be raised or lowered at will. Above this, at a short distance, is placed a screen of white or almost colorless card-board, at at angle of 45°, and pierced exactly over the centre of the mirror-lens with a small hole, through which the image is seen. This card also serves to reflect light on the mirror-lens, and to make the image appear on a white ground. With this microscope there is no need of the usual lenses or mirror to light up the object, since the mirror-lens itself causes the light to converge on the object.

NATURE OF THE PHOTOGRAPHIC IMAGE.

Dr. E. Reynolds recently read a paper, giving some curious results on the action of ozone on sensitive photographic plates, before the Dublin Chemical and Philosophical Club. He found that the undeveloped image upon a sensitized plate after exposure in the camera, subjected to the action of ozone, was completely obliterated, so that a new image might be taken upon it. This fact, he remarked, proved that the production of an image was due to a chemical action, and thus overthrows the mechanical theory of photographic images. The ozone in his experiments was obtained sometimes by the aid of electricity, and sometimes by the action of air upon phosphorus. — *Journal of the Franklin Institute.*

GLYPHOGRAPHY.

A polished plate of copper, such as is usually employed by engravers, is blackened by being washed over with sulphide of potassium, sulphide of ammonium, chloride of platinum, or other means. The plate is then washed and dried, and is evenly coated with a mixture of wax, resin, and sulphate of lead, the thickness of the coating not exceeding a thirtieth of an inch. This coating is white and smooth, and the plate when thus prepared is ready for being sketched upon, or for being photographed upon.

On the figure photographed, or traced by pencil, the artist proceeds to make his drawing with little tools like needle-points, fixed in wooden handles. These tools should vary in size, or rather in the thickness of the point, according to the nature of the work intended to be accomplished. It will be found most advantageous to use tools one side of which has been filed flat, and a curve given to them near the point by bending them while heated in the flame of the gas. Every touch or stroke of the artist should penetrate through the waxy varnish to the surface of the plate, which, being black, reveals every touch; the work thus appearing black on a white ground, in the same manner as if it were effected by pen and ink on white paper.

The coarseness or heaviness of the lines depends upon the tool by which they are cut; hence broad lines require a tool flattened at the point like a chisel. The drawing must be made as in nature, or non-reversed.

When the picture is examined and found to be right, it is dusted over with plumbago, which, by means of a bushy camel's-hair pencil, is distributed through every line and over every part of the surface. Although we find that other conducting substances, such as bronze powders, act better than plumbago, we have very beautiful pictures in which the coating is the same as that here described.

The plate thus prepared is immersed in an electrotype cell, and a thin tissue of copper is deposited on it by the battery. When the plate has been immersed at night, we find in the morning that the deposit of copper is sufficiently thick to allow of its being removed. The battery we use is Smee's, and the depositing solution is the sulphate of copper, rendered decidedly acid with sulphuric acid.

The cast thus obtained must be backed up with soft metal, and in this state it will, if printed from as a wood engraving, yield an exact fac-simile of the original drawing.

If it be required to lower broad masses of white, this can be effected in one or other of the following ways: —

After the drawing has been finished, and before it is brushed with black lead, paint over the broad masses of white with melted wax, and let the thickness of the mass thus painted on the surface be determined by the area of the white portion, care being taken not to approach too closely to the lines of the drawing. This having been done, proceed with the plumbago as already directed.

Another way by which to lower the broad whites is to take a cast in plaster of Paris from the original plate, and in this cast to lower any part required by means of a suitable gouge-shaped tool. From the plaster block thus trimmed may be obtained, by means of recasting in plaster and stereotyping, any number of metal blocks in a condition ready for printing.

We have in our possession some pictures which have been obtained from surface blocks prepared nearly as described, and which are so fine and delicate as to warrant any person, unacquainted with the method of their production, in believing that they were printed from engraved copper or steel plates. — *British Journal of Photography.*

CHEMICAL ACTION OF LIGHT.

The interesting researches of Prof. Tyndall as to the action of light on certain vapors and liquids may have no immediate effect upon the practice of photography, but it is impossible to say at what point in his discoveries a practical application may become obvious. Let us illustrate by a speculation upon the possibilities attending his recent discoveries. In his paper before the Royal Society he states that actinic light decomposes the vapor of nitrite and nitrate of amyl. Amyl is a radical analogous to ethyl and methyl, the hydrated oxide of amyl being known as fusel oil, as the hydrated oxide of ethyl is known as ethylic or common alcohol, and the hydrated oxide of methyl is known as methylic alcohol. Fusel oil is known to be a common impurity in ordinary alcohol, and its presence in collodion has long been regarded as injurious, and conducive to fog, without any knowledge of the reason why it should produce mischief. Prof. Tyndall's experiments suggest a series of possibilities. When fusel oil is in collodion, and comes in contact with nitric acid, either free in the bath, or liberated by action of free iodine in the collodion, a trace of nitrate of amyl may be formed, and this body, being present in the film when exposed to the action of light, and possibly decomposed, would, under some circumstances, yield, as a product of decomposition, valerianic acid, a substance answering to acetic acid, as the product of the oxidation of common alcohol, or formic acid in methylic alcohol. Or, possibly, in the decomposition, intermediate bodies, analogous to acetone or aldehyde, might be formed, with a well-known tendency to produce fog when present in a collodion film. Such a series of possibilities exist, and might furnish a clue to the fogging action of fusel oil when present in collodion, which, arguing from ordinary analogies, ought not to be more inimical to success than the ordinary alcohol employed in the manufacture of collodion. — *Photographic News.*

PORTRAIT FIGURES WITH NATURAL LANDSCAPES.

"I observe that considerable interest has been of late excited by some prints in which portrait figures have been combined with well-executed landscapes, with a perfect union of the full form. The following idea may or may not be that employed by the maker of the prints in question; but it would, I think, undoubtedly yield better results than the methods commonly in use, and, in some respects at least, with less labor. I give it for what it may be worth, not having had leisure to make any experiments myself: —

"Provide some pieces of glass and of mica of exactly the same size as the glass. Pose the model, supposed to be a standing figure (or any number of standing figures, — it being one great merit in this plan that a whole group may be introduced into the landscape with no more trouble than a single figure), against a black background and upon a black floor, and take the portrait (or the group) on a piece of mica. After fixing and varnishing, apply some thick water color on the back of the mica, behind all the transparent parts of the figure. Outside of the figures all, of course, will be transparent; this is the object of having a black background and black floor.

"Now select any view at pleasure. This may be a natural view, or an engraving, or a photographed view on paper (that is, a positive paper print). Prepare one of the pieces of glass as a dry plate. Put it in the dark slide with the mica portrait in front of it, and so expose at the view, engraving, or photograph. Take off the mica, develop the plate, fix and varnish. There will then be obtained a landscape negative with blanks exactly corresponding to the figures. Then attach firmly to it the mica plate, first, of course, cleaning off the color previously applied on the back of the mica behind the transparent parts of the figures. In attaching the mica, the figures must be made exactly to correspond with the blanks, and then it is cemented fast.

"I think it will be seen at a glance that this method offers some striking advantages over any of the usual plans; especially in this, that the result is not two negatives to be printed with the utmost care into each other, but a compound negative that any tyro can print as easily as an ordinary one.

"The atmospheric effects in the print, supposed to be got by faintly and delicately shaded backgrounds, are probably caused by the faint light which comes even from a black background; and, as more of this light is reflected from the upper part of any screen than the lower, this would exactly cause the atmospheric effect spoken of, by throwing a slight haze over the upper part of the picture. At any rate, this effect could be increased as much as might be desired, if found insufficient.

"This idea of a double negative, the front piece consisting of a transparent piece of mica carrying the figures, is, I believe, entirely new, and, in ingenious hands, might be made to produce a variety of interesting effects, especially in the combinations of objects which cannot, with portrait-lenses, be brought simultaneously into focus, with the advantage, too, of perfect simplicity and ease in the printing." — M. CAREY LEA, *in the British Journal of Photography.*

ELECTRICITY AND THE SENSITIVE PHOTOGRAPHIC FILM.

M. Becquerel finds that chloride and bromide of silver deposited on plates of platinum, when acted upon by light, give rise to a strong current of positive electricity, which is just the reverse of the kind of current which would be afforded by the platinum plate alone under the same circumstances. Now the chloride and bromide of silver are actually decomposed by light, — the former obviously so, the latter less visibly, — yet the bromide indicates a current of even higher intensity than the former. The conclusion is, that a precisely similar action takes place when the light acts on the chloride and on the bromide of silver, namely, reduction to a subchloride and subbromide respectively. On applying this curious test to the iodide of silver, it was found that it likewise gave rise to a current of positive electricity, under the influence of light, of nearly as high intensity as that afforded by the chloride. The inference clearly is, that iodide of silver is reduced to a subiodide, just as the chloride is to a subchloride, and the bromide to its lower state of combination.

Until recently all the evidence seemed to be tending to support the purely mechanical theory of the formation of the latent image; latterly, the complexion of affairs has altered, and the evidence tends in the direction of a chemical change as being the result of the action of light, the experiments of M. Becquerel, referred to above, forming a strong link in the chain. — *British Journal of Photography.*

LUMINOUS PHOTOGRAPHS.

One of the most curious inventions of the present day is the new kind of photographs, made on a so-called phosphorescent surface, of which absolutely nothing can be seen in the daylight, but which are distinctly visible in the dark. Many years ago, compounds were invented which had the property of shining in the dark many hours, and even days or weeks, after an exposure to sunlight for only a few seconds. These phosphoric compounds, called after their inventors, Canton's, Baldwin's, Bolognian phosphorus, etc., were formerly of no use whatever, but it was hoped that they might eventually reveal something concerning the nature of light; and such has indeed been the case, as the phenomena connected with these experiments are a strong argument in favor of the undulatory theory, and the correlation of forces.

An English photographer lately conceived the idea of covering a sheet of paper or glass with a layer of such a phosphorescent substance, and then treating it in a similar manner to paper or glass sensitized in the ordinary way for taking a photograph. Pictures taken in this way seem, by daylight, to have no existence, but the places where the light has acted, become phosphorescent or luminous in the dark, the shadows remaining invisible, the semi-tints slightly luminous, and the result is such a change in the surface that the picture is only perceptible in a dark room, by an unearthly glow of a greenish, blue, red, or purplish tint, according to the preparation used.

It is very easy to make such pictures. A sheet of albumen paper is moistened to make it sticky, and then equally covered with a thin layer of the finely powdered phosphorescent substance, or a pane of glass is covered with a thin coating of paraffine, to which, also, when warmed, the powder will stick; then the prepared surface is treated as in taking an ordinary photograph, either by placing it in the camera, or exposing it for a few seconds under a positive, to the rays of the sun, or the magnesium or electric light.

The only thing remaining to state is the preparation of these phosphorescent substances. One of the cheapest is Canton's phosphorus, and it is made by burning oyster-shells for half an hour, powdering and mixing with an equal weight of sulphur, and heating again for one hour in a covered crucible. The produced substance must of course be preserved in the dark, and protected from moisture in a well-closed bottle. Wach found that the luminosity is much increased by moistening the mixture of shells and sulphur, before the second heating, with a solution of sulphide of arsenic in liquid ammonia. The powder thus obtained emits so strong a light of blue color that it does not require perfect darkness to perceive its glow.

Baldwin's phosphorus, mentioned above, is prepared by dissolving chalk in nitric acid, then heating and grinding it to powder. The Bolognian phosphorus is made by simply heating a mixture of powdered heavy spar with the white of eggs, gum-water, or a solution of tragacanth. Fluor-spar is naturally such a phosphorescent substance, some specimens, however, more than others, and diamond appears to be the best; but the expense of the powder would hardly admit of its employment for the above-mentioned purpose. Experiments have proved this property, in some degree, to exist in a great number of substances not suspected to possess such a singular quality; for instance, many natural compounds of lime, baryta, strontia, and magnesia; besides corals, fossil bones, and teeth; the shells of eggs, oriental pearls, dry bleached linen, white paper, and even the stones extracted from the human bladder.

Grott has found that the same luminous rays — the blue and violet — which produce the photographic pictures also produce this effect, and that the rays which have no photographic powers — red and orange — not only do not produce it, but extinguish the existing luminosity. However, this is not because it is easily extinguished, as handling and even immersion in water will have no effect upon it, neither plunging the body in different gases. Groszer found that the luminosity was not even in the least impaired in a perfect vacuum. — *Scientific American.*

IMPORTANT PHOTOGRAPHIC IMPROVEMENT.

Mr. Joseph Buchtel, of Portland, Oregon, has recently devised what is said to be a very important improvement in printing pictures from negatives. The invention is described in the "Oregonian" as follows: —

"There has already been a complaint among photographists, that no perfect arrangement was known, by which an accurate, clear, and sharp impression could always be taken. The trouble has always been that no contact pad has been invented which would hold the sensitive silver plate, on which the pictures are printed, in perfect, air-tight contact with the negative glass. Every one has noticed that nearly every picture, even among the best, is blurred or indistinct in some of the minute lines. This is because the silver paper was not closely pressed in those parts upon the glass plate. The pad generally used is of felt, the finest of which has small pits and inequalities in its surface. Wherever there is a pit there will be a defect in the picture. If there are 100 of these little pits in a square inch, there will be 100 places in the picture where the minute lines are not brought out, and hence a blurred appearance. The platen board over the pad is perfectly straight. Now, if the negative glass, on which the pressure is brought, be warped, it is plain that some places will be pressed hard, while others will not be pressed at all, or only lightly. Then the picture will come out sharp and clear in the hard-pressed places and blurred in the others. Such pictures are valueless, and hence there must be great waste of silver paper, as well as of the time of the operator. This invention is designed to take the place of the felt pad in common use. It consists of an elastic bag, made of very fine, soft, and pliable India-rubber, air-tight, in two compartments, which lap each other by means of an ingeniously arranged suture. This bag may be filled with air, gas, or any fluid. It will be used in the same manner as the old pad. The negative will be laid in the printing-frames, the silver or sensitive paper laid on the negative, next the pad, and then the pressing-board or platen. Every photographer will see at once that the elasticity of the bag will accommodate its surface to that of the negative glass. That is to say, if the glass is convex, the air or fluid in the bag will flow, under the pressure of the platen, to those places which are low, and the surface of the bag will become an exact impression or counterpart of the glass surface. No part of the negative's surface, no matter how uneven it may be, can escape the pressure, and the pressure will be exactly equal everywhere. There will be no vacuums between the pad and silver paper, nor between the latter and the negative glass; hence there will be no discoloration of the silver paper, which always occurs from exposure to air.

Since the art of photography has been known, hundreds of attempts have been made to find a contact pad which would secure the results which Mr. Buchtel claims will invariably follow the use of his invention; but heretofore without success. It is simple in its principles of operation, and the only wonder is that it had not been thought of long since.

PLIABLE GLASS.

About three months ago we called attention to a new material, which had been introduced in Paris by M. A. Marion, under the above name, possessing valuable qualities for many photographic purposes.

The "caoutchouc pellicle" is in sheets the size of photographic paper, about 22 by 18 inches. It is thin, colorless, transparent, exceedingly pliant, possesses a fine surface, and is water-proof, or nearly so, not being affected by fluids until after long treatment, and then only slightly. It is exceedingly tough, bearing considerable strain without tearing, and is slightly elastic, stretching a little when pulled.

The multiplicity of purposes to which a material having most of the properties of glass without its frangibility, and which might be called flexible glass, may be applied in photography, will occur to most readers.

At present we have only had opportunity for experiment in two directions with the sheets sent to us. We have employed it as a protective surface to small pictures, in a manner similar to that in which sheets of collodion and gelatine have been used, and also as a substitute for glass in taking negatives. For the first purpose its application is simple and easy. A sheet of the material, having been cut to the required size, is immersed for a few minutes in clean water, or dilute alcohol and water would be better still. The picture to be protected is then wetted, either by holding under a tap, or immersing in a dish of water. The wet, vitreous sheet is then brought into contact with the wet surface of the print, which till then is kept in a horizontal position; the two being then raised into a vertical position, and drained, the surfaces come into close contact, the water running out from between them driving away all air-bubbles. A sheet of paper is placed over the surface, and the whole rubbed well down to secure firm contact. The protected print is then dried under pressure. The appearance of the finished print is very similar to that of a print "enamelled" with gelatine and collodion.

In our attempts to use the vitrified sheet as a support in producing negatives, we proceeded as follows: A piece of the sheet is cut about a quarter of an inch less than a plate of glass of any suitable size. The vitrified sheet is moistened at the back, and placed on the plate of glass, to which the moisture causes it readily to adhere. It is then coated with collodion, which, flowing over the edge of the sheet and up to the edge of the glass, protects it from displacement in the nitrate bath. This done, the manipulations are conducted in the usual way until the negative is finished, when it is easily removed from the glass by running a penknife round the edge and lifting away the negative on its limp transparent support. There are certain precautions necessary in these manipulations. It is important to see that the pellicle is quite flat on the glass, without wrinkles, and that the edges do not curl up so as to permit the collodion to flow under between the vitrified sheet and the glass.

The most curious difficulty we met in using the new material as a substitute for glass in taking negatives is one which we hope is exceptional, or in any case we are disposed to believe it is avoidable. It is this, — the exposure required is much longer.

We may here mention an ingenious application which Mr. Woodbury has for some time contemplated making of such a material as this. He proposes to sensitize a long strip of it by some trustworthy dry process; and, providing a camera with a couple of rollers, wind off from the supply roller sufficient for a negative. After exposure this would be wound on to the other roller, and a fresh supply at the same moment brought opposite the lens for further use. The compactness and convenience of such an arrangement will be readily understood. The working out of such an arrangement is a matter of detail which we need not discuss here.

The exact nature of the material and its mode of preparation are, of course, M. Marion's secret; but as photographers rarely like to work with materials of the constitution of which they know nothing, we may state at once that there is very little doubt that the basis of this fabric is collodion; and, although it is named vitrified India-rubber, it is very doubtful whether India-rubber enters at all into its composition. The strong and peculiarly characteristic smell of castor-oil is one of the first characteristics which came under our attention in examining the pellicle. On treating it with benzoline it remains unaltered. It is at once penetrated by ether, and softened, but, like collodion films under such circumstances, not readily dissolved. It burns in the rapid, explosive manner of pyroxyline, leaving a little sticky residue like burnt oil. Dr. Vogel described in our pages about a year and a half ago the "leather collodion" of Herr Grune, made from plain collodion containing 4 per cent. of soluble cotton and 3 per cent. of castor-oil, and this appears to be a substance of a similar constitution. Dr. Vogel proposed to supplement a film of the leather collodion with a layer of India-rubber in certain cases, and he describes the films so prepared as very solid and a little elastic. The object for which the preparation was then proposed was the transfer of negatives. It appears probable that to M. Marion has occurred the happy thought of expanding this idea, and forming a transparent fabric in sheets ready for use, which will have a variety of applications. Whatever the precise nature of material employed, the skill with which it is prepared, and the beautiful, transparent, tough, and flexible pellicle produced, confer a boon on photographers generally. — *Photographic News.*

PHOTOGRAPHY AT THE FRENCH EXHIBITION.

In no department of the Exhibition was there more activity of mind displayed than in that allotted to photographs. No recent discovery excites more curiosity and interest, nor calls into play more ingenuity and science and taste, than this of printing by the aid of light. The art, in all its various processes, has become of immense importance, admits of innumerable applications, and gives employment to a host of people, many of them highly endowed. Far more than the discovery of the telescope, of the microscope, or of a perfect balance, it has made a new era in science; and in the fine arts, also, it has exercised a prodigious influence. Photography is useful in so many ways, — in astronomy, in ethnology, in anatomy, in botany, in architecture, in land surveying, in engraving on wood and steel and copper, not to speak of ordinary portraiture, — that no modern art can be said more truly to live than this.

An index of patents relating to photography alone tells us that down to the end of the year 1859 upwards of 190 separate patents had been granted in England; and since that period the number has been enormously increased. This, however, gives a very insufficient idea of the energy with which the wonderful art is pursued; for, in point of fact, the most important discoveries in photography have not been protected by the patent laws. Thus, the collodion process — a process by which nine-tenths of the protographs in all countries are now produced — was all made known freely to the public by its originator. So likewise the essential principles of all the various carbon processes of printing were announced by their discoverers without any attempt to secure their rights by patent. So long ago as December, 1827, M. Niepce, then living at Kew, submitted to the Royal Society some pictures taken on silvered copper plates smeared with the bitumen of Judæa, — a substance which is soluble in certain essential oils, but not so after exposure to light. Specimens of his skill are in existence as perfect in appearance as on the day on which they were produced. There is the beginning of the carbon process. On the 29th of May, 1839, Mr. Mungo Ponten made a communication to the Royal Scottish Society of Arts to the effect that bichromate of potash applied to paper in solution accepted a photographic image which could not be removed by water, the portions protected from the light being readily washed away. There is a step in advance. In January of the last-mentioned year, M. Daguerre in France, and Mr. Fox Talbot in England, had each made public their independent discoveries of the daguerreotype and the talbotype.

Judging by the manner in which the prizes were distributed, the jurors attached less importance to the successful practice of photography according to known methods than to the discovery of new developments and applications of the art. They gave their chief prizes, not to the men who produced the best portraits, or the best landscapes, but to those who rendered such portraits and landscapes permanent. M. Lafon de Camersac received one of the three gold medals which the jury awarded; but the business which he pursues is not that of taking photographs, — it is that of transferring photographs to enamel. An ordinary photograph is apt to fade, and being upon paper it is easily destroyed; but M. de Camersac, by a process which he keeps secret, will transfer it with the most perfect accuracy to enamel; he will pass it through the fire, and return the picture to you vitrified. He has been working at this process of vitrification since 1851, and year by year since then has made such steady progress, and met with such success, that now he boasts of having furnished the public with no less than 15,000 enamels. These indestructible enamels can be made of any size. They do not cost much, and they are executed with rare taste and fidelity. The result is most valuable, for there is no other method of rendering photographic pictures indestructible that approaches this in the fidelity with which it reproduces all the attributes of the photograph to be preserved, and in the assurance of safety which it affords. And now we come to what is called the carbon process, or carbon printing. Is it possible to print a photograph on paper so that it shall be as permanent as the impression of a steel engraving in printer's ink? Whatever we may come to hereafter, it is generally accepted at present that if a photographic print is to rival ordinary prints in permanence, this can only be by reproducing it in an ink which, like printer's ink, has carbon for its base. So there are a great number of ingenious processes for transferring to gradations of carbon the gradations of light and shade which we see in photographs. The essential theory of these processes is suggested by the experiments of M. Niepce, announced in 1827, and of Mr. Mungo Ponten, announced in 1839. There are substances, soluble in water, which become insoluble when subjected to the agency of light. If a photographic image be transferred to the surface of such a substance, the light passing through the light parts of the negative, and not through the dark, will so act upon the surface that parts of it will wash away, and parts not. The surface when washed will be raised or depressed according to the quantity of light which at different points has acted upon it; and the depressions thus contrived will accept a film of carbon, which in its various gradations of thickness will more or less accurately represent the lights and shadows of the photograph.

Most of the French carbon prints are described as produced by the process of Poitevin, who, in 1855, succeeded in turning to account the discovery of Mr. Mungo Ponten. He combined carbon or any other pigment, in a fine state of division with gelatine, starch, or gum, applied it over the surface of his paper, dried it, submitted it to the action of light under a photographic negative, and so first produced what is now usually called a carbon print. The chief English exhibitors of carbon printing are Mr. Woodbury, of London, Mr. Swan, of Newcastle, and Mr. Pouncey, of Dorchester. Among these, as a discoverer, Mr. Pouncey stands first in point of time. His first announcements belong to the year 1858, — that is, three years after Poitevin's first success.

Mr. Swan, of Newcastle, comes after Mr. Pouncey in point of time: his discovery dates from 1864; he appears to have carried his process of carbon printing to a high degree of perfection. The latest process of carbon printing invented in England is that of Mr. Walter Woodbury. It is very simple, and the results are full of promise. A picture is transferred to a thin sheet of gelatine; water washes away those parts of the gelatine on which the light has not acted, and we have are lieved surface which perfectly represents the light and shadow of the picture. By hydraulic pressure the gradations of relief on the gelatine are transferred to soft metal, and the impressions, which are of much softness and beauty, are produced by mechanical means so simple that thousands of them can be obtained in a few hours. — *Druggists' Circular*

NOVELTIES IN PHOTOGRAPHY.

Photographic Light. — A pure and very bright yellow light, used when working with very sensitive chemicals, may be obtained in the following simple and cheap manner: Two little pieces of platinum wire, each ending in a little loop of one-sixth of an inch in diameter, are placed in the flame of a Bunsen burner. By placing a small lump of carbonate of soda in each of the platinum loops, by the fusion of the soda the colorless flame at once assumes an intensely yellow light. In such a flame a fused drop of carbonate of soda will last for a considerable time, hanging in the platinum loop like a drop of clear water. This is one of the best ways of producing a pure monochromatic flame.

Photographs from a Balloon. — An experiment of great interest in a topographical point of view has just been made by M. Tournachon, the photographer, better known by the name of Nadar, with the captive balloon at the Hippodrome. At a height of 300 metres (984 feet) he succeeded, in spite of the rotary motion of the aerostat, in obtaining several photographic proofs, successfully taken, representing most accurately the panorama of Paris. This is an important step in a strategic as well as in a geodesic point of view.

Preservation of Photographs.— H. Cooper, Jr., of England, gives the following formula for a preservative varnish which is stated to be an entire protection against fading: —

1 dram of gum dammar dissolved in 1 ounce of benzole.

1 dram of paraffine dissolved in 1 ounce of benzole.

Mix 4 parts of the paraffine solution with 1 part of the dammar solution.

Prints covered with this varnish are impermeable to water. A solution of the paraffine only will do, but is better with the gum dammar.

THE SCIENCE OF EXTINGUISHING A FIRE.

Experiments by M. Van Marum, in Holland, show that violent conflagrations may be extinguished by very small quantities of water, by means of buckets or small hand-pumps. The flame of any burning substance must cease, according to well-known principles and experiments, as soon as any cause prevents the atmospheric air from touching its surface; thus, when a small quantity of water is thrown upon a body in a state of violent conflagration, this water is at first partly reduced to vapor, which, rising from the surface of the burning substance, repels the atmospheric air, and consequently represses the flame, which, for the same reason, cannot again appear whilst the production of the vapor continues.

From experiment it appears that the art of extinguishing a violent conflagration with very little water consists in throwing it where the fire is most powerful, so that the production of vapor from the water, by which the flames are smothered, may be as abundant as possible; and in proceeding to throw the water on the nearest inflamed part, as soon as the fire ceases in that where you began, till you have gone over all the burning parts as expeditiously as possible. In thus regularly following the flames with the water, they may be everywhere extinguished before the part where you began has entirely lost, by evaporation, the water with which it was wetted, which is frequently necessary, to prevent the parts from taking fire again. After the flames of a burning body are extinguished, it cannot again take fire, for the above-mentioned reason, till the water thrown upon it be evaporated.

From what has been stated, it results, that to stop the most violent flame it is necessary only to wet the surface of the burning substance where the flame appears, and for this purpose only a small quantity of water is required, if it be applied with judgment to the burning part.

HEAT FROM BURNING GASES.

The temperatures produced by the explosion of gases mixed in definite proportions are not uniform. The highest degrees result at first by the combustion of only a fraction of the mixture, and the heat diffuses itself through the unaffected portion so as to reduce the temperature to a much lower degree. Then, as the mixture gradually cools off, another explosion takes place, resulting in a temperature of a yet lower degree, and the last portion of the mixture is only burnt when the temperature falls much lower still. In the combustion of carbonic oxide in oxygen gas, both in proper proportions, these three stages are at the temperatures of 5,491° F., 4,637° F. and 2,095° F. A mixture of equivalents of hydrogen and oxygen, when exploded, rises to 5,151° F., and hydrogen with the corresponding quantity of atmospheric air, to 3,675° F. Carbonic oxide, under the same circumstances, produces 5,500° F. and 3,625° F. Experiments with mixtures of carbonic oxide and hydrogen gas with not quite sufficient oxygen showed the remarkable fact, that these different stages of combustion result in the formation of definite compounds, as in this case, of hydrates of carbonic acid, in the following order: $2\,CO_2 + HO$; $CO_2 + HO$; $CO_2 + 2\,HO$; $CO_2 + 3\,HO$; $CO_2 + 4\,HO$; $CO_2 + 5\,HO$.—BUNSEN, *Poggendorff's Annalen*, Vol. CXXIII.

MELTING-POINT OF FUSIBLE SILICATES.

C. Sching finds, by a thermo-electric pyrometer, that silicates are formed and melted at the same temperature, and that the formation depends more on time than on temperature; that it depends, in fact, on the conducting power of heat possessed by the materials composing the silicates. He also finds the temperature required for melting metals and metallurgical products to be lower than usually stated, 1,431°–1445°, for melting the same; that the temperature of a glass furnace in operation is only 1,100°–1,250° C.;

that crystal glass is worked at 833°, and becomes completely liquid at 929°. A Bohemian green glass tube softens at 769°, and becomes liquid at 1,052°; pure limestone loses its carbonic acid by heating for several hours at 617°–675°. An increase of temperature will shorten the time.

METHOD OF CRACKING GLASS.

Mr. John M. Little, at a meeting of the Massachusetts Institute of Technology, exhibited some novel specimens of curved and tubular glass, cracked by a process which he had developed, showing a great and unexpected elasticity in this substance. After describing the old and unsatisfactory methods familiar to all chemical students, he explained this process, which consists in directing a gas flame, from a glass tube with an opening in its point so fine as to cause a needle-like jet, upon a crack previously started by a file. He can then run the crack before the flame in any direction he pleases, except that he cannot run one crack into another, — a fact which he explains by the supposition that an equal portion of the glass is heated on each side of the crack, and that when the line of fracture returns to near its commencement it must branch off in order that this necessary space may occur on both sides of its course. He showed that the fibre of the glass has nothing to do with the direction of the cracks. He can thus crack thick glass, even wine bottles; in this way utilizing for purposes of the household and the arts many heretofore useless broken glass vessels.

ELECTRICAL THERMOMETER.

A new English invention is an apparatus for employing electricity, in connection with a thermometer, to regulate the temperature of a room. An ordinary mercurial thermometer is provided with a platinum wire inserted in a glass bulb, so as to be in connection with the mercury, Another wire, capable of elevation or depression, is placed at the other end of the thermometer. These two wires connect with the two poles of a battery, and forming part of the circuit is an electro-magnet, whose armature controls the opening or closing of a valve regulating the admission of hot air. If it is desirable that the temperature of the room should not rise above 60° F., the point of the movable platinum wire is brought to that number on the thermometer. When the mercury registers 60° the circuit is closed, and the armature of the magnet closes the hot-air valve until the temperature becomes reduced, when the valve is again opened. Thus a nearly even temperature may be maintained, — a very desirable object in hot-houses.

THE FRENCH BAROMETROGRAPH.

It is usual in taking barometrical and thermometrical observations for the purpose of registration, as regards changes of weather and for foretelling weather, to take them at stated and regular intervals, so that the variations at those periods may be noted, and, if required, plotted out on a chart. Indeed, for obtaining quick and useful comparisons, there is nothing compared to the plan of projecting the curves of atmospheric variation on the charts specially prepared for that purpose; it enables one at a glance to see the variations of the barometer during the past day, saving the bother and calculation necessary where the observations are simply noted down as so many figures. But there is one great objection attendant upon observations of this nature; however carefully they may be recorded or described on charts, they are but observations of the time only, and show nothing more. For instance, the heights of the barometer at the two usual times of observing, in the morning and evening, are recorded, and a line drawn on the chart from the one point to the other is assumed to show the variation between those times. True, it does to some extent, but only to the extent of the difference of the two. In stormy or unsettled weather the rise and fall of the barometer may be considerable between the two periods of observation, and yet it is possible that at the two periods the observed indication will be precisely the same. The chart would consequently show an even state of pressure, whereas the opposite would be really the case. Accurate results can, therefore, only be obtained when the observations are made hourly, or, at least, at very frequent intervals. This is, as far as regards personal observation, quite impracticable for the generality of observers; and to give a true and faithful record of the variations of the barometer from minute to minute and from hour to hour, we can only look to mechanical means for bringing about this much-desired result.

Among the plans suggested very few have been ever practically carried out, and of those we have seen their great expense proves an almost insurmountable barrier to their adoption. The barometrograph seems to combine simplicity with cheapness, and accuracy with ease of observation. The records are continuous and comparable, and are produced by the variations of the barometer known as the aneroid. The pressure of the atmosphere affects four metallic boxes, as in the ordinary aneroid, having their upper and under faces undulated; a vacuum is made in each of them separately, and they are attached together in one series, so that for an equivalent variation of pressure the movement is four times greater than it is for one box only. A very strong flat steel spring acts upon the barometric boxes in an opposite direction to the atmospheric pressure. This spring controls the indicating lever by means of a connector, which receives the action from the extremity of the spring, and communicates it to the lever at a point very close to its axis, whence it follows that a considerable multiplication of movements is the result.

The indications of the movements of the lever are registered in the following simple manner: A cylinder is revolved by the regular movement of an ordinary pendulum time-piece; it makes a complete revolution in one week, and carries a glazed paper, which has been smoked black by means of a candle. At the extremity of the lever is a very fine spring, pointed at the end, which rests upon the cylinder and traces a white line upon the black ground. At the end of each week the paper is changed for a fresh one, the old one being prevented from having its record destroyed by having a coat of varnish. The whole operation takes but little time, including the attachment in a book, or, when required, the record of one week to that of the preceding, so that the indications may be continuous. The barometrical arrangement of this instrument is far less liable to error than the ordinary aneroid, where so many movements and accessories are required to translate the changes of the barometric box to the indicating needle on the face of the instrument. In order to render the indication recorded useful for comparison, the paper can be divided into equal parts, representing the days of the week, and again subdivided to represent the principal divisions of the day; this has been done in practice, and instruments similar to what we have just described have been in use some time, earning great approbation for the fidelity and utility of the observations recorded by them. — *Scientific American.*

FREEZING MIXTURES.

A remarkable mixture, discovered by Berzelius, for producing intense cold, is the following: —

Two or three pounds of chloride of lime is heated until it forms a porous mass, and is powdered and passed through a sieve, by which operation it absorbs just enough moisture as is necessary to cause it quickly to dissolve in water. It is then mixed with half its amount of snow in a wooden vessel placed in a mixture of snow and salt. In the interior of this cooling mixture, mercury or ether may be frozen when introduced in a platinum crucible or glass ball.

When this powdered chloride of lime is dissolved in half or two-thirds its amount of cold water, it will easily freeze water when introduced into the mixture in a proper vessel, and this may perhaps finally be found a cheaper freezing mixture than any of the common ones now in use, as by simple evaporation the original salt may be regained.

Other freezing mixtures are: —

Mixtures.	Parts.	Descent of Thermometer.
Carbonate of Soda,	1	70° Fah.
Nitrate of Potash,	1	
Water,	1	
Chloride of Ammonium,	1	60°
Water,	1	
Sulphate of Soda,	3	70°
Water,	2	
Nitrate of Ammonia,	1	50°
Water,	1	

As these mixtures are made simply with water, and not with acids, the ingredients may be regained by evaporation and recrystallization of the salts, and therefore they are much less expensive than the solutions in acids.

FORMATION OF ICE UNDER WATER.

In the 16th annual report of the Detroit Board of Water Commissoners, for 1867, are detailed the efforts of the commissioners in devising some way of preventing the ice from choking up the main inlet pipe. This pipe extends 150 feet into the river, and terminates in a bell-shaped mouth elbow, 3 feet in diameter, turned upward, in water 25 feet deep. Covering the end of the pipe is a boiler-plate strainer, perforated with half-inch holes, 144 to the square foot. Inside the shell of the strainer is a diaphragm plate with similar holes, and below this the strainer shell has 4-inch holes, to allow the sand to pass through, so as not to bank upon the outside of the strainer. When the engine is pumping, the water is required to pass through the strainer holes at the rate of 120 barrels per minute. This is the full supply, but in extreme cold weather, under certain circumstances, it is with great difficulty any water can be obtained, in consequence of the accumulation of ice. The circumstances under which the difficulty occurs are, when the weather is cold and ice is forming in the lake above, and on the shores of the river, and the river is free from ice over the strainer. But when the river is covered with ice over the strainer, the difficulty does not occur at any degree of cold. The great difficulty occurs when the thermometer ranges from 7° or 8° to 18° or 20° above zero; but when the mercury rises above 20° the difficulty soon ceases. The greatest number of detentions, it has been observed, occurs at night, and when the sun is obscured by clouds, but, when the sun is unclouded, no difficulty is ever experienced.

With the rapidly increasing consumption of water, the commissioners foresaw that the time would very soon arrive when it would not be safe to permit any detention to the pumping engines, and that this remarkable phenomenon must be solved and the difficulty overcome.

As no experiments had ever been previously made, and the theory was so strongly presented that the trouble was wholly from anchor-ice forming on the strainer, an opening was cut through the down-stream side of the strainer, and a self-acting door was hung; but this and the plan of suspending a line of booms so as to retain a covering of ice over it when the rest of the river was not covered, both failed to accomplish the object sought. The theory that the covering of the entire surface of the river by ice prevented radiation, and by that means the ice did not form on the strainer, was strongly urged; but, if so, any covering over the strainer would answer the same purpose. To test it, last summer submarine divers built a submerged platform of planks immediately over the strainer; but this proved of no avail, for the stoppages occurred at a higher temperature than before.

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On the 29th of last December, when but a very limited supply of water could be obtained, divers went down, examined the strainer, and found that it and its surrounding piles were one mass of ice particles collected into a mound some 10 feet high and about 15 feet in diameter, and that large quantities of minute crystals of ice were rapidly passing and adding to the mass already collected. Specimens of the ice were brought to the surface in a bag. It was in sheets and particles thin as paper, translucent, with sharp, pointed edges. A further examination developed the fact, that the small amount of water the pump was then receiving came through the lower or down-stream side of the strainer, this being the only point where the diver could approach it, and which was found but slightly covered with ice. Having ascertained the existing state of affairs, the commissioners felt confident that a remedy could now be provided, and with a large piece of canvas they had the strainer completely covered and encircled, except on the down-stream side; but temporary relief only was afforded by this expedient, and another descent to the strainer was undertaken. The diver went down and found out this very important fact, that, with the temperature of the atmosphere at 29°, the water at the surface was 33°, while at the bottom of the river it was 35°. At this descent much less ice was found on the strainer and its surroundings than at the first time. The lower side was clear, but on the upper side the action of the current had worn the ice into elongated cones, pointing up stream. At this time the pump was receiving a full supply of water. About 3 hours later, the diver again descended (thermometer 33°); he found the ice had entirely disappeared. The wooden platform was removed, since which time no trouble was experienced, until the surface ice of the river began to move, when there were a few hours during which no water could be obtained; but with this exception no further delays have since occurred.

It is clearly proved that ice particles are ever present in the river, and are continually passing down by the action of the current, collecting upon whatever obstructions they happen to meet with in their passage. The commissioners, therefore, advise the entire removal of all spiles and other substances adjacent to the strainer, believing that with nothing but the smooth dome of the strainer for these particles to lodge upon, the quantity that will accumulate cannot very seriously prevent the flow of water to the inlet pipe. — *Scientific American.*

FINDING THE DEVIATION OF THE COMPASS.

The "Mechanics' Magazine" describes an invention designed to simplify the process for finding the error on the common steering compass, or, in other terms, the deviation of the magnetic from the true meridian. It has been patented by Major-General Shortrede, of Lee, who attains his object by making some additions to the steering compass as usually made, by which it becomes virtually an azimuth compass, without interfering with its ordinary use in steering. One way of effecting this is by attaching at opposite sides, to the rim of the cover, a semi-circular arc or band of a convenient width, having along its middle a narrow slit, by means of which it may be directed to the sun or other heavenly body; or through which the sun's light, shining over the centre, and on the edge of the card, shows by a bright streak on a dark ground the compass-bearing by observation. This being compared with the bearing, determined astronomically, gives a difference, which is the error or deviation of the compass from the true meridian. On a surface projecting from the rim of the bowl, or on the rim of the cover, are graduations, which are read as usual by a zero mark on the other rim. When the sun's light is too faint to give a distinct streak, or in observations of moon, star, or planet, the object may be viewed through the slit, either directly, or as reflected from the glass of the cover beneath the slit. In such cases the observation is made by taking the usual reading of the card at the lubber line, and also the reading on the rim, giving the angle between the lubber line and the object. According to their position, the sum or the difference of these readings gives the compass bearing of the object; and this compared with the true azimuth, gives the error or deviation from the meridian.

As a high wind acting on the continuous arc may cause the compass to have a tremulous motion, in order to avoid or lessen this inconvenience in such cases, the arc is removed and replaced on the side toward the object by a short piece about an inch high, and on the other side by a shorter piece, each piece having in it, as in the arc, a narrow slit. The piece toward the object being fitted with a reflector, which may be either of the usual sort, with a hinge so as to be turned according to the altitude of the object, or it may be a portion (about an octant) of a glass cylinder fixed horizontally; the object reflected in either of these ways may thus be viewed through the slit or hole on the opposite side. There is yet another way of attaining the end in view. Graduate a rim of the bowl or cover of the common binnacle compass, putting a proper zero-mark on the other rim, by turning the cover so as to bring a bar of the roof into the shadow of the opposite bar, — the zero-mark indicates the angle between the object and the ship's head. This, with the azimuth of the object and the usual reading of the card suffices, as above shown, to give the true meridian, and the deviation of the compass from it. — *Scientific American.*

CONSTANT GALVANIC CURRENT.

The following observations may have occurred to others, but not having met with them published, they may be of value, as tending to the perfection of our scientific instruments, by providing the source of a constant galvanic current, of large quantity and very great intensity. The bichromate of potash battery furnishes a current of great force, and its simplicity, economy, and convenience of management would make it preferable to the double fluid batteries, but for its want of constancy when a current of large quantity is required. Experimenting with it lately, I became satisfied of the cause of this defect. Although there may be a large reservoir of liquid, only the stratum between the plates is active, and, as no gas is being given off, there is no circulation; this soon becomes exhausted, and as it is renewed merely by diffusion, can only maintain a current equivalent to the fresh supply of liquid thus obtained. I therefore used a thin beaker as the containing vessel, and placed it over a Bunsen's burner capable of maintaining a moderate circulation of the liquid, and as I expected, the battery now gave its fullest force with absolute constancy, until the complete exhaustion of the exciting fluid. Mechanical stirring of the liquid or motion of the plates will produce a similar result; and thus by any of the various modes which may be employed, this battery can be made to yield a current more powerful than any other known form, without giving off any noxious gases, and as absolutely constant as can be desired. — JOHN T. SPRAGUE, *in Chem. News.*

ELECTRIC CLOCKS.

A new form of electric clock, invented by M. L. De Combettes, consists of a long pendulum, on the lower portion of which is fixed the clock-face. The weight is a sort of box containing an electro-magnet and armature, which, on being attracted, disturbs the equilibrium of the pendulum, and consequently gives it motion. The movement of the armature transmits motion to the hands of the clock in a manner somewhat similar to the mechanism of the alphabet-dial telegraph instrument. In order to make and break the electric circuit, the movement of the pendulum is made use of, one pole of the battery being connected permanently, through the axis of suspension, to one end of the electro-magnet, whilst the other pole is connected to a metal plate, against which a point of the pendulum, in connection with the electro-magnet, makes contact at every beat, thus completing the circuit and causing the electro-magnet to attract the armature. It is stated that only a weak battery is required, and that two Daniell's cells will keep it working for several months.

An electrical clock in the rotunda of the Philadelphia Merchants' Exchange has a running gear consisting simply of two cog-wheels and a ratchet-wheel. The driving power is supplied by a weak galvanic battery, the currents from which, transmitted through two galvanometer coils, placed one on each side of the clock-case, act upon steel bar magnets set within the pendulum ball. The latter swings between the two coils, so that when one is positively charged the ball is attracted until, by contact, it becomes similarly electrified, and consequently repelled; then, swinging over to the negative coil, it becomes negatively charged, and again repelled; and thus the vibrations are kept up indefinitely, or as long as the battery continues working. The alternate positive and negative charges are made and broken by a simple slide-bar moved by a wire pin on the pendulum-rod. — *Mechanics' Magazine.*

MAGNETO-ELECTRIC MACHINES.

In Mr. Wilde's machine, the induced current from permanent magnets is made to excite a row of electro-magnets, so that the armature of these secondary magnets gives off a powerful current of electricity, which may be at once applied to experimental purposes, or made to excite a third row of electro-magnets, and so *ad infinitum.* In the machine of Messrs. Siemens and Wheatstone, the trace of residual magnetism in a soft iron electro-magnet is made to act upon the armature, and the wires from this armature, being carried around the electro-magnet, increase the intensity of the magnetism already present there; they, in turn, increase the power of the current from the armature, so that, by constantly turning the handle, the quantity of electricity increases till a powerful current is obtained. In the machine invented by one of Mr. Ladd's assistants, the electro-magnet is fitted with a double armature. The current from one is used to increase the power of the electro-magnet, and that from the second is the one used for experimental purposes. This machine, when turned by hand, will heat 7 inches of platinum wire .01 of an inch thick to redness; and will give flashing sparks of the electro-light between carbon points, and would give a continuous illumination if turned by machinery.

At the 1868 meeting of the British Association, Mr. W. Ladd made the following communication "on a further development of the Dynamo-Magneto-Electric Machine."

"At the meeting of the British Association, last year, I brought before the section one of my small dynamo-magneto machines, the first that had been made upon that principle. I have since constructed a much larger machine, and it may be interesting now to give some particulars respecting it. The object in constructing it was to supply a good electric light for the purpose of lecture demonstrations. It is constructed upon the double-armature principle, both armatures being placed end to end, so that their magnetic axes cross each other at right angles. The short armature contains 108 feet of very stout copper wire, and sends its currents into 240 lbs. of copper wire surrounding the electro-magnet, exciting a large amount of magnetism in the body of the machine. And as the second armature is also made to revolve between the poles of this electro-magnet, a sufficient effect is produced at the two ends of the 312 feet of very stout copper wire (which is wound upon it) to produce a good electric light from the carbon poles of the regulator. But in order to make that light sufficiently continuous, it is requisite that the armatures should revolve from 1,800 to 2,000 revolutions per minute; but as the armatures have to be magnetized and demagnetized twice during each revolution, there would be in the latter case 4,000 flashes of light per minute. Now, it has been shown that every time iron becomes magnetized it is elongated, and again shortened when demagnetized. At every alteration, therefore, of the condition of the iron some small amount of heat must be evolved, and would increase to such an extent that, if unchecked, it would in course of time be so great as to destroy the insulation of the wire. To obviate this, I have perforated the two poles of the electro-magnet as close as possible to the armatures, and a stream of cold water circulates twice round the machine. This carries off the heat in a most effective manner, and no appreciable detriment in its electrical results occurs. I have not yet ascertained the quantity of the mixed gases given off per minute, but it is most interesting to notice the continuance of the decomposition of water which takes place for some seconds after all motion in the machine has ceased."

He did not wish it to be inferred that the sole cause of heat was the elongation of the iron. Doubtless the electric currents passing through the wire would produce heat; but he believed that the quantity of heat produced by that means was small as compared with that produced by the elongation of the iron itself. He entertained this opinion for the following reason: They had lately applied one of these magneto machines, driven by steam power, in connection with a large inductorium, giving about 18-inch sparks; and after a few hours' work it had been found that the copper or primary wire surrounding the core of the coil appeared to be quite cool, while the iron core itself was considerably heated. He therefore mainly assigned the production of the heat to the cause he had specified.

Mr. C. W. Siemens believed that the chief cause of the heat which was developed must be attributed to currents, because the same cause which sets up a current in the coil surrounding the electro-magnets will naturally set up a current, in the copper itself, large in proportion to the greater area open for the passage of the current; and the heat developed will also be large in proportion to the less conducting power of the iron as compared with the copper. In order to test this, he had one of the long keepers notched in the edges, and by that means he obtained a greatly reduced heating action, though he could not entrely obviate it. If his view were correct, — that the heat was due to currents in the armature, — then it could not be entirely obviated, because they must not separate the armature, as that would destroy the continuity; they could only notch it. To his own mind, the theory that the heat was produced by elongation of the metal was not at all satisfactory. If, however, currents would not explain the phenomenon, they must look rather to some other action in metals, produced by magnetism, than seek to explain it by the mechanical elongation and compression of the metal.

EFFECT OF THE GALVANIC CURRENT UPON THE TENACITY OF WIRE.

Mr. James Wylde has made public the results of some experiments which are of great importance to telegraphic science. He says that he found, some years since, that when intense currents were passed through the best copper wire, in only one direction, its tenacity was gradually destroyed, so that it could finally be crushed to pieces by the fingers. This loss of tenacity occurred first and in a greater degree at the negative pole. An examination with a microscope revealed at the broken surface a complete molecular change, a crystalline structure having taken the place of the fibrous. He states that, having entered upon some extended experiments in connection with submarine explosions by means of the voltaic current, he was frequently annoyed by the breaking of one of the wires, and in all cases found the structure at the broken part crystalline. From these facts he infers that intense currents passed through submarine cables must eventually deteriorate them, and counsels their avoidance. The frequent reversal of the current, in regard to direction, lessens or entirely prevents the molecular change in the wire. — *Scientific American.*

REMARKABLE RELATION BETWEEN THE MAGNETISM OF SOME METALS AND THEIR ATOMIC AND SPECIFIC WEIGHTS. BY P. H. VAN DER WEYDE, M. D.

When we divide the specific gravity of the different metals respectively into their atomic weights, we obtain quotients which indicate, not directly, but relatively, the distance of their atoms (upon the supposition that the atomic weights indicate really the relative weights of their atoms, which is only probable, but not proved). Comparing those quotients in the subjoined table we find the following remarkable results: —

	Spec. Grav.	Atom. Wt.	Quotient.	
Cobalt,	8.5	30	3.53	remains paramagnetic at white heat.
Iron,	7.8	28	3.59	is only magnetic below bright red do.
Chromium,	6.8	26	3.82	" " " dark "
Nickel,	8	31	3.90	" " " 600° F.
Manganese,	7	27.6	3.94	" " " 4° F.
Palladium,	11.8	53	4.49	
Platinum,	21.5	99	4.57	
Zinc,	6.8	32.5	4.78	
Aluminium,	2.56	13.7	53.5	
Iridium,	16	90	6.2	
Cadmium,	8.7	56	6.4	
Magnesium,	1.74	12	7	
Mercury,	13.5	100	7.47	
Lead,	11.4	104	9.12	
Osmium,	10	100	10.00	
Gold,	19.4	196	10,005	
Silver,	10.47	108	10.3	
Lithium,	0.593	6.4	10.9	
Antimony,	6.7	130	19.4	
Bismuth,	9.8	208	21.22	

OBSERVATIONS.

1st. The 5 magnetic metals have all quotients below 4.

2d. The so-called non-magnetic metals have all quotients above 4.

There is, however, one exception to this rule in the case of copper, of which the respective specific and atomic weights are 8.8 and 31.7, of which the quotient is 3.602; but then it is probable that the atomic weight of copper needs correction, and should be doubled to 63.4, in which case the quotient would be 7.204, and it would then fall among the other non-magnetic metals.

3d. The quotients are the smallest for those metals which are the most permanently magnetic, even at high temperature, and *vice versa*.

4th. As cooling increases by contraction the number expressing the specific gravity, it will consequently decrease the quotient obtained by using this increased specific gravity as a divisor, in perfect accordance with the fact that cooling increases the paramagnetic property.

5th. As, inversely, heating decreases by expansion the specific gravity, it will increase this quotient, in accordance with the fact that heat diminishes paramagnetism, and finally destroys it in all metals, with the single exception of cobalt, which has the smallest quotient of all, and consequently can stand some increase.

6th. The experiments of Faraday on diamagnetism and paramagnetism, with very powerful electro-magnets, have proved that palladium and platinum are the strongest paramagnetic next to the first five in the above list; they have in my list, also, the smallest quotients connected with them.

7th. In the same way as diamagnetism is the opposite of paramagnetism, the larger quotients in the above table belong to diamagnetic bodies, as, for instance, mercury, antimony, and bismuth. The last is the strongest diamagnetic substance experimented upon, and possesses the greatest quotient in the above table.

8th. If we were able to cool the other metals so as to increase their specific gravities to such a degree as to have a decided effect on the amount of this quotient, we might perhaps succeed in discovering in several of them paramagnetic qualities by means of Faraday's apparatus.

9th. Heating decreases the paramagnetic qualities, with the specific weight, and consequently increases the quotient. That it may do this to such a degree as to make the body diamagnetic, is proved in the case of oxygen gas, which, when cool, is paramagnetic like iron, and, when hot, diamagnetic like bismuth.

10th. That this relative distance of the atoms (upon which, of course, the specific gravity of bodies depends) is closely related to their magnetism, is again proved by their crystals, which are always less dense in the direction of their optical axis, and expand by heat more in one direction than in another; and by Pluecker, who has demonstrated that they are diamagnetic in the direction of their optical axis, or of the longest axis of crystallization. In some of these crystals this action is so strong that they are influenced by the magnetism of the earth; as, for instance, a properly cut crystal of kyanite (a dense silicate of alumina), when suspended on an axis, will behave like a compass needle, and may be used as such, — a fact little known, but worth knowing. — *Amer. Mining Journal.*

ON THE CONSTRUCTION OF A GALVANOMETER FOR THE DETECTION OF WEAK ELECTRIC CURRENTS.

At the 1868 meeting of the British Association, Mr. F. H. Varley explained that the smaller the magnet used in a galvanometer was, the greater would be the sensitiveness of the instrument. The small magnet of Sir W. Thomson had a mirror attached to it to reflect a beam of light, so that a small motion of the magnet gives movement to this imponderable indicating arm, and which is rendered apparent by the movement of a line of light upon a darkened scale. But it had frequently occurred to the author that smaller and lighter magnets might be employed by calling in the aid of microscopic power, and the instrument which he had constructed took two forms, both of which had been found to answer exceedingly well. The first consists in suspending, with a single filament of silk, a magnet made of the finest steel wire that can be obtained, and rendering its motion apparent by viewing it through a rectangular prism by means of a microscope, in the eye-piece of which is placed a small graduated scale, photographed on glass. The magnet appears to be a black bar bisecting the field of view; and as the finest wire obtainable for this purpose appears as thick as a scaffold-pole when sufficiently magnified, it is obvious that the slightest motion of the magnet must be rendered conspicuous by the image moving to and fro over the graduated scale placed in the eye-piece. The second form is more sensitive than the first. A small magnet, made of flat steel, polished on one face, is suspended in the usual manner by a single filament of silk, and a small mico-photograph of a graduated scale is placed at such a distance from the reflecting surface that each of the photographed divisions shall equal two minutes of arc as nearly as possible. The image of the scale thus reflected is sent in a line with the optic axis of the microscope, and any deflection given to the magnet causes the photographed scale to appear to move across the field of view. The reflecting surface moving doubles the apparent motion, giving the amount due to the angle of incidence, plus reflection. A movement of one graduated division being produced by one minute of deflection, if magnified 60 times by the microscope, will render a motion equal to 1 second of arc apparent. Where desirable, a small scale placed in the eye-piece can be made to give a vernier reading upon the magnified scale. The magnifying power can be increased where desired, and very minute amounts of motion rendered measurable. The great difficulty of using instruments of such extreme sensibility, which are interfered with by extraneous vibrations, can be to a great extent overcome, by insulating the various parts from vibration by means of antagonizing spiral springs, and preventing finer vibrations from being communicated through the wire itself by covering the wire with silk or cotton wrappings, to act as dampers to the wire. The advantage of this galvanometer consisted in the fact, that it was not necessary that the place where it was used should be darkened. The instrument is appropriate to thermo-electric currents and those of exceedingly feeble intensity.

TELEGRAPH INSULATION.

Mr. Varley, well known for his skill as an electrician, and especially for his services in connection with the Atlantic cable, has lately obtained the following patent: —

Insulators for telegraphic wires are usually made with an iron pin, coated with what is known as vulcanite, or hard vulcanized India-rubber, and secured by means of plaster of Paris, or other cement, inside of a porcelain, or other earthenware cup inverted. As heretofore made it has been found that the vulcanite covering is liable to be porous, and full of what are known as blow-holes, and that the iron or steel pin is liable to rust, by reason of the presence of the vulcanite covering, and that the accumulation of the rust is liable to crack the vulcanite covering.

And the first part of said invention relates to a method of preventing the pin from rusting, and consists in coating the iron or steel pin with zinc, and then coating the zinc with tin, or an alloy of tin, preparatory to applying the vulcanite covering. The zinc is applied in the well-known manner of galvanizing iron, and the zinc is coated with tin, or an alloy of tin, by dipping in a bath of molten tin, or alloy of tin, in the same manner as sheets of iron are usually tinned; and, after being so tinned, the preparation of India-rubber, or other vulcanizable gum, mixed with sulphur, is applied in the green or plastic state, and then subjected to the vulcanizing heat to be hardened, in a manner well known to manufacturers of vulcanite. When so made, the vulcanite will be found to be solid and without blow-holes, and the pin will not rust however much it may be exposed. The cement used for securing the pin inside the inverted cup is more or less porous, and the presence of such pores renders the insulation imperfect.

And the second part of said invention, which relates to a method of avoiding such defect, consists in saturating the cement with paraffine wax, to fill up the pores. In practising the second part of said invention, the iron pin, with its covering of vulcanite, is inserted in the cup, without touching any part of the surface thereof except the bottom of the inside of the inverted cup, and the intervening space is filled with cement, made, by preference, of 1 part of plaster of Paris and 2 parts of Portland cement; but other cement may be used, such as plaster, or Roman or Portland cement alone. After the parts have been united by the cement, the whole is put in a bath of melted paraffine wax, at a temperature of about 224° F., and there left until all bubbling ceases, which indicates that all the water has been expelled from the cement, and that the pores have all been filled. In this way all the pores and interstices are filled with paraffine wax, thereby rendering the insulation more perfect, and as there are no pores into which moisture can lodge, there will be no danger of fracturing the parts by the expansion of water in freezing, as heretofore.

The third part of this invention consists in covering the telegraph-wire itself, at the point of support, and for a distance of a foot or more on each side, with a covering of hard rubber, similar to that placed on the insulator. This is carried into effect in the following manner, namely; first, pieces of ordinary galvanized telegraph-wire are tinned, and then covered with hard vulcanite, in the same manner that the insulated pins are covered, as above described; secondly, these pieces of wire are spliced into the telegraph-wire at each point of support by means of the usual soldered joints. Prior to being used, these pieces are boiled in paraffine wax, and, from time to time, when their surface becomes damaged by the solar actinic rays and exposure, they are washed and rubbed with paraffine oil or coal-tar naphtha, which renews the insulating power of the surface.

These insulators are principally useful where the wires are exposed to the spray of the sea, the rain washing them clean. This oil is very useful with all kinds of insulators, for the purpose of renovating the surface. — *Scientific American.*

ELECTRIC MARINE BUOYS.

M. Emile Duchemin has been for several years engaged in experimenting on the ocean as an electric agent, and has recently arrived at results which may turn out to be important, and which are certainly interesting. The object in view is the construction of a marine pile which shall give a constant current of electricity as long as the elements last. He tried at first with copper and zinc, but the result was not satisfactory; the gas produced sometimes left a non-conducting substance on the surface of the copper, and a polarizing action set in which threatened failure. Lately M. Duchemin has substituted a cylinder of retort-charcoal for the copper, with a plate of zinc suspended in the interior, the whole being connected by a cross-piece of wood, and buoyed by means of cork floats. Several of these piles were thrown into the basin at Fecamp, and the results are thus described by the inventor: "At the extremity of two conducting wires I could produce sparks, and during two months this new electrical generator worked an electrical bell without cessation until a Norwegian vessel by accident destroyed the buoy."

Further experiments led M. Duchemin to the conclusion that by multiplying the number of piles he could increase not only the quantity but the tension of the electric current. This was an unexpected result, and in a certain degree in opposition to the experience of the laboratory; but, as M. Duchemin says, the sea is a basin differing from those used in laboratories; the immensity of its extent, the chemical composition of its water, its incessant motion, all point to the probability of new laws to be studied. The nature of the water of the ocean may exercise a great influence on our planet, and the study of this may possibly change our received ideas respecting the currents which affect the compass. Admitting that the vast basins of the sea are in contact with land containing metallic principles, electric currents may be thus formed which will explain the magnetic action of the earth on the needle.

M. Duchemin has succeeded in convincing the French government that the destructive action of sea-water on metals may be made to produce electrical currents for useful purposes, and experiments are now being carried on to test the subject at the cost of the Marine Department. Experiments tried during the summer of 1866 gave promising results, and at the end of last September, M. Duchemin was summoned to Cherbourg to assist the Commission in its labors. An experiment has been made before the President of the Marine Council of Works, with 3 elements, each about the size of a man's hat plunged in sea-water, at Paris, and a sufficient electricity was produced to keep a Ruhmkorff coil of 16 inches in action, and produce sparks of two-fifths of an inch in length. At Cherbourg, the currents of 7 elements plunged in the sea, after having traversed more than 100 miles of copper wire, made a needle deviate 8°.

The Cherbourg Commission entered upon another kind of experiment to ascertain whether these marine piles would not protect iron from oxidation. When an iron plate, of which the surface had been cleaned, was placed in connection with the positive pole, it soon became completely oxidized, but it remained unaffected when attached to the negative pole. Seven elements, of 16 inches in circumference, sufficed to protect an iron plate, having a superficies of several square yards, for an entire year, and at the end of that period the elements themselves were in good working order. The experiments made tend to show that the zinc employed in his marine piles is capable of preserving from oxidation a surface of iron equal to 18 times its own; but, as the chemical effect depends on the number of pairs, M. Duchemin believes that a much higher result still is to be obtained, the Commission having at present employed but a very small number of elements.

How, asks M. Duchemin, is the different action of the two poles on iron to be explained? The oxygen obtained by electrical action on water possesses energetic principles for oxidizing metals; the hydrogen produced in like manner possesses the contrary power, which, however, is not evinced by hydrogen prepared in the usual manner. A current of ordinary hydrogen passes through a weak solution of perchlorure of iron containing a small quantity of ferrocyanide of potassium without producing any effect, while a current of hydrogen produced from sea-water produces a deposit of Prussian blue.

A somewhat similar effect is observed, says M. Duchemin, in the perchlorure of iron pile invented by himself and used at M. Oudry's great galvano-plastic works at Passy. In this pile the nitric acid is replaced by liquid perchlorure of iron and the acidulated water by sea-water. The advantage of this over the Bunsen pile is that it does not disengage hypoazotic gases, which are injurious to gold and silver deposits.

Among the proposed applications of the marine pile is the preservation of the plates of ships lying in harbor, where, says M.

Duchemin, they suffer infinitely more than at sea. Nothing, he says, is necessary for the preservation of the armor plates but to ensure communication between every part of the cuirass and the negative pole of a powerful pile placed in each basin.

The other applications to which the marine pile may possibly be adapted are: The explosion of submarine mines and torpedoes, experiments with both having been made by the marine administration; the cleaning of ships' bottoms, which M. Duchemin proposed to effect by connecting one pole of a Ruhmkorff coil with the iron plating of a vessel and the other with the sea, which causes the molluscs to quit their hold; the transmission of instructions on board ship; the signalling the depth of water in ports and other places, such as beneath the keels of vessels; the transmission of electric telegrams from ship to ship during naval engagements; for night signals, with the aid of the coil, together with Geissler's tubes; for engraving plates in sea-water by the means of cutting out as with acids; and, lastly, the possibility of using the marine pile not only for illumination of light-houses and beacons, but also on board ship. — *The Engineer.*

LIGHTNING AND ITS EFFECTS.

At the Chicago (1868) meeting of the American Association for the Advancement of Science, Prof. Stoddard read a paper on the "Nature of Electric Discharge."

That theory seems very unwieldy which conceives of electricity as two fluids imponderable and indefinitely rare, quiet when united but intensely active when separated, and that all the violent effects are due to the transfer of the fluids through bodies, and this conception constantly manifests itself in the statements of the laws and phenomena of electricity.

Few, it is believed, will object at present to the view that the electric force is molecular; that, whatever doubt may exist as to its precise nature and mode of operation, it is connected with and acts by and through those particles which chemistry contemplates as atomic; that whatever changes or disruptions are wrought by it are operations going on among these atoms; and that electric discharge is not the transfer of matter, but of some change along the line of discharge, producing other correlated forces. All electrical excitement preceding discharge is the state of induction, transferred according to Faraday, along lines of particles to other bodies. This condition is one of tension, and the tendency of the particles is to undergo some change antagonistic to cohesion, and consequently resisted by this force. As long as cohesion can resist the electrical force the condition is statical. If the tension rises to a sufficient degree, the particles yield and undergo the change which the force requires. This is discharge.

The change, in which consists discharge, will be violent in proportion to the degree of tension, and the character of the change will depend upon the nature of the body. The substance may be split, torn asunder, as in trees; ground to powder or fractured, as in glass or other brittle bodies; melted as in metals, or chemically separated, as in compound bodies. These various actions are the equivalents of the electric force, and are its correlated forms.

The energy, in that particular form we call electricity, has, in each of these cases of discharge, been expended. As a cause, it has acted, and as such has disappeared. Its further existence must be sought for in its effects. The mechanical and chemical separations, the heat and the light, are all so many evidences of the electric force and exact measures of it.

That all these changes are the results of molecular displacements seems plain from the effects. When passed through a thick plate of glass, the discharge pulverizes, along its track, the glass to an impalpable powder. A violent separation of particle from particle has taken place, as if the molecular spaces were filled with an explosive substance. A blow from a hard body, or from a fluid that would drive the particles before it and leave a clear opening. Each particle is so disrupted from the adjacent ones as to break up the cohesion, while none are thrown off except at the surface, where there is no force to counteract the explosive action. The pulverized atoms must occupy more space, and naturally press outward in the direction of least resistance. The burr on both sides of a card merely indicates the strong molecular repulsion acting from within outward. The imprisoned air in bodies of loose texture will have its influence; but the double burr will be produced in their plates of wax, in which air cannot be present in sensible quantity. When a tree is riven by lightning, the splintering is caused by the repulsive energy acting along the line of discharge. If the fibres of the wood, when the fracture takes place, had been changed to gunpowder or gun-cotton, and exploded, the results would closely represent those effected by electricity. So when a body is melted by the discharge, the heat in producing liquidity certainly acts upon the molecules. But it is unreasonable to suppose that the heat is developed by the discharge merely on the surface, and then passes inward by the slow process of conduction. On the contrary, it flashes into intense energy, at the same instant, among all the particles of the mass. The inconceivable rapidity of the change caused by electricity, leaves no time for conduction.

That chemical affinity is a molecular force, no one, it is presumed, will doubt. But the very intimate relations of the chemical and electric forces, so much so as to induce in some minds a belief of their identity, will hardly permit us to assign a molecular character to one and not to the other. The light which pervades the atmosphere for some distance around the point where lightning strikes the earth, does not seem, from the cases the writer has witnessed, to be a gleam or reflection from the brighter track of the spark, but rather a light produced in the air, for some distance around, by molecular disturbance, the same in kind, but less in degree, as that which rivals sunlight along the central path. A green tree, at which the writer happened to be looking the moment it was struck, was covered from top to bottom with a diffused flame, in the midst of which the central stream of fire gleamed in tortuous course along the trunk. It is not to be supposed, however, that the electric induction, and the tension caused by it, which precede discharge, exist only along the line of violent action.

The line of discharge may be considered the resultant of the electric tension for some distance around, and along this line is experienced, at the moment, all the accumulated force from inductive action.

The violently disruptive effects which sometimes occur, are adequately explained by the heat produced along the line of discharge.

No other known agency generates heat so suddenly and of such intensity as the electric force. The reason is plain. The electric force, being itself molecular, develops, or, as some would prefer, is converted into heat at the same instant throughout the whole body, and its explosive power is exerted simultaneously between all the particles, and needs no transfer by conduction. The violence with which some chemical compounds explode is proportional, other things being equal, to the consentaneousness of the action among the particles.

Allowing the velocity of electricity to be the same as that of light, the time in which a coin or metallic bullion on the person would be melted is inconceivably short, less than the twelve-billionth part of a second. The same explosive action expended on the air causes the terrific sound of thunder. Near the path of discharge, it is a crash, sharp, spiteful. At a distance, it is toned down by the elasticity of the air into a roar which shakes the very earth. It seems strange that some writers should attribute the sound to the collapse; it is but the reaction from the condensed air around the line of displacement, and of course cannot exceed the force of displacement. The latter, then, is the primary cause of the sound; the collapse only repeats the undulation with some loss of force.

Surprise is sometimes expressed that the human body, when struck, is not torn or burned. The electricity is a good deal diffused through so large and so good a conductor, but the texture of the body is of such a nature, composed of porous, elastic solids filled with liquids, that its particles readily yield to the requirements of the force without disruption.

The mechanical, and perhaps chemical, disturbances on the nervous system, even if there be no other, are quite sufficient to account for the fatal effects of the electric shock. The experience of the writer was, that a discharge from a battery of 12 jars of 1 gallon each, passed through the length of the body, is best expressed by the phrase, "a stunning blow."

If these general laws be correct, precautions for safety should conform to them. A lightning-rod is intended to afford a ready passage between the cloud and earth to any electricity which may be accumulating. If it discharges the electricity as fast as it is generated, then there can be no collection in quantity or intensity sufficient to cause violence. The rod is a good conductor; that is, its particles readily assume the conditions required for discharge; hence it offers a comparatively unobstructed channel for the passage of the electricity, and, of course, prevents any dangerous accumulation. The rod anticipates the danger; it gradually and safely transmits to earth an amount of electric energy which, if discharged at once, would have manifested intense violence. If the powder in a cannon were burned grain by grain during a few seconds, it would not even move the ball, and yet the same force has been expended as when exploded at once. He had been inclined to consider the electricity of the cloud to bear to that of the earth the relation of intensity to quantity; that an equivalency of force may exist between all. Quantity in the galvanic battery has its equivalent force in the intense flash of the induction coil. It may also be admitted that quantity in the earth is represented by intensity on the points of the rod. In this case, an identity of action is established between the points and the cloud. It need hardly be said that to insulate a rod from the building it is intended to protect is useless, if not worse. The house is in a state of electric tension as well as the rod, and the object of the rod is to relieve all such tension. To do this it must be in electric communication with the house. Indeed, the insulation is after all a sheer pretence, and is practically impossible, for the building and rod are connected through the earth. If the roof is metallic all the better. It affords surface to diffuse the force, and sharp edges and innumerable points to discharge it. No better rod can be constructed to connect such a roof with the the earth than its water conductors. Pass iron or copper rods from these into moist earth, or better, connect with the water-pipes of a city, or the water of a well, or the gas-pipes, and insurance against lightning would be profitable to the company insuring.

LIGHTNING-RODS.

At the 1868 meeting of the American Association, Mr. James Bushee presented a paper on the defects of lightning-rods.

The use of metallic rods for the protection of life and property from the destructive effects of atmospheric electricity is acknowledged to be efficient when the laws of electrical science are regarded. The writer of the paper had had various opportunities for observing the effects of lightning, and his attention was early called to the singular fact that a large majority of the buildings struck and injured were those having rods attached, and instances have occurred where houses with rods have been affected with the current, while houses in the vicinity, without rods, have escaped. Hence some had doubted the efficacy of lightning-rods, and others had rejected them altogether as wrong in principle and positively dangerous. The writer believed, however, that there was, in these implements, a remedy for the effects of lightning.

The question thus arose, What is the cause of the numerous casualties from lightning where rods are used, and how, if possible, can such disasters be prevented? To answer this question he had for 10 or 12 years examined the cases occurring in Worcester, Mass., and the adjoining towns, as well as elsewhere, as well by personal visit as by correspondence. The result appeared to be that buildings have been struck and more or less injured, irrespective of any particular kind or style of rod now in use, whether of iron or copper, and that the great defect of rods in general is due to: —

1. The construction of the rod and its arrrangement on the building.

2. To its imperfect connection with the earth.

In regard to the first defect, he referred to the common practice of erecting two or more points on the roof, each, perhaps, being attached to a chimney, and connecting these in a single rod extending to the ground. In instances of injury where such a rod was used he had almost invariably found that the point of lateral distance would be at or very near the point of junction where the arms entered the main rod. Electricity may be regarded as a dynamic force, bearing a striking analogy to other forces in nature which are governed by well-known dynamic laws. So far, then, as this analogy seems to hold, it may be cautiously used as a guide to correct conclusions. Suppose a heavy charge to be received at the same time upon each arm of the rod. The different forces pursuing their respective channels rush together at the point of junction, where the intensity is greatly increased, where the single rod below, being no larger than either branch, and having but half the conducting power of both, is unable to carry the double charge so suddenly imposed upon it; hence a portion of the burden is compelled to seek an unnatural mode of conveyance through the building. This arrangement, then, is equivalent to taking away half the conducting power of the rod, hence, increasing, in the same ratio, the liability of a disruptive discharge. If the rod from the ground were enlarged in proportion to the number of points, the objection would be considerably removed.

The mode of connecting the conductor with the ground was next considered. It is the common practice to run the rod into the ground from 3 to 6 or 8 feet, or until it is supposed to reach the moist earth, this being generally considered sufficient for all practical purposes.

Observation, however, proves that the loam, sand, or gravel which comes in contact with the rod in ordinary cases is entirely inadequate in conducting power to convey a heavy charge of electricity from the rod into the earth, with anything like the facility with which it is discharged from the cloud to the rod.

The writer had no hesitation in believing that nine-tenths of the casualties which had come to his notice, where the conductors had failed to accomplish their purpose, were due to an overcharge of the rod caused by the resistance of the electricity in its passage into the earth. The receiving power of the rod exceeds the discharging power. A channel is open through the pointed conductors for a free passage of electricity from the cloud to the rod, but no adequate means is provided for its escape to the earth. The rod thus becomes a reservoir of electric force of great intensity, and when the tension is forced beyond certain limits a portion of the charge breaks away from its proper channel. There is generally no enlargement of the rod or extension of surface where it enters the ground, but merely a continuation of the small rod used on the building, thus presenting a very limited surface to the imperfect contact of imperfect conducting materials, which must impose great resistance to the free exit of the charge. The effect of resistance would be more clearly brought out when it was considered that water had sometimes failed to dissipate the charge as freely as it was conveyed from the cloud to the rod. In some cases the glass insulators are broken, and sometimes large quantities of earth are thrown up where the rod enters the ground, and generally a lateral discharge injures the building to the hazard of life.

If every obstruction to a free escape of the charge to the earth could be removed, he believed that casualties from lightning would be comparatively rare, even if the rods in general use should be left in other respects as they now are.

INCREASE OF THE QUANTITY OF ELECTRICITY FROM INDUCTION COILS.

In volume xv. of the "Proceedings of the Royal Society," Rev. T. R. Robinson treats of the means by which an increase in the quantity of electricity may be obtained from induction coils. To increasing the power of the exciting battery, there are the objections of injury to the acting surface of the contact breaker, and disproportionate minuteness of effect beyond moderate limits; if we make the outer helix of larger or thicker wire, we find that length gives no increase in quantity, while that obtained by thickness soon reaches a limit. The best method is to combine several coils collaterally, in a manner analogous to that in which galvanic cells are united for quantity.

He arrives at the following general results: 1. Two helices in series give no increase of quantity, though their intensity nearly equals the sum. 2. The quantity of helices connected collaterally equals the sum of their separate effects. 3. The quantity increases with the diameter of the wire, to a maximum reached when this is about one-sixty-fifth of an inch. 4. Helices on different primaries combined produce more effect than when on the same primary.

ELECTRICITY WILL NOT PASS IN AN ABSOLUTE VACUUM.

It is now well established that the electric spark will not pass through an absolute vacuum. M. Gassiot made a vacuum in his apparatus by filling it with carbonic acid and exhausting by the ordinary process, the residue being then absorbed by caustic potash. By the new process of the Alvergniat Brothers, in which a vacuum is produced by means of a mercurial air-pump of their contrivance, this result is shown in an easier and more rapid manner. In a half hour an almost absolute vacuum is produced in a tube provided with 2 platinum wires, placed at a distance of 2 millimetres, or about .08 of an inch. When the requisite tension is obtained, the tube is heated to redness by charcoal or Berthelot's lamp; when the vacuum is so complete that a spark will not pass, the communication is closed between the tube and the machine. The electric spark in such a tube will not pass from one platinum point to the other over the above small interval.

TELEGRAPHIC FEATS.

On February 1, 1868, the wires of the Western Union Telegraph Company from San Francisco to Plaister Cove, Cape Breton, and the wires of the New York, Newfoundland, and London Telegraph Company from Plaister Cove to Heart's Content were connected, and a brisk conversation commenced between these two continental extremes. Compliments were passed between San Francisco and Valentia, Ireland, when the latter announced that a message was just then being received from London direct. This was said at 7.20 A. M., Valentia time, Feb. 1. At 7.21 A. M., Valentia time, the London message was started from Valentia to San Francisco; passed through New York at 2.35 A. M., New York time; was received in San Francisco at 11.21 P. M., San Francisco time, Jan. 31, and was at once acknowledged, — the whole process occupying 2 minutes' actual time, and the distance about 14,000 miles. Immediately after the transmission of the above message, the operator at San Francisco sent an 80-word message to Heart's Content in 3 minutes, which the operator at Heart's Content repeated back in 2 minutes 50 seconds, — distance about 5,000 miles. — *New York Journal of the Telegraph.*

On the wires of the Western Union Telegraph Company, 94 messages of 20 words each were transmitted from Washington to Cape Breton by one wire in an hour. On the same day 33 messages were sent in as many minutes from Cape Breton to New Orleans.

TREATMENT OF TUMORS BY ELECTRICITY.

From the well-known facts that a slight occasional current of galvanism will develop a muscle, while the continuous use of the same current will, by over-stimulation, cause it again to waste, it occurred to Dr. M. H. Collis that the absorption of tumors might be brought about by this agency. After trying various forms of battery, he returned to the simple voltaic pile, composed of a dozen or more couples of zinc and copper, 1½ inches square, or of small cylinders or plates of wood covered with felt and wrapped round with zinc and copper wire. These are excited by salt and water, or by sulphuric acid in the proportion of 1 to 20 parts of water. The batteries of wire coiled on wood are much the lightest, and more convenient in proportion to their strength; they preserve their activity sufficiently, and do not wear out so soon as the voltaic pile of zinc and copper plates; as many or as few as are desired can be used without delay in arrangement. A very strong current, either as to quantity or tension, is not required. A small quantity is sufficient to excite the nerves of the blood-vessels; and there should be just tension enough to insure that the current pass through the part to be acted on, and not merely round by the skin. It is believed that this is a medical agent of considerable energy, and capable of yielding results of such importance as to warrant its frequent use. — *British Medical Journal.*

NEW FORMS OF GALVANIC BATTERIES.

At a meeting of the Chemical Society, in February, 1868, Dr. De La Rue described a small voltaic battery of 10 cells, constructed by Dr. H. Müller and himself, on a new principle. The negative element was chloride of silver fused around a central silver wire, which served as a conductor; this was bent over and connected by means of a small caoutchouc band to a rod of zinc, which need not be amalgamated. The exciting liquid was salt water, which in course of time became charged with chloride of zinc, and required to be renewed only when metallic zinc began to be deposited on the negative plate. Ten of these little couples, 3 inches or less in height, were mounted on a wooden frame supported and sliding upon glass uprights, so that the battery was very easily put in action. Its tension was so great that a cubic inch of the mixed gases was given off from water in about 20 minutes.

Constant Battery. — Boettzer has constructed a galvanic battery of such constancy that it retains its activity for several years. It is admirably adapted to the working of electric clocks, ringing electric bells, and the requirements of electro-metallurgy. Each cell consists of a cylinder of thick plate zinc, enclosed in a glass jar. In the centre of the cylinder is placed a bar of compact coke, and the intervening space is packed with a powder composed of a mixture of equal volumes of pounded sulphate of magnesia and common salt, moistened with a saturated solution of these two substances. The salt mixture is moistened from time to time. — *Artisan.*

New Portable Battery. — A new form of carbon Smee battery, adapted for transportation, and for use where an escape of acid would be very objectionable, is described, with a figure, in the "Journal of the Franklin Institute," for February, 1868. A short test-tube, or like vessel, contains the dilute sulphuric acid or acid sulphate of mercury, which is employed as an exciting fluid, and is closed at top by a zinc cover, having a piece of soft rubber beneath it to secure a tight joint, and held in place by an elastic band attached to hooks or lugs, passing under a block in which the tube or vessel is set. The elements, zinc and carbon, are suspended from the cover, the carbon being insulated by a rubber washer. The connections between successive cells are made by spiral springs of brass wire, which are thrust over conical points, attached to each element. The elements do not enter the liquid when the cell is in an erect position, but action is established by inverting the apparatus. A battery of 95 such cells operated in a most satisfactory manner. In connection with telegraphic instruments it produces remarkable effects, and in medical use occasions contractions that no induced current will produce.

Manganese Battery. — A battery, composed essentially of peroxide of manganese and a single liquid, chloride of ammonium, has been recently constructed by M. Leclanché, and, according to "Les Mondes," has been already somewhat extensively adopted, or, at least, taken on trial by several telegraph companies on the Continent. It has been long known that peroxide of manganese possesses an electric conductivity similar to that of metals. The author uses only the natural crystalline peroxide of the purest quality. This is broken up and placed in a porous vessel, where it surrounds a carbon plate, forming the positive pole of the battery; the negative plate outside the porous vessel is simply a thick rod of zinc; the liquid which bathes both plates is a concentrated solution of sal-ammoniac. It appears to be a very constant form of battery, and exceedingly economical.

Battery of Iron and Sulphuric Acid. — The cylindrical glass vessel holds a cylinder of wrought or cast iron, within which is placed a prism of carbon, and water acidulated with oil of vitriol. Two pairs are sufficient for working an ordinary electrical bell. These elements are very cheap, and, if the liquid becomes concentrated, it may be used in another battery, where the cylinder of iron is replaced by one of zinc.

Battery of Zinc and Ferrous Sulphate. — By introducing a zinc plate or cylinder into a concentrated solution of ferrous sulphate it will dissolve under disengagement of hydrogen, and hydrated ferric oxide will be precipitated; carbon being used as before within the zinc. Two of these pairs will last two days for a common house-bell.

Copper and Zinc. — The bottom of a wide-mouthed bottle is covered by a disk of copper, to which is attached a copper wire, and which is covered first with dry, powdery carbonate of copper, and then with a disk of felt or cloth. The remaining space within the bottle is filled with sand, the whole covered by a zinc disk with another copper wire. The contents are then moistened by a solution of muriate of ammonia (20 per cent.) in water, and the flask hermetically closed. On closing the current, the salt, before unaffected, will be decomposed into muriatic acid, which passes to the zinc-pole, and into ammonia, by which latter the carbonate of copper is rendered soluble; and by its decomposition this latter produces a secondary current equal in intensity to a pair of Daniell's. This instrument, therefore, consumes its material only as long as it is in activity, and it has of late been prepared for use on several French railroads.

Balsamo's Battery. — M. Balsamo has presented to the French Academy a battery, both elements of which consist of iron, the one being immersed in a solution of chloride of calcium, the other in diluted sulphuric acid, — the two solutions being separated by a porous cell. The iron in the sulphuric acid acted as the positive element, and the other as a negative. A constant and quite an intense current is obtained by this arrangement. Another novel battery, termed an "electric buoy," is now being experimented upon at Cherbourg. It consists of a zinc plate and a cylinder of carbon, attached to a cross-piece of wood, having sea-water as an exciting liquid. Still another variety is that of M. Miergue, of Bonfarik, consisting of a cylindrical cell of porous carbon, containing nitric acid, and an exterior cylinder of amalgamated zinc in a cell full of water.

New Galvanic Exciting Liquid. — M. Delamier, in a communication to the Academy of Science, states that the following mixture forms an exciting liquid for galvanic batteries of great energy and economy, disengaging no deleterious fumes or gas. Dissolve 20 parts by weight of proto-sulphate of iron in 36 parts of water. Then stir in 7 parts of a solution of sulphuric acid (equal parts); then in the same manner add 1 part of diluted nitric acid (equal parts).

TRANSMISSION OF SOUND.

From the observations of M. Flammarion, as taken in a balloon, it appears that sounds produced on the surface of the earth are transmitted upward to great heights. The whistle of a locomotive is heard 3,000 metres high; the noise of a train of cars, 2,500; the barking of dogs and the report of a musket, 1,800; the sounds of a town (including the crowing of the cock and the ringing of bells) often 1,600; the beating of a drum and the tones of an orchestra, 1,400; the rumbling of carriages on a pavement, 1,200; a loud human voice, and, in a very still night, the rushing of a river, 1,000; the croaking of frogs 900; and the chirp of the cricket 800 metres. This is not true of sounds proceeding from above downward; for while he could hear a voice speaking 500 metres below, his own voice could not be clearly distinguished more than 100 metres below. On one occasion, when the balloon was 900 metres high, was heard a piece of music, executed very nearly beneath, as distinct and perfect as if only a few metres distant; the parts could be clearly distinguished even at a height of 1,400 metres; this observation was repeated 5 times, and he noticed the permanence of the intensity of all the tones, which were transmitted with the same quickness and reproduced the music at this height in perfection. The clouds did not oppose any obstacle to the transmission of sound. — *Comptes Rendus, July*, 1868.

VELOCITY OF SOUND IN TUBES.

M. Kundt has established that the velocity of the propagation of sound diminishes with the diameter of the tube, — the diminution, however, only becoming sensible at a diameter equal to one-fourth of the length of the wave of sound or note yielded. Above this diameter, and in larger tubes, the velocity remains the same.

He finds also that the diminution of the velocity of sound in tubes full of air increases with the length of the wave of sound. He further has established that fine powder (as the extremely light powder from dried gelatinous silica), in the interior of a large tube, had no effect on the velocity of transmission, while in tubes of small diameter the velocity decreased in proportion to the quantity and lightness of the powder. He finds, finally, that the velocity of propagation in a tube is not influenced by the intensity of the sound, nor by the roughness or smoothness of the interior.

NEW FACTS IN ACOUSTICS.

M. Regnault, of the Institute of France, has been making use of the new sewers of Paris for the purpose of testing, on a large scale, some of the questions in acoustics concerning which there has been much doubt. By firing a pistol in tubes and sewers of various diameters, he found that the sound was carried to the following distances: 1,282 yards in a passage of 4.2 inches diameter; 4,191 yards in a passage of 11.8 inches diameter; 10,494 yards in a passage of 43 inches diameter. The nature of the materials and the construction of such passages exercise great influence on the rapidity with which sound is transmitted. In the large Paris sewers, trumpets are used to convey orders to the workmen, and it is found that in those passages whose sides are cemented, the sound is conveyed to a much longer distance than in others whose sides are left as first constructed, with the rough stones only. It is one of the primary principles laid down in text-books, that the velocity of the vibrations of sonorous bodies in the same medium is the same for all sounds, grave or sharp, strong or feeble, and whatever may be their pitch; but the researches of M. Regnault would seem to show that this generally received belief is not correct. He asserts that sounds of different pitch are not propagated with equal rapidity but separate from each other on the way.

Acute sounds, also, travel with less swiftness than grave ones: thus, when a barytone sang in very long sewers, and at the entrance of water conduits, the key-notes were heard at a distance before the harmonics which succeeded it and one another, according to the degree of their altitude. The propagation of sound consequently disarranges the harmonics of which it is composed; thus an air, embracing a certain extent of the gamut, if heard at a long distance, would be seriously altered. This decomposition in tubes may be on account of the friction caused by the sides of the tube or passage-way, and cannot be noticed in the open air. The facts propounded by M. Regnault will cause the philosophers to renew their investigations with renewed interest. — *Scientific American.*

VIBRATIONS OF SOUND RENDERED VISIBLE.

M. Tréves has made the following curious mechanical experiment: Two steel tuning-forks, brought to the same pitch, were topped with small mirrors, and placed opposite to each other in 2 vertical planes at right angles. One of them, No. 1, was, moreover, surrounded with a strong coil of wire, receiving an electric current from a nitric acid pile composed of 4 elements. A fiddlestick being now drawn across each of the tuning-forks, the vibrations commenced, and immediately a perfectly motionless luminous circle was produced in the mirror of No. 2. But no sooner was No. 1 magnetized by the admission of the current, than the circle became an ellipse, and swayed to and fro, denoting the action of a new vibratory motion. As soon as the current ceased the figure became a fixed circle again. This experiment may serve to investigate the vibratory powers of iron and steel according to their composition and physical state. — *Galignani.*

INSTRUMENT FOR ANALYZING SOUNDS.

An instrument has been exhibited before the Academy of Sciences, called by its inventor, M. Daguin, an "analyzing cornet." What we describe as noise is of course made up of an infinite number of musical notes, and these the cornet is designed to analyze, just as a prism separates a ray of white light into its colored components. In appearance the instrument resembles a trumpet, having a nozzle to fit into the ear instead of a mouth-piece, and furnished with holes like a clarionet. Provided with one of these instruments, the roaring of a cataract or the howling of the winter's blast may be resolved by the listener, skilled in the necessary fingering, into the softest melody, which, of course, is heard only by himself.

MUSICAL TELEGRAPH.

Mr. Wm. Boyd, of Cambridge, Mass., has invented and matured a system of telegraphy by sound, which may yet be brought into familiar use. The special feature of the scheme is the adoption of the 4 sounds of the common chord of the natural major key (or the corresponding notes of any other major key), namely, C, E, G, C, or do, mi, sol, do, or 1, 3, 5, 8; the last being the mode by which they are designated in this alphabet. These 4 sound letters, never more than 3 being used at once, admit of a variety of 84 combinations, representing the letters, points, marks, figures, and word-contractions which compose the alphabet. The letters and points most frequently used are represented by the lowest numbers, and consequently the fewest sounds. For instance, the letter E is represented by the tone 1 or C; T, by the tone 3 or G; O is made by the combination 11 or CC; K requires 3 sounds, and is represented in the alphabet as 153, or in tones by CGE. To give a more extended example, we take the word "alphabet," which is easily readable by sounds as follows:

	A	L	P	H	A	B	E	T
	5	35	133	18	5	138	1	3
or	G	EG	CEE	CC^2	G	CEC	C	E

Mr. Boyd's system could be readily and profitably used as a code of signals, either land or marine; and is equally adapted for church-bells, steam or air whistles, or for a key-bugle, or cornet-à-piston, or any other far-sounding diatonic instrument.

SUMMARY OF NEW FACTS IN NATURAL PHILOSOPHY.

Observing the Bessemer Converter Flame. — At the Atlas Steel Works, Glasgow, a very neat contrivance has for some time been used for enabling the observer to determine the point when the combustion of the carbon is completed. A square, thin frame contains a combination of colored glasses; for instance, one dark yellow and two blue, or any other colors giving together a very dark neutral tint. Looking at the flame through these glasses affords the double advantage of preserving the eye from unpleasant effects of the intense light, and of making all smoke and other disturbing changes invisible. The flame, when thus viewed, looks white so long as the intense brilliancy due to the burning up of the carbon continues, but changes to a deep red at the moment all the latter has been consumed.

The Spectrum Reconstructed. — Prof. Listing, of Gottingen, considers the solar spectrum as made up of nine colors, in the following order: brown, red, orange, yellow, green, blue, indigo, violet, and lavender. He has also calculated the number of vibrations of each, and has found that their numbers constitute an arithmetical progression; the interval between one color and the next always being 48,524 billions of vibrations per second. The number of vibrations constituting the two extreme colors are represented by 364 trillions for the brown, and 801 trillions for the lavender.

Shadows from Transparent Bodies. — By means of the electric light a piece of glass can be made to throw a perfectly black shadow. This will be the result, provided the two surfaces through which the ray passes are not perfectly parallel, the deepness of the shadow depending upon the variation.

Influence of Colored Light on the Decomposition of Carbonic Anhydride by Plants. — According to Cailletet, the red and yellow rays of light are the most favorable for this decomposition. Light which has passed through a solution of iodine in carbonic disulphide prevents decomposition altogether. Under the influence of green light not only does no decomposition take place, but new quantities of carbonic anhydride are formed. A fresh leaf exposed to sunlight, under a bell of green glass, exhales nearly as much carbonic anhydride as it would in the dark. — *Comptes Rendus.*

Effect of Artificial Light on the Green Color of Plants. — M. Ermins, in the "Revue Horticole," records the following fact: Some lilacs were placed for forcing in a heated cellar, partially lighted with gas; those leaves that were exposed to the light became green, as if they had been in the open air, while the remainder were etiolated.

Light from Metallic Carbons. — M. Carré recently exhibited to the French Academy some of his metallic carbons, or carbons impregnated with iron, antimony, etc., which were found to give a light over one-third more powerful than that obtained from the ordinary carbon employed for the electric light.

Annual Amount of the Sun's Heat on the Earth. — Pouillet has made observations with a pyrheliometer, from which he estimates that the amount of heat annually received by the earth from the sun would melt a crust of ice surrounding the earth 101 feet thick.

Internal Stratum of Invariable Temperature. — The heat which the earth receives from the sun does not penetrate more than from 50 to 100 feet. At Paris this stratum of invariable temperature is found at a depth of 86 feet.

Power of the Sun's Rays. — A lens has recently been made for Mr. Parker, of London, 3 feet in diameter, 3 inches thick in the centre, and weighing 212 pounds. In the focus of this powerful lens the most refractory metals are almost instantly fused and completely dissipated in vapor, while unyielding stony substances are as readily vitrified.

Fusion of Glass. — Herr C. Sching has shown, by the application of the thermo-electric pyrometer, that the temperature of a glass furnace in operation is only from 1,100° C. to 1,250° C. Crystal glass becomes completely liquid at 929° C., and is worked at 833° C. A Bohemian glass tube softens at 769° C. and becomes liquid at 1,052° C. Pure limestone loses its carbonic acid by heating for several hours at 617° C. to 675° C. The gas can be driven off more rapidly by increasing the temperature.

New Pyrometer. — A new pyrometer of English make, designed by M. Wood, of the Tees Iron Works, consists of a metallic tube connected at one of its extremities to a pillar of porcelain, and at the other with an index on a dial, upon which the degrees of heat are measured. When used, the instrument is held over the aperture of a blast furnace, and the heated air passing through expands the tube longitudinally, and the difference in length as compared with the porcelain standard is indicated on the dial. In a recent experiment, the temperature was registered from 66° F. to 1,200° F. in less than a minute.

Heat from Friction. — Mr. Addy exhibited, at a recent meeting of the Massachusetts Institute of Technology, an iron step which had supported a mill-stone weighing 1,200 pounds, and revolving from 100 to 120 times per minute. The shaft was of iron, about 2 inches in diameter, surrounded by a ring of hardened steel three-eighths of an inch thick. After running with the above speed for several months, it suddenly broke down, twisted off. On examination the steel and iron were found to be on one side firmly welded together, from the heat generated by friction, probably from a lack of lubrication.

Temperature of Regelation. — Prof. Edward Hungerford, of Burlington, Vermont, at the 1868 meeting of the American Association, gave an account of some experiments on snow and ice at a temperature of below 32° F. The main point was to show that it is not necessary for the reunion of broken ice and snow into a compact mass that any portion of the mass should attain a temperature above the freezing-point. He thought, from his experiments, that the theory of Professors Tyndall and Forbes of regelation is not correct, and is not necessary to explain the movement of glaciers. He thought, also, that the snow at the summits of mountains might be converted by pressure into glacier ice at temperatures far below the freezing-point of water.

Effect of Surface on Radiation. — The following experiment was made recently, by Mr. Balfour Stewart, at the Royal Institution. A cannon-ball with chalk-marks upon it, and a tile with a white and black pattern, were heated to redness and viewed in a darkened room. It was found that the black parts of both objects emitted more light than the white ones.

Trees vs. *Evaporation.* — Trees should not be cut away from the borders of ponds, as they protect the water from evaporation. In the summer of 1864 a calculation was made, which showed that in 40 days the evaporation of an unprotected pond, containing about 14,000 gallons of water, was 9,000 gallons; as much, in fact, as would have supplied a flock of 500 sheep for the time.

Heat Generated by Magnetism. — If a magnet, its poles pointed upward, be made to revolve rapidly in a vertical axis below a small copper plate, on which is placed a glass flask, the temperature in the flask is sensibly increased; it is believed, that in a copper vessel containing water sufficient heat may be generated by the rapid rotation of the magnet to make the water boil.

On the Electric Conductivity of Platinum, as affected by the Process of Manufacture. — Mr. C. W. Siemens gave in a paper before the British Association, in 1868, the results of experiments which hat been made in fusing and condensing platinum, from which it ap peared that platinum, which had been obtained by fusion, differed from platinum which had been obtained by condensation; that between platinum at 80° and platinum at 100°, the variation was in the one case 26 per cent., and in the other, 28 per cent., and that in dealing with platinum it was necessary to discriminate very carefully between condensed and fused.

Perforation of Glass by the Electric Spark. — Mr. E. S. Ritchie exhibited before the Massachusetts Institute of Technology, an inch cube of clear glass, which had been perforated by the Rhumkorff electric spark, which he has succeeded in obtaining of a length of 14 inches. He can perforate in this way glass 1⅝ inches thick, but the apparatus must be arranged in a peculiar manner, or the spark will go over instead of through the glass. The spark will not go through twice in the same place, but make a new passage each time.

Electrical Experiment. — M. Becquerel, in making some researches into the subject of the dialysis of the electrical currents, lately found that in passing discharges from an induction coil, between the upper surface of a saline solution, contained in a glass tube, and the extremity of a platinum wire fixed at a short distance, the spark was surrounded with a cloud, colored according to the sort of salt used in the experiment.

Electricity of Steam. — In investigating the electricity of steam, Faraday found that dry steam gave no excitement, and that the electricity resulted from the friction of the vesicles of water against the sides of the orifice.

Collection of Electricity from the Air. — An English gentleman, by means of a mile of insulated wire, sustained on poles 100 feet high above the tall trees of his park, has collected, during a heavy fog, enough free electricity from the atmosphere to charge and discharge a battery of 50 jars and 73 square feet of coated surface, 20 times in a minute, with a report as loud as a cannon.

Magnetic Disturbance during Volcanic Eruptions. — Professor Palmieri, of Naples, who is engaged in making observations on all phenomena connected with the last fire outbreak of Mt. Vesuvius, states that he has never seen the magnetic needle so frequently or seriously disturbed as it is at present, and the seismometer records at least 10 distinct earthquake shocks daily.

Study of Longitude by Telegraph. — The actual difference of longitude between Washington and Havana, as demonstrated by recent communication for the purpose, over the cable, is 5°, 21′ and 8 2-10″. The time occupied in the passage of electricity between the two cities is thirty-five one-hundredths of a second.

Tungsten Steel Magnets. — In a recent lecture, Mr. C. W. Siemens spoke of the remarkable effect of tungsten upon steel, in increasing its power of retaining magnetism when hardened. A horse-shoe magnet of ordinary steel, weighing 2 pounds, is considered of good quality when it bears 7 times it own weight. The famous Haarlem magnet supports 13 times its own weight. But Mr. Siemens has succeeded in producing a similar horse-shoe magnet, of tungsten steel, which will carry 20 times its own weight, suspended from its armature.

Facts in Telegraphy. — In France, the greatest distance over which a telegraphic message can be transmitted is about 600 miles; in Prussia, about 500; in Belgium, about 160; in Switzerland, about 200 miles. The charge for a message of 20 words, over the greatest distance, in France, is 1s. 8d.; in Prussia, 1s. 6d.; in Belgium and in Switzerland, 5d. In Great Britain, 2s. is charged for the transmission of a message over 500 or 600 miles, and 1s. 6d. for any message sent 160 or 200 miles.

Expansion of Petroleum. — According to M. Deville ("Comptes Rendus") petroleum increases in bulk by one-hundredth of its volume for every 10° C. of heat. A due allowance for this expansion is necessary in storing petroleum for fuel, or the casks may be burst and destructive explosions ensue.

Strength of the Wind. — In observatories generally anemometers are made to register a force of 45 lbs. to the square foot, 36 lbs. being set down in the charts as a "violent hurricane." In the new Liverpool observatory, after the experience of the great storm of December, 1863, the anemometer sheet was made to register 60 lbs., which was supposed to be ample for any gale in that latitude. On February 1, 1868, after two days of a north-westerly storm, the registering pencil went far beyond this limit, and it is estimated up to 70 or 80 lbs. to the square foot, — a pressure probably rarely exceeded by the gales of the West Indies. The barometer stood at 29° at the time.

Tides at Hell Gate. — At the last meeting of the National Academy of Sciences, Mr. Henry Mitchell presented a paper on the tides of Hell Gate. It is new, and deeply interesting to New York merchants. It goes to show that the two tides entering by Sandy Hook and Hell Gate form there a tide neither the sum nor more than the sum of the two, but of an intermediate depth. If the tides met there at the *full* it would be different, but one is 4 hours behind the other, and 65 per cent. of the whole tide is the result. Looking at the increase of Sandy Hook, it is clear that Hell Gate acts as maid-of-all-work to the harbor and sweeps its floors clean. In fact, the tidal circulation of Hell Gate is the life-blood of the harbor and saves it from destruction.

CHEMISTRY.

ORGANIC CHEMISTRY.

At the 1868 meeting of the British Association, Mr. Alfred R. Catton read a paper on organic chemistry, which commenced by giving a brief *resumé* of the results described in the reports presented by him to the Association at the Nottingham meeting in 1866, and at the Dundee meeting last year, and of the objections which had been raised as to those results and the manner in which they had been obviated.

In consequence of these objections, and the admitted difficulty of the research, and in consequence of the liability to error therein, it was considered desirable that the research should be commenced *de novo*, and that Dr. Anderson, Professor of Chemistry in the University of Glasgow, be invited to aid the author with his advice and assistance; and the results presented in this report had received his approval.

Taking into consideration the nature of the objections which had been made, it was considered to be of the greatest importance at the outset to try to obtain the products produced synthetically in the reaction in quantities which formed a much higher percentage of the quantities of substances employed in the reaction. To this problem his past efforts have been directed, and they have been completely successful. Instead of only obtaining, as previously, 7 grammes of organic sodium salts formed synthetically from 100 grammes sodium, he has obtained 25 times that amount, or from 100 grammes sodium he has now succeeded in obtaining 175 grammes of sodium salts of acids formed synthetically.

He gave in detail an account of the results of a large series of experiments, which it would be impossible to render intelligible unless given at length, for which we have not space. He found that a larger amount of products was obtained by keeping a stream of carbonic acid constantly passing through the apparatus.

His conclusions were: —

1. That where a current of dry carbonic acid is kept constantly passing through absolute alcohol, which is in contact with sodium amalgam containing about 2 per cent. of sodium, for every 150 grammes of sodium used in the reaction, at least 175 grammes of sodium salts formed synthetically are produced, about 35 grammes of which are the sodium salts of volatile acids, and the remaining 140 grammes are the sodium salts of fixed acids.

2. That the volatile acids do not consist entirely of formic acid, but contain at least one acid of higher molecular weight.

3. That the fixed acids are principally acids having a greater atomicity than basicity, and they were originally produced as sodium salts, in which both the basic and typical hydrogen of the acid are replaced by sodium.

THE ARTIFICIAL FORMATION OF ORGANIC SUBSTANCES.

Mr. C. Greville Williams made a communication to the Royal Institution, which is published in their "Proceedings" for May, 1868, on the above subject. After defining and illustrating the two great engines of chemical research, analysis and synthesis, he proceeded to show that all attempts hitherto made to separate chemistry into two distinct branches, organic and inorganic, had failed, and to argue that chemistry was "one and indivisible." The grand problem, which consisted in taking the chemical elements themselves, and building them up *gradatim* into the proximate principles existing in the tissues of plants and animals, until lately appeared almost hopeless. This apparent difficulty was shown to arise from the mistake of supposing the proximate principles of animals and vegetables to result from an occult power vaguely termed the "vital force." He maintained that whenever the proper reagents were made to act upon each other under the proper conditions, the same substances were produced which at one time were supposed to require the aid of vitality for their formation.

He then proceeded to enumerate some of the principal instances where substances originally derived from animals or vegetables had been formed synthetically. Wöhler's synthesis of urea was shown to be one of the earliest in point of date, and his method was described, and also Kolbe's new process by the mere heating of ammoniac carbonate to a point just below that at which urea is decomposed. Other steps in the history of synthesis were shown to be: the conversion of carbonic disulphide into carbonic tetrachloride or perchlorinated marsh gas, the former being a purely inorganic body; the production of acetic acid from carbonic disulphide, or one of the most marked of the so-called organic acids from purely inorganic materials; the synthesis of oxalic acid by the direct union of carbonic anhydride with sodium, as accomplished by Dr. Drechsel. As oxalic acid, by mere distillation, yields formic acid, the synthesis of the first leads directly to a new synthesis of the second.

He then showed how complex bodies, hitherto obtained from animal and vegetable sources, can be built up from elemental carbon and hydrogen. If carbon can only be made to combine directly with hydrogen, no matter how simple the resulting compound may be, it becomes possible to effect the synthesis of a vast number of the most characteristic substances found in animals and vegetables. This result has been accomplished through the agency of acetylene, a most remarkable hydrocarbon first noticed by Edmund Davy in 1836.

He showed how acetylene can be formed from inorganic materials by Berthelot's process, in which a stream of hydrogen is passed through a globe in which the voltaic arc (from 70 or 80 cells of a Grove's battery) is produced between carbon points. At this tremendous temperature the carbon unites directly with the hydrogen. Much larger quantities may be formed by the decomposition by the induction spark of carbonic tetrachloride in presence of hydrogen. But the simplest way is by drawing air through the flame of a common glass spirit-lamp, by means of an aspirator.

Simple as is its formula, almost all the animal and vegetable substances which have been formed by pure synthesis may be obtained from it. In this way may be formed olefiant gas, alcohol, succinic acid, — the last due to the researches of Maxwell Simpson. That the synthesis of succinic acid is a direct step to that of tartaric acid is known from the researches of Perkin and Duppa. The synthesis of the organic alkaloids can also be effected from inorganic materials.

One of the most interesting cases of synthesis recently accomplished is that in which Mr. W. H. Perkin succeeded in producing artificially the odoriferous principle of new hay and the tonquin bean. Until lately nothing was known about coumarin, except that it was a colorless crystalline body, having the formula $C_9H_6O_2$. Artificial coumarin was obtained from the hydride of salicyl, having all the fragrance and beauty of that obtained from the tonquin bean.

From these instances he maintained that there was no natural barrier between organic and inorganic chemistry. Starting from inorganic matter, he had ascended step by step to some of the most complicated bodies secreted by animals and vegetables. What could be more distinctly inorganic than nitrogen, carbon, and oxygen? What more distinctly an animal secretion than urea? What more completely inorganic than acetylene? What more distinctly vegetable in origin than coumarin?

Chemists have, then, so far, done what a very few years ago would have been regarded as possible only by aid of the vital force. The bonds which unite organic substances with organized beings "are so close, that we cannot imagine life *without* matter, and it is equally difficult to conceive the assumption of vitality *by* matter; but we must never cease to look anxiously for the solution of the problem. The impossible is a horizon which recedes as we advance, and the *terra incognita* of to-day will to-morrow be boldly mapped upon every school-boy's chart!" — *American Journal of Science, November*, 1868.

REDUCTION OF CARBONIC ACID TO OXALIC ACID.

Dr. E. Drechsel has achieved a triumph in synthetical chemistry by producing the oxalate of soda by means of carbonic acid. A mixture of pure sodium and dry sand is heated in a flask to about 350° C., over which a stream of dry carbonic acid is rapidly passed. After a few hours the metal becomes red and ultimately black. To avoid the reduction of the carbon, the heat should be moderated in the latter part of the operation, and the whole slowly cooled. Left in the air to oxidize, and then exhausted with water, about one-tenth of the mass is found to be oxalate of soda. In the same way oxalate of potassa may be obtained from an amalgam containing 2 per cent. of potassium.

CHEMICAL CALCULUS.

Sir Benj. C. Brodie, Professor of Chemistry in the University of Oxford, in a lecture "On the Mode of Representation afforded by Chemical Calculus as contrasted with the Atomic Theory," assumes as his unit that portion of ponderable matter which at the melting-point of ice, and at a pressure of 760 millimetres of mercury, occupies a space of 1,000 cubic centimetres. To denote units of chemical substances, he uses Greek letters as symbols, and in such a manner as to indicate that nitrogen, phosphorus, chlorine, bromine, iodine, and several other so-called elementary substances, are compounds containing hydrogen, in combination with unknown elements. It is claimed that this system shows there are three, and perhaps four, fundamentally distinct classes of elemental bodies. The first may be represented by hydrogen and mercury; the second by oxygen and sulphur; the third by nitrogen and chlorine. The only novelty in this classification is the grouping together of elements of widely differing "atomicity." What advantages may be gained by assuming that substances not yet decomposed are compounds, and using symbols of volumetric units as a more mathemetical form of expression, the author has not yet satisfactorily shown.

CHEMICAL NATURE OF CAST IRON.

A "Report on the Chemical Nature of Cast Iron," by Dr. A. Matthiessen, read before the British Association in 1868, was important, inasmuch as it stated that although he and Dr. Prug had made seventy experiments in the production of pure metallic iron from its various compounds, they had not succeeded in obtaining any iron perfectly free from sulphur. He hoped, however, by continuing his researches, to obtain a perfectly pure sample of metallic iron.

In the course of the discussion which followed, Mr. Sutton suggested that probably the presence of sulphur in iron was only another instance of the persistence of that element in the atmosphere, as shown by the experiments of Mr. W. F. Barrett, who first devised the method of detecting the presence of sulphur upon the surfaces of bodies exposed to the air, by projecting upon them a flame of hydrogen, a magnificent blue flame resulting therefrom.

EFFLORESCENCE AND HYDRATION.

According to M. Debray, a hydrated salt has for each temperature a tension of dissociation which is measured by the elastic force of the aqueous vapor which it emits at this temperature. Therefore, a salt effloresces when the tension of its watery vapor is greater than that of the aqueous vapor existing in the atmosphere. A dry salt becomes hydrated when the tension of the aqueous vapor contained in the atmosphere is greater than that which the salt emits at the same temperature. Hydrous salts which do not effloresce owe this property to the fact that the tension of the aqueous vapor emitted by them at ordinary temperatures is always inferior to that commonly possessed by the watery vapor of the atmosphere; they effloresce when placed in an atmosphere where the elastic force of the aqueous vapor contained in the air is less than that which they emit. — *Comptes Rendus.*

THE MONOCARBON SERIES OF COMPOUNDS.

The modern chemist is able to separate organic carbon compounds into divisions which greatly simplify his science, — always recognizing as preliminary facts: first, that every body of the organic type is built upon the element carbon; and second, that this element possesses the property of combining with itself, by which property it is enabled by the combinations it makes with other elements, to produce distinct series of compounds, which are classified, in accordance with this rule, into monocarbons, dicarbons, and so on.

In illustration may be given the names of the first five series: —

The Methyl series:	in this the carbon	stand	as	1—C.
The Ethyl series:	"	"	"	2—C_2.
The Propyl series:	"	"	"	3—C_3.
The Butyl series:	"	"	"	4—C_4.
The Amyl series:	"	"	"	5—C_5.

and so on up to the Melisyl series, where the carbon stands C_{20}.

Every one of these groups, as well as the higher ones, possesses an analogous compound called an alcohol. We have methylic alcohol, wood spirit or naphtha; ethylic alcohol, ordinary alcohol; propylic and butylic alcohols; and amylic alcohol, fusel oil or potato spirit. The difference of the carbon may be shown by burning them in spirit lamps: the methylic lamp burns with little light and no smoke, not blackening a white plate; the ethylic lamp yields a faint trace of darkness of unconsumed carbon; the propylic and butylic lamps have cloudier flames and yield much deposit; while the amylic lamp burns dull and heavy, its light peering through smoke, and yielding enough unconsumed carbon to cover the plate in a few seconds.

In combining with other elementary bodies to produce the groups of the monocarbon series, the carbon forms first a union with hydrogen, producing a new and basic substance called a radical. When the carbon in this series combines with 3 atoms of hydrogen, it produces the radical methyl CH_3, from which various compounds may be made, as follows: —

Hydride of methyl (marsh gas),	CH_3H.
Chloride of "	CH_3Cl.
Iodide of "	CH_3I.
Bromide of "	CH_3Br.
Fluoride of "	CH^3Fl.
Cyanide of "	CH_3CN.
Nitrite of "	CH_3NO_2.
Methyl alcohol,	$\left.\begin{matrix}CH_3\\H\end{matrix}\right\}O$.

In these the radical remains always the same, and these compounds are, in fact, salts of the radical.

To come to the particular subject of this article, — if we take the hydride of methyl, or marsh gas, in which the carbon molecule is said to be saturated with hydrogen, and subject it to the action of chlorine, the chlorine can be made to replace the hydrogen, as follows: If 1 part of the hydrogen be replaced by chlorine, we have chloride of methyl, CH_3Cl; if 2 parts of the hydrogen be replaced by chlorine, we have a new radical, methylene CH^2, combined with 2 of chlorine, forming the bichloride of methylene, the subject of this article. If 3 parts of hydrogen be replaced by chlorine we have the radical formyle CH with 3 of chlorine, forming the terchloride of formyle, or chloroform, $CHCl_3$. If the whole of the hydrogen be replaced by chlorine, expunging altogether the radicals of carbon with hydrogen, the resultant compound is the tetrachloride of carbon CCl_4.

All these compounds possess the power of producing anæsthesia when inhaled as vapors by men and animals. This was well known of the last two. This knowledge in regard to the first two we owe to Dr. B. W. Richardson. — *Medical Times and Gazette, Nov.*, 1867.

ON FERMENTATION.

At a meeting of the Bavarian Academy, in May, 1868, Liebig delivered a lecture on fermentation, in which, after alluding to certain alleged errors of Pasteur on this subject, and to the well-known fact that fresh pure beer-yeast left to itself, in the presence of water, disengages carbonic acid and produces alcohol, he states that he had found that the power of yeast to excite fermentation is retained as long as this process is going on; at its close putrefaction sets in. He regards this process as a vital act in the interior of the cell, and as the immediate cause of the action of yeast in the fermentation. When a solution of sugar comes into contact with the yeast cell, the inner decomposition of the latter is retarded, and the molecules of sugar in contact with the cell are decomposed. One hundred parts, by weight, of yeast left to themselves, furnished 9.18 per cent. of alcohol. Pasteur has assumed that this alcohol is produced from the cellulose of the yeast, which had changed itself into sugar. If this were true, the cellulose ought to disappear; it remains behind, however, unaltered. During the formation of alcohol no trace of ammonia is generated. As some of the most remarkable products of this vital process, Liebig mentioned leucine and tyrosine, and a nitrogenous substance containing sulphur. — *Chemical News.*

CHEMICAL ANALYSIS OF SANDSTONES.

Dr. Phipson has examined specimens of sandstones of different geological formations, to ascertain if it be possible to determine the particular strata to which a sandstone belongs by the nature and proportions of the substances which it yields to boiling hydrochloric acid. His analyses appear to show that: 1. Tertiary sandstones yield to the acid, principally lime and peroxide of iron. 2. New red sandstones will yield peroxide of iron, lime, and magnesia, and the latter will be found almost invariably in the proportions necessary to constitute dolomite. 3. The sandstones of the coal measures give a notable amount of protoxide of iron and some manganese, as well as lime and magnesia. 4. The old red sandstones give peroxide of iron, lime, and magnesia, but the lime is in excess, and not in the proportion to form dolomite. 5. In the older sandstones, talc or silicate of magnesia appears, with or without the ingredients above named. — *Chemical News.*

PREPARATION OF OXYGEN FROM THE AIR.

M. Boussingault, in 1852, found that, on passing a current of air over baryta heated to dull redness, oxygen was subtracted from the air, and binoxide of barium formed; and that, upon then raising the heat to bright redness, the oxygen was set free so easily that it might be first absorbed and then evolved *ad infinitum.* M. Gondolo has recently made some improvements in the details of the process, which permit the preparation of oxygen in this way on a manufacturing scale. He substitutes wrought or cast iron tubes for porcelain ones, coated internally with magnesia, and externally with asbestos, so as to diminish the porosity of the tube and the consumption of fuel. The tubes are arranged in a brick furnace, with dampers, by which dull or bright redness may be obtained at will. To the baryta a mixture of lime, magnesia, and a small quantity of manganate of potash is added; this prevents fritting of the material. M. Gondolo says that he has made 122 alternate operations, and that the atmospheric oxygen and nitrogen are easily separated upon an industrial scale. The apparatus has been at work 6 months, and fulfilled its purpose completely. — *Quart. Journ. of Science, July,* 1868.

GREEN ROTTEN WOOD.

Mr. Sorby communicates the following to the "Quarterly Journal of Science" for July, 1868, in relation to the color of green rotten wood, and whether it has any relation to the *phycocyan* of Cohn. "I have examined it carefully, and find it is quite distinct from that or any other coloring matter with which I am acquainted. The chief constituent is a green-blue color, insoluble in water, and only sparingly soluble in alcohol or benzole, and not fluorescent; whereas, phycocyan is soluble in water, and very fluorescent. The spectra are also quite different. It gives merely 1 absorption band very near the extreme red; whilst phycocyan gives 2, both much farther from the red end. In its general characters it is related to chlorophyll, but is quite distinct from it. The wood also contains 2 yellow colors, which make it more green; and also a substance of a claret color, which seems to make it somewhat dull. This claret color is insoluble in water, but much more soluble in alcohol than the green-blue, and is quite different from any other substance which has come under my notice. On the whole, both these colors are very interesting, since they belong to classes of coloring matters which are so rare that I only know one or two other examples out of some hundreds which I have examined and classified."

HARDNESS OF ANCIENT MORTARS.

Mr. Spiller communicated a paper on this subject to the British Association, in 1868, of which the following are the conclusions, from the chemical examination of the ancient mortars from Burgh, Pevensey, and other Roman castra: that the lime and carbonic acid are invariably united in monatomic proportions, as in the original limestone rock; and that there is no evidence of the hydrate of lime having at any time exerted a power of corroding the surfaces of sand, flint, pebbles, or even of burned clay, with which it must have been in contact for long periods. Further, that the water originally combined with the lime has been entirely eliminated during this process of recarbonation; and, this stage passed, the amorphous carbonate of lime seems to have been gradually transformed by the joint agency of water and carbonic acid into more or less perfectly crystallized deposits or concretions, by virtue of which its binding properties must have been very considerably augmented. Messrs. Abel and Bloxam assign, as one of the causes of the hardening of mortars, the formation and subsequent crystallization of the carbonate of lime.

REDUCTION OF CARBONIC ACID TO OXALIC ACID.

A mixture of pure sodium and dry sand was heated in a flask to the boiling-point of mercury, and a rapid stream of dry carbonic acid passed. After a few hours, the silvery aspect of the metal changed to a red mass, and ultimately became nearly black. Toward the end the heat should be moderated to avoid reduction to carbon, and the whole slowly cooled. Left in the air for the sodium to oxidize and then exhausted with water, it furnished a solution containing oxalate of sodium. From 10 parts of sodium 1 part of calcic oxalate was obtained. Potassium amalgam containing 2 per cent. of the alkali metal acts in the same way.

GLASS FOR CHEMICAL PURPOSES.

Prof. J. S. Stas, wishing to ascertain what should be the composition of glass at the same time unaffected by acids and sufficiently fusible to be easily manipulated, instituted some experiments, with the result that a glass having for bases sodium and calcium, if it contains a sufficient excess of silica, resists acids almost as well as refractory Bohemian glass, having for bases potassium and calcium. It being known that a mixture of equal molecular weights of the carbonates of sodium and potassium is much more fusible than the most fusible of either carbonate by itself, he endeavored to replace, in the composition of refractory glass unattacked by acids, a portion of the potassium by an equivalent quantity of sodium. A very refractory glass being obtained by about,

Silica,	75.00
Oxide of Potassium,	15.00
Oxide of Calcium,	10.00
	100.00

he replaced in such a glass half of the potassium by its equivalent of sodium, thus: —

Silica,	77.00
Oxide of Potassium,	7.70
Oxide of Sodium,	5.00
Oxide of Calcium,	10.30
	100.00

In this glass the bases are in the proportion of 1 atom of calcium ($Ca'' = 40$) to 1 atom of potassium and 1 atom of sodium. The glass made according to this formula had a yellowish reflection, was excessively hard, but little elastic, and as free from hydrometric properties as the best refractory glass of Bohemia. — *Chemical News, Jan.*, 1868.

OZONE AND ANTOZONE.

An experiment of Schönbein, illustrating the simultaneous formation of ozone and antozone, is as follows: Into a flask of 500 c. c. capacity, and 3 or 4 centimetres in diameter across the neck, a little ether is poured, — just enough to cover the bottom, — and a spiral of red-hot platinum is plunged into the vapors. It is necessary to avoid heating the flask too strongly. The platinum glows until all the ether has been destroyed. The experiment is repeated two or three times, and now the question is to demonstrate that both ozone and antozone are formed in this slow oxidation of the ether. The first is easily shown to be present by the iodide of potassium and starch paper. To show the presence of antozone, the flask is rinsed with a small quantity of ether, which will then be sufficiently charged with peroxide of hydrogen to give clearly the perchromic acid reaction. Some solution of bichromate of potash is placed in a test-tube, and a drop of sulphuric acid added, the ether with which the flask has been rinsed is then poured in, when the ethereal layer becomes colored a beautiful violet-blue. The conclusion is that, during the formation of ozone, antozone is also formed, — this, in the presence of water, being converted into peroxide of hydrogen. — *Chemical News*, *Jan.*, 1868.

M. Houzeau has classed the conditions in which oxygen exists in the atmosphere under three kinds: first, inactive oxygen, which produces not the slightest perceptible action upon moist ioduretted paper; secondly, oxygen directly active, which immediately imparts a bluish tint to the above paper, developing at the same time a peculiar and characteristic odor; thirdly, oxygen indirectly active, possessing no perceptible odor and requiring the aid of another body to affect the test-paper. The invigorating nature of country air is presumed to be due to the presence of the second of these modifications of oxygen, which may be regarded as identical with the substance ozone. It cannot be caused by the first description of gas, since inactive oxygen does not affect iodine or its preparation; nor to the third class, since oxygen, indirectly active, requires the aid of an acid to affect the test-paper. But the air of the country, although it imparts a bluish tint to slightly ioduretted litmus paper after the lapse of a short time, does not redden the most sensitive litmus, even after it has been submitted to its action for many hours. It affects its complete discoloration, but does not redden it. Having demonstrated that the first and third of the presumed modifications of the gas oxygen do not bestow upon country air its peculiar properties, it is but natural, and moreover reasonable, to attribute them to the presence of the second, or ozone proper. Granting this assumption, it is manifest that the odor which invariably betrays the existence of ozone should also be present in the air, and unquestionably so it is. Whenever pure air is respired in the mass, it has not only a distinct smell, but also a distinct color. It would be in vain to seek for this air in the crowded streets of a metropolis, but in the open country the lungs can appreciate the vital energy they inhale.

In support of his theory, M. Houzeau carried out an experiment, which is at once curious, interesting, and conclusive. Being well aware of the property that flannel and other stuffs possess of condensing in their pores diluted ozone or oxygen, he caused two linen cushions to be prepared of precisely the same material and size, and placed one in the open air, and the other in a room badly ventilated and well filled with company. After the expiration of a certain time, he had them both brought to him, and ascertained that the first emitted a distinct odor similar to that of ozone, while the second was completely inodorous. Fresh air in its normal state is endowed with decided powers of decoloration. Litmus and turmeric paper, exposed to its influence and sheltered from the effects of rain, dew, and sunlight, are blanched in a short time, demonstrating that ozone acts energetically as a decolorizing agent. It has long been known as a powerful disinfectant, and, could means be devised for procuring it in a free state, it would be of the greatest advantage in purifying vitiated atmospheres. — *Comptes Rendus*, *March*, 1868.

Dr. Thomas Andrews made the following communication to the Royal Society: —

"It was assumed for many years, chiefly on the authority of Schönbein, that the body in the atmosphere which colors iodide of potassium paper is identical with ozone; but this identity has of late been called in question, and, as the subject is one of considerable importance, I submitted it lately to a careful investigation, the results of which I beg to lay briefly before the society. The only property of ozone, hitherto recognized as belonging to the body in the atmosphere, is that of setting free the iodine in iodide of potassium; but as other substances, such as nitric acid and chlorine, which may possibly exist in the atmosphere, have the same property, no certain conclusion can be drawn from this fact alone.

"One of the most striking properties of ozone is its power of oxidizing mercury, and few experiments are more striking than that of allowing some bubbles of electrolytic oxygen to play over the surface of 1 or 2 pounds of mercury. The metal instantly loses its lustre, its mobility, and its convexity of surface, and, when moved about, it adheres in thin mirror-like films to the sides of the containing glass vessel. The body in the atmosphere acts in the same way upon pure mercury; but from the very minute quantity of it which is at any time present, the experiment requires some care in order that the effect may be observed. On passing a stream of atmospheric air, which gave the usual reaction with test-paper, for some hours over the surface of mercury in a U-tube, the metal was distinctly oxidized at the end at which the air first came into contact with it.

"This experiment, however, cannot be considered conclusive, as mercury will tarnish and lose its mobility under the influence of many bodies besides ozone.

"It is well known that all ozone reactions disappear when ozone is passed through a tube containing pellets of dry peroxide of manganese, or other body of the same class. The same thing occurs with the substance supposed to be ozone in the atmosphere. About 80 litres of atmospheric air were drawn, at a uniform rate, through a tube containing peroxide of manganese, and afterward made to play upon very delicate test-paper. Not the slightest coloration occurred, although the same paper was distinctly affected when 10 litres of the same air, without the interposition of the manganese tube, were passed over it.

"But the action of heat furnishes the most unequivocal proof of the identity of the body in the atmosphere with ozone. In a former communication ('Philosophical Transactions' for 1856, p. 12), I showed that ozone, whether obtained by electrolysis or by the action of the electrical brush upon oxygen, is quickly destroyed at the temperature of 237° C. An apparatus was fitted up, by means of which a stream of atmospheric air could be heated to 260° C. in a globular glass vessel of the capacity of 5 litres. On leaving this vessel, the air was passed through a U-tube, 1 metre in length, whose sides were moistened internally with water, while the tube itself was cooled by being immersed in a vessel of cold water. On passing atmospheric air in a favorable state through this apparatus, at the rate of 3 litres per minute, the test-paper was distinctly tinged in 2 or 3 minutes, provided no heat was applied to the glass globe. But when the temperature of the air, as it passed through the globe, was maintained at 260° C., not the slightest action occurred upon the test-paper, however long the current continued to pass. Similar experiments, with an artificial atmosphere of ozone, — that is, with the air of a large chamber containing a small quantity of electrolytic ozone, — gave precisely the same results. On the other hand, when small quantities of chlorine or nitric-acid vapor, largely diluted with air, were drawn through the same apparatus, the test-paper was equally affected, whether the glass globe was heated or not.

"From these experiments I consider myself justified in concluding that the body in the atmosphere, which decomposes iodide of potassium, is identical with ozone." — *Proceedings of the Royal Society.*

Ozone is a powerful disinfectant, and, when generated on the large and cheap scale possible by Wilde's electro-magnetic machine, may be of very great service in hospitals and other buildings where large collections of people vitiate the air.

CORROSION OF CAST IRON.

It has been often stated that cast iron, when exposed to the action of sea-water or to atmospheric influences, under certain conditions, becomes "rotten;" an expression which is intended to indicate a loss of strength or cohesion without a corresponding alteration of volume or size. This phenomenon is entirely different from common oxidation, or rusting, which latter process shows itself by attacking the surface, and gradually reducing the size of the article, which, so far as it remains intact by this external reduction, does not seem to lose its qualities, so that the reduced strength of a rusted bar is simply proportionate to the reduction of its original section. The state of corrosion which would justify the term "rotten" is a reduction of cohesion without any apparent removal of material, and is not easily recognized externally. The nature of this change has for a long time remained unexplained, until some very interesting experiments established its scientific *rationale*. We believe that this scientific discovery is due to Mr. Crace Calvert, of Manchester, who some years back carried out a series of very interesting experiments on this point. Mr. Calvert immersed cast-iron cubes, made of Staffordshire cold blast iron, and cast 1 centimetre in dimension, into acidulated water. Each cube was placed by itself in a corked bottle with 80 cubic centimetres of a very diluted acid. Amongst the acids tried were sulphuric, hydrochloric, and acetic acid; their action upon the iron was very slow, and it required a long time to show any change whatever. After 3 months of contact, Mr. Calvert found that, although the external appearance of the cubes was not changed in any way, some of the cubes, and particularly that in contact with acetic acid, had become so soft externally that a knife-blade could penetrate 3 or 4 millimetres deep into the cube. The solutions were then removed and replaced by fresh acid of the same kind in each bottle, this removal being continued every month for 2 years. After this period, changes had been effected in almost all the cubes, only the penetration was more or less complete according to the nature of the acid. Acetic acid had acted most energetically of all; next came hydrochloric and sulphuric acid. Phosphoric acid showed no similar action. The result of the action of the acid was a complete change of the nature of the metal, without any alteration of its bulk or of the appearance of its surface. The cubes of gray cast iron, which originally weighed 15.324 grammes each, weighed only about 3½ grammes at the end of 2 years, and their specific gravity was reduced from 7.858 to 2.751. The iron had been gradually dissolved or extracted from the mass, and in its place remained a carbon compound of less specific weight, and very small cohesive force, which occupied the same bulk as the original cast iron. The composition of the cast iron and of the carbon compound which remained in its place after 2 years of contact with acetic acid was found by Mr. Calvert as follows: —

	Original Cubes.	Carbonaceous Substance.
Iron,	95.413	79.960
Carbon,	2.900	11.070
Nitrogen,	0.790	2.590
Silicium,	0.478	6.070
Phosphorus,	0.132	0.059
Sulphur,	0.179	0.096
Loss,	0.108	0.205

Acids, like hydrochloric, sulphuric, and acetic acid, are to be found in water under a great variety of circumstances. Sea-water contains these, or at least the elements from which they can be formed by decomposition of the organic or inorganic matter contained in them; they appear in the air, and are carried by the rain or snow down to the surface, particularly in the vicinity of manufacturing localities. The gradual deterioration of cast iron when exposed to actions of that kind — a change which is all the more dangerous, as it is not immediately apparent to the eye — may therefore be considered as a possibility, and in the presence of acidulated water or sea-water may be even called an established fact. It is probable that a coating of the metal or paint, in so far as it is impervious to water, may prevent, or at least lessen this injurious action, but this has not as yet been established by direct experiment. There are many engineering structures relying for their safety upon the strength of cast iron in contact with sea-water, and the chances of injury from this action should never be lost sight of during the periodical inspection of such works.—*Engineering.*

DISSOLVING BONES.

The importance of phosphates, such as common bones, as fertilizers, especially in grain culture, can hardly be over-estimated.

There exist, however, some obstacles which yet prevent waste bones, nearly always cheap and within reach, from being generally used. The great distances in the far West, and other inconveniences, render their purchase in powder form expensive, and for grinding them at home, or dissolving in acid, there is still less chance.

Professor Ilienhof, in Russia, has, however, lately discovered a method for dissolving them, which must prove highly economical and suitable in unsettled countries, where, owing to the great abundance of forests, wood ashes are cheaply secured — indeed, are almost always at hand. This new process of treating bones consists of mixing them with wood ashes and slaked caustic lime, and keeping the mixture constantly moist. As in the preparation of lye for manufacturing soap, the alkaline carbonates in the ashes, such as carbonate of potassa, are by the action of caustic lime converted into free caustic potassa, attacking and quickly dissolving the bones.

The following practical example will illustrate the necessary proceeding: Suppose the wood ashes to contain about 10 per cent. carbonate of potassa, and that 4,000 pounds of bones are to be worked up; then we take 4,000 pounds of ashes, 600 pounds of caustic lime, and 400 to 500 pounds of water. A ditch, some 2 feet deep, of such width and length as to hold 6,000 pounds of the mixture, is dug, and near it a second ditch, being some 25 per cent. larger, and both lined with boards. The lime is then slaked, and, when crumbled to a powder, mingled with the wood ashes, 2,000 pounds of bones piled up in layers and covered up with the mass in the smaller ditch, 3,600 pounds of water added, and the whole left to itself. From time to time small quantities of water are added, to keep the mass moist. As soon as it is found that the bones are so far decomposed that when pressed between the fingers they are soft and crumble, the second portion — that is, the other 2,000 pounds of bones — is brought into the larger ditch, and covered in layers with the first mass, and left to decompose.

After the whole mass has undergone decomposition it is suffered to dry, by removing it; and, lastly, to facilitate its reduction to powder, mixed with 4,000 pounds of dry turf, or some other dry vegetable earth. The mixture is repeatedly stirred about with a shovel, and may at once be brought upon the fields. Manure prepared thus will contain about 12 per cent. of tribasic phosphate of lime (3 CaO, PO_5), 2 per cent. of nitrogenous matter. This manure must, from its composition, produce an admirable effect upon grape-vines. Liebig, in generally recommending this new fertilizer, thinks an addition of gypsum an improvement for many kinds of fruits. — *Agricultural Report.*

CRYSTALS CONTAINING FLUID.

Mr. J. B. Dancer lately read a paper before the Literary and Philosophical Society, of Manchester, England, containing a brief history of the discovery of fluids in crystals, including Sir H. Davy's chemical experiments on the fluids and gases obtained from the cavities in quartz crystals; Sir David Brewster's discovery of the pressure cavities in the diamond, ruby, emerald, amethyst, chrysoberyl, etc.; the existence of minute crystals in these cavities and the two new and remarkable fluids, which are immiscible, but sometimes found together in the same cavity — one a liquid hydrocarbon, named Brewstoline, the other Cryptoline; his experiments and examinations of artificial crystals deposited from aqueous solutions; his examination of the Koh-i-noor diamond and others in the East India Company's museum; and the geological speculations to which these discoveries gave rise.

Mr. Dancer mentioned the experiments of his late father and others in producing artificial gems by intense heat, and stated that his own attention was drawn to this subject some 24 years since by Sir David Brewster presenting him with a specimen of topaz containing fluid. Since that time he had examined a large number of crystals of various kinds, and had found fluid in quartz from South America, Norway, the Alps, Ireland, Snowdon, and the Isle of Man; and in fluor-spar from Derbyshire. This latter specimen contained a considerable quantity of fluid, which burst the crystal at 180° temperature. [After this paper was written, Sir David Brewster informed the author that the fluid contained in crystals of fluor-spar was water, and that the cavities burst at a temperature of 150°.] He suggested the employment of the microscope as a valuable assistance in detecting spurious from real gems. Very few of the latter are perfect, and the flaws and cavities are so distinct in character from those which are so abundant generally in artificial gems that very little experience is sufficient for the purpose. This mode of testing of course is limited to transparent crystals, but might be employed when the usual methods are not practicable. He also mentioned Mr. Sorby's discovery of fluid cavities in the quartz of granite, in the quartz of volcanic rocks, and also in the feldspar ejected from the crater of Vesuvius, and Mr. Sorby's method of determining the temperature at which various rocks and minerals are formed. At the conclusion of the meeting, crystals containing fluid were exhibited under the microscope, and the expansion of the fluid by elevating the temperature of the crystal while under examination. — *Mechanics' Magazine.*

ANILINE COLORS.

The starting-point of the manufacture of these colors is the benzole of coal-tar, mixed, as is usually the case, with a variable proportion of toluol. The boiling-point of this mixture is about 90° C., and it yields nitro-benzole, which boils at 235° C., while pure nitro-benzole has it at 213° C.

The conversion of pure nitro-benzole into aniline is brought about by Béchamps' process, — metallic iron and acetic acid, — which is performed in iron tanks provided with stirrers and heated by steam; the top being closed by a species of still-head enables the volatilized products to be collected.

Commercial aniline is never chemically pure, but presents a mixture of pure aniline, toluidine, and odorine. Ordinarily it is free from quinoline, which is obtained directly from the basic oils of the heavy tar-oils. Its color is from yellow to dark-brown, and has the odor peculiar to odorine, a hydrocarbon boiling at 133° C. Its boiling-point is rarely found to agree in any two samples, as it varies from 180° C. to 250° C., at which latter degree it remains constant. If the boiling commences below 180° C. it indicates the presence of considerable quantities of odorine, which makes it of poor quality.

The aniline used for the various colors is taken of different composition and boiling-point. A. W. Hofmann has shown that a mixture of an equivalent of aniline and two of toluidine produces the largest yield of rosaniline (fuchsine). The substance used for this manufacture begins to boil at about 175° C.; till 190° C. some 10–15 per cent. have passed over, and up to 200° C., when 80 per cent. pass over, it rises very gradually.

Aniline blue and purple require an oil which begins to boil at 190° C., and at 200° C. has lost only 60 per cent. Evidently with these properties it contains less aniline than the preceding one.

The changes which these bases undergo when converted into dyes, or compounds of rosaniline, are brought about by the destruction of a portion of them.

Neither pure aniline nor toluidine alone produce the colored alkaloid, but with substances like chloroform, chloride of carbon, iodide of cyanogen, iodoform, or formiates, as well as with iodine and corrosive sublimate, the change occurs.

Aniline blue results from various processes. The one most commonly used at present is that of Girard and De Laire, the Bleu de Paris, made by heating fuchsine with fluid aniline. The original process produced a blue with a reddish tinge; but by the addition of some organic substances, acetic acid, methylic alcohol, the blue is obtained pure. It is distinguished from all other blues by not appearing green in candle-light.

The various shades of purple to blue and violet are made from fuchsine by Hofmann's method, that is, heating (1) fuchsine and

(2) iodide of ethyl with (2) alcohol in a closed vessel at 100° C. for variable lengths of time; the blue resulting from longest exposure.

Aniline green is produced from a solution of sulphate of rosaniline in dilute sulphuric acid and some aldehyde, which is heated until its color has changed to dark-green. Addition of a solution of hyposulphite of soda separates the color.

When a salt of aniline in solution is exposed to the action of certain oxidizers, as salts of copper, chlorate and bichromate of potassa, it yields a black dye, of such depth that ordinary gall or madder blacks appear gray or green in comparison. The fastness of this color, its resistance to the action of acids, alkalies, soaps, and sunlight, render it of great importance to manufacturers, and make it one of the great achievements of late years. — *Druggists' Circular.*

HOW TO TEST THE PURITY OF WATER.

It is of importance to be able to test the quality of water, not only when for special purposes absolutely pure water is required, but even in cases where such purity is not requisite, it may be of great interest to ascertain of what the impurities consist.

Pure water must satisfy the following conditions. — 1. It must have no residue whatever when evaporated in a clear porcelain or platina dish.

2. It must form no precipitate with a solution of nitrate of silver, which would indicate common salt, some other chloride, or hydrochloric acid.

3. It must not precipitate with a solution of chloride of barium, which would indicate a sulphate or sulphuric acid.

4. It must form no precipitate with oxalate of ammonia, as this would indicate some soluble salt of lime.

5. It must not assume any dark or other shade of color when passing sulphuretted hydrogen gas through it, or mixing it with the solution of a sulphide salt, as this would indicate the presence of lead, iron, or some other metal.

6. It must not become milky by the addition of lime-water, or a clear solution of sugar of lead, as this would indicate carbonic acid.

7. It must not discolor by adding solutions of corrosive sublimate, or chloride of gold, or sulphate of zinc, which discoloring would indicate the presence of organic substances. When boiling water with chloride of gold, the least trace of organic matter will reduce the gold, and color the water brown.

Results of these tests. — 1. Almost all spring waters are found to leave a residue upon evaporation.

2. Common salt is found not only in most springs and rivers, but even in rain-water, many miles inland, when the wind blows from the ocean.

3. Sulphuric acid and sulphates are found in many springs;

the Oak Orchard Spring, N. Y., for instance, is very rich in the free acid.

4. Waters from lime regions all contain lime in large quantities, and, in fact, this is the most common impurity of spring waters.

5. Iron is contained in large quantity in the so-called chalybeate springs; also copper and other metals are encountered; lead incidentally, by the lead tubes through which it often is made to pass.

6. Carbonic acid is the most common impurity; even distilled water is not always free from it. Water will naturally absorb carbonic-acid gas from the atmosphere, which always contains it; its principal source of supply being derived from the exhalations of man and animals.

7. Organic substances are often found in the water of running brooks, streams, and rivers, and are of course obtained from the vegetation and animal life in the water itself, and from the shores along which it floats.

Remarks. — 1. The healthfulness of water depends on the nature of the residue left after evaporation; for many chemical and other operations, where absolutely pure water is required, the leaving of residue at once proves the water unfit for use.

2. The existence of small quantities of common salt in the water is not objectionable, it being not injurious to health.

3. Sulphuric acid and sulphates may be objectionable for daily use; however, such waters are used medically to stop diarrhœa and excessive tendency to perspiration.

4. Lime waters do not agree with some constitutions, producing diarrhœa and diverse disturbances; very small quantities of lime, however, are not injurious.

5. Iron is healthy, and is a tonic; in fact, this metal and manganese are the only ones which may be used in large doses, not only with impunity, but even with benefit; however, there is also a limit. Over doses of iron may produce diarrhœa and slight eruptions of the skin, or pimples.

6. Carbonic acid is not objectionable when drinking the water; on the contrary, it makes it more palatable, and most mineral waters owe their reputation to this substance.

7. Organic substances are perhaps the most objectionable, principally when decaying; such waters may even propagate diseases, and require careful filtering or boiling, or both, to make them fit for internal consumption. — *Scientific American.*

DANGERS FROM KEROSENE.

At a recent meeting at the Massachusetts Institute of Technology, Mr. Frederic E. Stimpson, Secretary of the "Committee on Chemical Products and Processes," made the following report in behalf of that committee, on the subject of the "difference between the volatile hydrocarbons known in the market as gasoline, benzine, and naphtha; and wherein danger is to be apprehended in the use of these liquids for illuminating purposes."

"This committee would respectfully report that after careful examination they find that the term naphtha is a general term, and covers both the other terms. The word naphtha is one of great antiquity; it has long been applied to certain springs in Persia from which is obtained a volatile, limpid, bituminous liquid, having a strong, peculiar odor, and generally a light-yellow color.

"When the art of distilling coal tar became known, the same term was applied to the more volatile products of such distillation; the heavy products being called dead oil and asphaltum. The term was next applied to the most volatile products from the distillation of coal for oil. When petroleum took the place of coal for this purpose, the term naphtha was again used to distinguish the more volatile, so-called 'light' products from the heavier ones. This is still its use, and in our market all volatile products of petroleum lighter than illuminating oil (or what is known among our dealers as 'kerosene,' which has a specific gravity of eight-tenths or 45° by Baumé's Hydrometer), are designated by the general name of naphtha.

"Of the naphthas those of a gravity from 45° to 80° B. are often, though improperly, called benzine or benzole. True benzole is a product of coal tar, and differs essentially from any liquid obtained from petroleum. The term 'gasoline' is applied to all naphthas having a specific gravity lighter than about 80° B., the lightest known being about 90°.

"This committee find, however, by reference to Professor C. M. Warren's unpublished determinations, that none of these products are simple bodies. All of them are mixtures, in indefinite proportions, of at least 12 hydrocarbons, distinguished from each other by their boiling-points, which vary from 32 to 318° F., and are nearly as follows: 32, 47, 86, 99, 142, 156, 195, 208, 247, 261, 303, and 318°.

"While gasoline contains mostly those hydrocarbons whose boiling-points are low, kerosene is composed chiefly of those whose boiling-points are comparatively high. The isolation of any one of these products being a matter of great difficulty, few have attempted it, and your committee have had to rely on the labors of a fellow-member for much valuable information on the subject. To completely separate the constituents of any sample would be the labor of many months.

"Your committee also report that there is great danger from the careless use of naphtha, — first, on account of its great inflammability; and, second, from the liability of forming explosive mixtures of the air and vapors. The liquids are not in themselves explosive, neither are the vapors; but both are highly inflammable. If the liquids escape by any means and form pools, or saturate porous substances, the near approach of flame may cause the vapor to ignite and set fire to the whole exposed surface of the liquid.

"The vapors, it is true, are not explosive, but they become so when mixed with air in certain proportions, and this committee would particularly call the attention of the society to the fact that such mixtures are more likely to be formed in what are called empty cans, which have contained hydrocarbons, and, from their supposed emptiness, are imagined by ignorant people to be free from danger. A light may be applied with but little or no danger to a vessel full of gasoline or gasoline vapor, or even such a mixture of vapor and air as would produce lighting gas; but in case the vapor be mixed with a sufficient quantity of air, it would instantly explode."

A writer in the "Boston Journal of Chemistry" makes the following statement: "Kerosene accidents occur from two causes: First, imperfect manufacture of the article; second, adulterations. An imperfectly manufactured oil is that which results when the distillation has been carried on at too low temperature, and a portion of the naphtha remains in it. Adulterations are largely made by unprincipled dealers, who add 20 to 30 per cent. of naphtha after it leaves the manufacturer's hands. The light naphthas which have been spoken of, as known in commerce under the names of benzine, benzoline, gasoline, etc., are very volatile, inflammable, and dangerous. They, however, in themselves, are not explosive; neither are they capable of furnishing any *gas*, when placed in lamps, which is explosive. Accidents of this nature are due entirely to the facility with which *vapor* is produced from them at low temperatures. But the vapor by itself is not explosive; to render it so, *it must be mixed with air*. A lamp may be filled with bad kerosene, or with the vapor even, and in no possible way can it detonate, or explode, unless atmospheric air has somewhat got mixed with vapor. A lamp, therefore, full, or nearly full, of the liquid, is safe; and also one full of pure warm vapor is safe. Explosions generally occur when the lamp is first lighted, without being filled, and late in the evening, when the fluid is nearly exhausted. The reason of this will readily be seen. In using imperfect or adulterated kerosene, the space above the line of oil is always filled with vapor; and so long as it is warm, and rising freely, no air can reach it, and it is safe. At bed-time when the family retire, the light is extinguished; the lamp cools, a portion of the vapor is condensed; this creates a partial vacuum in the space, which is instantly filled with air. The mixture is now more or less explosive; and when, upon the next evening, the lamp is lighted without replenishing with oil, as is often done, an explosion is liable to take place. Late in the evening, when the oil is nearly consumed, and the space above filled with vapor, the lamp cannot explode so long as it remains at rest upon the table. But take it in hand, agitate it, carry it into a cool room, the vapor is cooled, air passes in, and the vapor becomes explosive. A case of lamp explosion came to the writer's knowledge a few years since, which was occasioned by taking a lamp from the table to answer a ring of the door-bell. The cool outside air which impinged upon the lamp in the hands of the lady rapidly condensed the vapor, air passed in, explosion occurred, which resulted fatally. If the lamp had been full of fluid, this accident could not have occurred. Before carrying it to the door, flame might have been thrust into the lamp with safety; the vapor would have ignited, but no explosion would have taken place."

HYDRIODIC ACID.

Prof. Winkler uses the following improved process, in order to avoid loss of iodine, which is not uncommon in the officinal method, beside yielding an acid of much greater strength if desired. Bisulphide of carbon is saturated with iodine in a tall cylinder or flask, and a sufficient quantity of water is poured on, according to the proposed strength of the acid. The tube from the sulphuretted hydrogen apparatus reaches to the bottom of the cylinder, and the gas is decomposed in the same manner, while the sulphur as it separates dissolves in the bisulphide. As soon as the latter is decolorized the current of gas is stopped, and the watery solution is separated from the oily solution of sulphur by means of a moistened filter. After heating it for a short time at the boiling-point in a retort, the acid will be chemically pure, while the bisulphide is also recovered by simple distillation. For the preparation of hydrobromic acid this process is not applicable, because it is not possible to prevent altogether the formation of sulphide of bromine.

BLEACHING OF TISSUES.

Some recent researches by M. Kolb on the bleaching of tissues will be found of interest to those engaged in this department of the arts. We give a condensed account of these experiments as contained in the London "Chemical News": —

Flax was the fibre chiefly experimented with, alkalies being the reagents whose effects were studied, the object being to fix precisely the nature of the substance which passes by the name of resin, gummy matter, gum-resin, saponifiable matter, etc. Elementary analysis gave no information; it gave figures which closely approached the percentage composition of cellulose. The employment of various solvents used in organic chemistry, on the contrary, led to certain conclusions by a chain of facts. The fibre, after treatment with alkalies, furnished strongly colored lyes, which had a certain tendency to mould; this result suggested the idea of a saponification, and led to the examination, as solvents, of alcohol, ether, and essential oils. The yellow coloring matter is completely insoluble, and these liquids only remove from the fibre a white fatty matter and a green essence, the penetrating odor of which is found slightly perceptible in bleachers' lyes. The whole only constitutes 48 per cent. of the weight of the fibre, and is the portion really saponifiable in caustic alkalies; the alkaline carbonates leave this fatty matter in the fibre, which becomes, at the same time, more supple. After exhaustion by alcohol, the fibre, boiled in weak potash, soda, or ammonia solution, gave, in three cases, a loss in weight of 22 per cent. Carbonate of soda possesses exactly the same solvent power, but it acts more slowly. The brown lyes thus obtained, neutralized by hydrochloric acid, give a brown gelatinous precipitate; but the coloration of the liquid still indicates the incompleteness of the precipitation. Neither acid in excess nor lime of baryta will precipitate that which remains of the coloring matter in solution. This soluble portion varies according to the amount of alkali, and especially according to the duration of the ebullition; thus, 12 hours' ebullition with ammonia suffices for acids to cause no precipitate in the solution. The fibre treated by boiling water loses at the end of a week 16 per cent. of its weight, and 18 per cent. when pressure intervenes; the matter dissolved is acid to litmus, colors the water slightly, and possesses the singular property of browning by simple contact with alkali.

Considering these first characters, it is difficult to admit the presence of a resinous matter. Caustic alkalies or alkaline carbonates do not act as simple solvents, for, in boiling the fibre with determinate amounts of carbonate of soda or sulphide of sodium, it was found that after 8 hours' ebullition no trace of carbonic acid or hydrosulphuric acid remained. Resins do not give similar results; they saponify equally well with sulphides and alkaline oxides. Lime does not precipitate this substance dissolved by the alkalies; the fibre boiled with milk of lime loses the same weight as in soda, a soluble combination being formed with lime, containing 48 parts of this oxide for 100 of the coloring matter. Chalk gives the same result, although more slowly. The treatment by chalk and lime presents this particular, — that the solutions obtained remain colorless, and that the precipitates obtained are white. Analysis assigns to the substance, soluble in alkalies and reprecipitated by acids, the following numbers: hydrogen, 5.0; carbon, 42.8; oxygen, 52.2.

The research has led to the establishment of the following facts: The gummy substance which adheres to the fibres of flax is nothing else than pectose. The soaking or steeping of the fibre appears to have for its object the determination of the pectic fermentation, and the pectic acid which results remains fixed on the flax, either mechanically or in part, in the form of pectate of ammonia. The caustic alkalies in the cold form gelatinous pectates, which preserve the fibre from being completely attacked. Pectic acid being weak, the alkaline carbonates have in the cold only a feeble action upon the fibre. Ebullition, on the contrary, transforms pectic acid into an energetic acid, — metapectic acid; the carbonates are then strongly attacked, and their employment becomes as efficacious as that of caustic alkalies. The carbonate of soda, even in large quantity, is not a cause of the weakening of the fibre, which loses more strength from the employment of caustic soda, especially when the lye is concentrated. The employment of lime, even in the cold, weakens the fibre considerably. But the chief cause of the destruction of the solidity of the fibre is too long digestion, particularly with caustic soda. M. Kolb says that, after having proved the existence of pectose in the unsteeped flax, and of pectic acid in the same flax after steeping, it is to be hoped that the attention of chemists will be drawn to the pectic fermentation, well known doubtless as a scientific fact, but of which no one suspected an industrial application of so high importance. — *Scientific American.*

SUBSTITUTE FOR ANIMAL CHARCOAL.

Mr. Stanford has recently exhibited to the British Pharmaceutical Conference a new kind of charcoal, which appears to possess many valuable properties. This substance consists of the coal produced from the long stems of a species of sea-weed — *Laminaria digitata* — which is thrown up in great abundance in certain localities, especially upon the western shore of the Hebrides. This sea-weed is collected and dried in the air. When first thrown up, it is in the form of long fleshy stems, 7 to 8 feet in length, and about the thickness of the wrist, but when dried, presents hard, horny, flexible rods, about the size of the finger. When carbonized, these stems swell out into a highly porous charcoal, about 3 times their original volume. This charcoal contains about 40 per cent. of salts, free from sulphides, and is very rich in iodine.

After lixiviation, the residual mass has the following composition, with slight variations: —

Carbon	50
Phosphate of lime	4
Carbonate of lime	26
Carbonate of magnesia	6
Silicic acid	5
Alumina	2
Sulphate of potash	5
Chlor. iodine	5

— and about 1.25 per cent. ammonia.

It generally contains, in addition, about 15 per cent. of water, which it is very difficult to separate, the charcoal having a most powerful affinity for moisture.

Attention was called to the remarkable analogy between the chemical composition of this and of animal charcoal, which appeared to class it with that substance, and render it unlike any other charcoal of a vegetable origin. It cannot be used for sugar refining, on account of the large percentage of carbonate of lime; but it possesses decolorizing and deodorizing properties, superior, weight for weight, to the best animal charcoal; tested with solution of caramel it decolorizes 25 per cent. more than animal charcoal under the same conditions.

It has been subjected to continued filtration of the thickest town sewage, for several months, without the least clogging, and its efficacy after this treatment remained unimpaired. — *Druggists' Circular.*

ATTAR OF ROSE. BY DR. R. BAUR, OF CONSTANTINOPLE.

Attar of rose, or rose-oil, is the volatile oil obtained on the southern slopes of the Balkan by distilling the flowers of *Rosa damascena*.

Pure attar of rose, carefully distilled, is at first colorless, but speedily becomes yellowish. Its specific gravity at 18° R. (72.5° F.) is 0.87; its boiling-point 229° C. (444° F.). It consists of an elæoptene and a stearoptene, the former the source of the odor, the latter of the property of congealing into a solid form.

Pure attar of rose, once distilled, solidifies at a temperature of from 11° C. to 16° C. (51.8° F. to 60.8° F.), or still higher. It is soluble among other things in absolute alcohol and in acetic acid. Its odor is rose-like, with a peculiar honey-like sweetness, agreeable only when highly diluted. Attar is adulterated chiefly with the so-called geranium of Palmarosa oil.

The Turkish geranium oil is, according to the most credible accounts, derived from a grass of the genus *Andropogon*, from which it is distilled in the months of December and January in the neighborhood of Delhi. It comes to Turkey by way of Arabia, and is sold here by Arabs in large, bladder-shaped vessels of tinned copper, holding about 120 pounds each. When recent, it is tolerably limpid, bright-yellow to brownish, often colored green through containing copper, and very frequently — indeed mostly — contaminated by the addition of a fatty oil.

The geranium oil as it arrives is, however, by no means in a proper condition for mixing with attar. Its odor and color must, as far as possible, be assimilated to those of rose oil, and to this end it has to be refined. By this process it loses its penetrating after-smell, and, according to the goodness of the sample treated, acquires, sooner or later, a pale, clear yellow color. It also loses the property, which it possesses in the unrefined state, of acquiring a red color (separation of Cu_2O) upon long standing.

Geranium oil does not solidify at —20° C. (—4° F.), but becomes at that temperature turbid and thick. Like attar, it takes up ozone from the air, and shows an energetic reaction with iodine; it is easily soluble in ordinary spirit of wine, and affords like attar a well-crystallized compound with CaCl. It is quite inactive to a ray of polarized light.

Geranium oil is mixed with attar in almost any proportion, from a few parts per cent. up to 80 or 90. The differences in congealing-point are not quite in proportion to the relative volumes of the two oils which are mixed, apart from the variable properties of each.

Many attempts have been made to discover some chemical reaction which would reveal the falsification of attar with geranium oil, but hitherto mostly in vain. As completely deceptive, may be noticed Guibourt's test with the vapor of iodine; and also that with K I and starch. The author has had the opportunity of preparing a standard attar of rose on the spot, and was also in a position such as scarcely another chemist ever had for investigating the whole subject. Pure attar gives with iodine and with iodide of potassium and starch the same reactions as when it is mixed with geranium oil, and even those with pure geranium oil are hardly different. The proposed tests of NO_5, NO_4 and SO_3 are equally devoid of value. — *Druggists' Circular.*

THE OXYGEN GAS-LIGHT.

According to a letter of Dr. Doremus, of New York, as published in the "Druggists' Circular" for 1868, pp. 252, 253, the oxygen gas-light possesses the following advantages: —

1. It is more purely white than any of the lights ordinarily used; hence must be a blending of the various colors in quantity and proportion more nearly approaching the sunbeam. All the more delicate shades of whatever hue are seen almost as though illuminated by daylight. It is well known that this cannot be said of coal gas, as ordinarily employed; for paintings, decorations, colored dresses, ribbons, gloves, etc., present certain tints by natural light, and others by the usual artificial lights.

2. It is many times more brilliant than the standard gas-light, with the same consumption of coal gas. According to the French reports, it excels by 16½ times that produced in the city of Paris. I find it to exceed ours (that of the Manhattan Gas Company) consumed in the English standard Argand burner, with 15 holes, and with glass chimney 7 inches in height, to the same, and at times to a greater, extent. When this light is caused to pass through the hot ascending current of gases from any ordinary flame, the refraction of the light can be seen on a white surface, literally causing these lights to produce their own shadows.

3. The light is steady and without flicker. Our "bat-wing" and "fish-tail" burners yield wavy, tremulous flames, very trying to the eyes, and especially annoying and injurious to those who are obliged to employ artificial light for many consecutive hours. Even the highly esteemed Argand cylinder of light loses character when placed beside it. This must be so of necessity, for they are flames, and therefore agitated by the constant currents of air which they themselves excite and which may be produced by other causes, while this light (the oxygen gas) emanates from a solid pencil of compressed magnesia, fixed in a solid support, and rendered incandescent by jets of carburetted hydrogen (or hydrogen) burning with pure oxygen.

4. Much less heat is thrown out by this light than from any of the gas or petroleum flames, although it excels them all in brilliancy; and the discrepancy is still greater if the comparison is made with lights of equal illuminating power. The uncovered hand cannot be held over the ordinary Argand burner, yet it may be placed over this light with impunity, though it so far exceeds it in brightness. The explanation of this apparent paradox is simple: Coal gas, when mixed with air, as in the various forms of "Bunsen's burners," so well known in chemical laboratories and used in

"gas stoves," may be consumed without producing light, except of a pale-blue color, too feeble to enable one to see with. Thus, the whole effect of the combustion is to generate heat, which is the object aimed at, while the same coal gas, not mingled with air until burned, will furnish light as well as heat. Hence we may have the same amount of chemical action, at one time resulting in heat alone, and under other conditions evolving luminous as well as calorific rays, furnishing a beautiful illustration of the correlation of forces. When oxygen and pure hydrogen unite they produce a most intense heat, over 14,000° F., and ranking next to the galvanic current, yet the flame is almost invisible by daylight. If, however, any solid body be held in it, even though non-combustible, as lime, magnesia, etc., the imponderable force heat is transmuted into light.

By this mode of illumination, therefore, one of the objectionable features in the use of coal gas — namely, the oppressive heat, both in private residences, churches, and theatres (especially in the summer season) — is in great part removed.

5. This light does not vitiate the air as much as other lights of equal brilliancy, — a sanitary condition too often neglected. Ordinary artificial lights injure the atmosphere in two ways, — by removing its oxygen, which is so essential for respiration, and by producing carbonic-acid gas. A single 6-feet burner will yield as much of this poisonous gas as 8 or 9 persons would expire in quietude, while it would abstract more oxygen from the surrounding air than they would absorb in the same time.

In this new lamp, oxygen is supplied in sufficient quantity to consume the coal gas, — the atmosphere is not taxed to aid the combustion, — and as the consumption of carburetted hydrogen in this burner is from one-sixteenth to one-twentieth for the same illuminating power, there will be proportionally less of impurities resulting from its use. From our gas flames a portion of unconsumed carbon always arises, which darkens the ceilings, soils the walls and the furniture. No such smoke escapes from this light, for the combustion is complete.

For out-of-door illumination it has an additional advantage, that by no possibility can it be "blown out." The chemial action is so intense that it cannot be extinguished in the stormiest weather; and even if the two gases be shut off for a minute or two the glowing pencil of magnesia will relight them when they are again turned on. The preparation of this oxygen differs markedly from the making of coal gas; there is no ill odor attending it, and, if hydrogen should be employed, as proposed by the same ingenious French chemists, their method of fabricating it by heating fine anthracite coal dust, peat, or other carbonaceous substance, mingled with hydrate of lime, would furnish us with means for illuminating and heating, without contaminating the atmosphere of our crowded cities with the nauseating and unwholesome gases with which we are now annoyed.

In point of economy, by the use of oxygen and carburetted hydrogen combined, with the same amount of light, the public may save from 30 to 40 per cent. in money, allowing large profits to the manufacturers; or, for the same price, may have many times more brilliant, perfect, and wholesome light than is offered them at present.

In the Drummond light the piece of lime usually employed crumbles in a few hours. These pencils of compressed magnesia last a week, and, by recent improvements in Paris, crayons have been patented, which have thus far proved to be indestructible, as "they have been employed for 30 consecutive days without any alteration, being like new." This style of lamp requires a duplicate tube, — one for the oxygen, and the other for the common illuminating or pure hydrogen gas.

For furnaces and factories, where the oxygen would be prepared on the spot, I learn that it can be generated at a cost of from 2 to 3 dollars a thousand cubic feet! Any chemist can foresee what a revolution this is destined to produce in metallurgic and other operations where this agent is demanded. Its relation to iron and steel involves millions of dollars. So speedily has this been appreciated abroad that the large steel works in Bradford, England, have already made arrangements for the immediate adoption of this process. I learn also that the proprietors of one of the largest iron works in France are negotiating for its use, and that furnaces are being erected for generating oxygen by this system, to be employed in one of the French glass factories at Lyons; in lieu of long chimneys and blasts of diluted oxygen, that pure oxygen is to be used for blowing fires.

For the economical production of hydrogen gas, to be used as a substitute for coal gas, these chemists employ the hydrates of potash, soda, strontia, baryta, lime, etc., intimately mixed with charcoal, coke, anthracite, or peat, and raise them to a red heat in retorts.

The reaction between hydrate of lime and fine anthracite coal would be, that the water of the hydrate would be deoxidized by the carbon, forming carbonic acid, and hydrogen gas would be liberated: $2\ (Ca\ O,\ HO) + C = Ca\ O + CO_2 + H_2$.

On remoistening the lime, it again becomes a hydrate, and the process may be repeated. By absorbing the carbonic acid, hydrogen may thus be isolated with the same facility and at a much lower price than coal gas, with the advantage alluded to of avoiding the generation of the ill-odored gases, at the same time utilizing the coal-dust refuse.

The loss in delivering said gas through lengthened tubes, owing to its diffusive power, may be overcome by simply coating the interior of said pipes with some cheap and impervious lining, at the same time carefully securing the joints.

CARBOLIC ACID.

The following are extracts from a lecture of Dr. C. Calvert: —

"The disinfectant, or rather antiseptic, properties of carbolic acid are very remarkable. The beautiful researches and discoveries of M. Pasteur have shown that all fermentation and putrefaction is due to the presence of microscopical vegetables or animals, which, during their vitality, decompose or change the organic substances, so as to produce the effects which we witness, and carbolic acid exercises a most powerful destructive action upon these microscopic and primitive sources of life. Carbolic acid, therefore, is an antiseptic and disinfectant much more active and much more rational than those generally in use.

"And allow me further to add that disinfectants, such as chlorine, permanganate of potash, or Condy's fluid, operate by oxidizing not only the gaseous products given off by putrefaction, but all organic matters with which they may come in contact; whilst carbolic acid, on the contrary, merely destroys the causes of putrefaction, without acting on the organic substances. The great difference which, therefore, distinguishes them, is, that the former deals with the effects, the latter with the causes. Again, these small microscopic beings, these ferments, are always in small quantities as compared to the substances on which they act; consequently a very small quantity of carbolic acid is necessary to prevent the decomposition of substances: therefore its employment is both efficacious and economical. Moreover, carbolic acid is volatile; it meets with and destroys, as Dr. Jules Lemaire says, the germs or sporules which float in the atmosphere, and vitiate it, and this cannot be the case with Condy's fluid, chloride of zinc or iron, which act only by contact, and are mere deodorizers. This is why carbolic acid was used with such marked success, and therefore so largely, in England, Belgium, and Holland, during the prevalence of cholera and of the cattle plague. The antiseptic properties of carbolic acid are so powerful that one one-thousandth, even one five-thousandth will prevent the decomposition, fermentation, or putrefaction for months of urine, blood, glue solution, flour paste, fæces, etc., etc.; in fact, its vapor alone is sufficient to preserve meat in confined spaces for weeks; a little vapor of this useful substance will preserve meat for several days in the ordinary atmosphere, and prevent it being fly-blown; lastly, one ten-thousandth has been found sufficient to keep sewage sweet.

"Manufacturers have not yet availed themselves of one tithe of the valuable properties of carbolic acid, and in this direction a new field is open to its use; still I may cite a few instances. The preservation of wood has been already referred to, and, thanks to its use, the great trade in skins and bones from Australia, Montevideo, Buenos Ayres, etc., is benefited. Wild animals living there in herds are slaughtered by thousands. Formerly they came to us in a bad state, half putrid, emitting an insupportable odor, and only fit for manure; in this state their price was not more than 150 francs the 1,000 kilogrammes; now, thanks to carbolic-acid treatment, they arrive perfectly preserved; they can be employed for all the uses to which green or raw bones are usually applied, and the value of bones is raised as much as from 250 to 300 francs. Hides also arrive putrid, unless they have been dried rapidly in the sun or salted, which necessitated a long and costly operation; whilst it is only necessary to immerse them for

24 hours in a solution of 2 per cent. of carbolic acid, and dry them in the air, to secure their preservation. It is probable that in a short time the blood, intestines, and other parts of these animals will be, by means of carbolic acid, converted into manure, and imported into this country. In England, carbolic acid is used for keeping anatomical subjects, and the preservation of all animal matter. Carbolic acid is also utilized in preventing the decomposition of the preparations of gelatine and albumen, used in spinning, dyeing, and calico printing."

PERMANGANATE OF POTASH.

Dr. Beranger-Feraud, of the French navy, after trying wood charcoal, chlorine, chloride of lime, carbolic acid, and protosulphate of iron in deodorizing the bilge-water of ships, comes to the conclusion that permanganate of potassa far exceeds them all in rapidity of action and thoroughness of effect, and says: "I made use of a solution of permanganate of potash, of the strength of half an ounce of crystals to a quart of water. One ounce and a half of this solution, which has a fine crimson color, added to a pint of foul bilge-water, effectually removed all bad odor in 3 minutes, with a change of color to a dirty grayish-brown.

"The purifying action of permanganate of potassa is so remarkable that its success in the disinfection of putrid matters of every kind may safely be assumed. I have derived the greatest advantage from its use for many other sanitary purposes besides those just mentioned. It not only effectually destroys the foul odors arising from suppurations, and from putrefying and fæcal matters, but it acts likewise on many other odorous substances. I will cite a curious fact in confirmation of this. Having one day inadvertently imbued my hands with a concentrated solution of carbolic acid, I could not rid myself of the penetrating and offensive smell. Repeated washings with soap, followed by applications of vinegar, chloride of lime, and ammonia, failed to remove the odor. Being on the point of attending a consultation to which I was very reluctant to carry so nasty a smell, I was in despair. The idea occurred to dip my fingers in permanganate solution. The first application caused a notable diminution of the carbolic odor; after the third, it had entirely gone."— *Med. Press and Circular.*

DRY-EARTH DISINFECTION. BY FREDERIC LENTE, M.D.

"My visit to the asylum for the insane, or 'Jamaica Lunatic Asylum,' in Kingston, affords me an opportunity to illustrate the excellent effects of the 'dry-earth system' of sewage, and to give positive proof of these results even when employed in comparatively large institutions. This system is destined soon to attract a large share of attention throughout the world from physicians, and from sanitarians generally; and I feel that the time and space are well spent in spreading any new or positive information on the subject before the readers of the 'Journal.' One very great source of trouble and expense, especially where there is no head of water with an abundant supply, is the arrangement of suitable water-closets, and subsequently the constant supervision and expensive repairs which they usually require. Dr. Allen has obviated the whole difficulty, in the case of his establishment, at one stroke, and not only gets rid of excrementitious matters by a very simple method, but actually makes it a source of no inconsiderable profit. He has secured this result by the adoption of the above system, which he calls the 'earth closet.' He found, on assuming charge of the asylum, the dormitories constantly offensive from the gases emanating from the badly constructed drains, and diseases generated thereby. He closed up all these at once, and in each closet placed a suitable vessel, and alongside a covered box of ordinary dry earth. This is the whole contrivance. A little of the earth, say 2 or 3 handfuls, is first thrown in, and after the vessel has been used the same amount is thrown over, just enough to cover it well. All odor is checked at once. In fact, odor is almost entirely prevented by the earth already in the vessel. This may remain until it is convenient for the attendant to remove it. The doctor has extended the system to the bedside, and I can testify that it answers perfectly. Each commode has an earth-box attached, and if a bedpan is used a little earth is thrown in; and, what is remarkable, the discharge may be left upon it for inspection when necessary, and the odor is completely absorbed. The contents of the vessel, when emptied, are thrown into a box or barrel under shelter; when full, this is allowed to stand a couple of weeks or so, when it becomes perfectly dry, and may be used over again several times, if necessary, without any change either in its appearance or odor. Dr. Allen has also used it in his own house, where he carries out the earth system, as a matter of experiment, as many as five times successively. In places where earth is difficult to be had, this is a fact worth remembering. Of course, its value as a manure is thus multiplied by as many times as it is used. When assistants are scarce, the receptacle for the contents of the vessels may be kept in the hall or ward, without any danger of contamination of the air. Instead of china or earthen ware vessels for the closets or commodes, Dr. Allen has had constructed by a carpenter small cubical boxes, which slide in and out as a drawer, and which are not even lined, but merely well pitched, and then painted on the inside with gas tar; a shallow box for the earth forms the back of the commode. This answers every purpose and costs him almost nothing. This system has also been introduced into the general hospital by Dr. Steventon, and I saw there a closet to which 80 negroes were having access for all purposes, and there was not the least unpleasant odor about it, which cannot be said of any water-closet accommodating half that number, with the thermometer at 85°, that ever came under my observation. With the old system of drains, — but, it must be confessed, a very imperfect one, — in that hospital, although the closets were in a detached building, and every care taken to insure cleanliness, the mortality among the patients occupying beds in the ends of the wards adjacent, and in close proximity, was frightful, — out of all comparison with that of the other parts of the establishment. It ceased as soon as the nuisance was abated. During the prevalence of epidemics, and among the dwellings of the poor, this system becomes invaluable, as it is both cheaper and better than any other, requires no skill or experience, is always ready, or easily attainable. After having been used once or twice, or as long as it is found advantageous to do so, it forms the most concentrated and valuable of all manures; and, when understood by the agriculturist, ought to command a high price. It is, in fact, *poudrette*, but far more powerful as a fertilizer, even when only used once, than poudrette as usually manufactured. The amount of money thus saved in an institution containing several hundred patients would be considerable, and more important still, if used as in the case of the Jamaica Asylum, in the cultivation of a farm worked by the more quiet class of patients.

"In a crowded population, where it is important to carry the cultivation of the ground to its highest possible yield, it becomes proportionally more valuable. In the dormitories of the worst lunatics, the box or utensil for excretions is pushed by an attendant through an opening in the wall at the floor, from the outside, and the patient can thus use it without the possibility of getting hold of it for mischievous purposes. Even for private residences, especially in the country and in villages, this would be a very cheap and convenient arrangement. The closet, placed on the ground floor, but not necessarily, might open by a door about a foot square into a back yard, and thus obviate the necessity for conveying the utensil through any part of the house; nor would it be necessary to remove the vessel more than once a day. This arrangement would be far less expensive than even the commonest privies, which, however well constructed, are notoriously offensive in hot weather, and are often the foci of dangerous epidemics.

"In the December number of the 'London Lancet' is a notice of the 'Bengal Sanitary Commission's Report on Experiments made to Test the Dry-Earth System.' It has been in operation in India for upwards of a year, having been first recommended by the Rev. Mr. Moule. 'The Commission further reports,' says the 'Lancet,' 'that the system is one of the most valuable contributions to practical sanitation, and is particularly well adapted for gaols.' 'The result of official inquiries, as to the working of the system in Bengal, shows that it is thoroughly established in the hospitals, lunatic asylums, and gaols.' Dr. Mouatt, the Inspector General of Gaols, pronounces its introduction to be, 'without exception, the greatest public benefit conferred by a private individual, in a matter so essential to public health, that he is acquainted with.' The Inspector remarks that the employment of dry earth was introduced by Sir Henry Lawrence in the Punjab 'many years before it was perfected as a system by Mr. Moule.' It is gratifying to find, from this report, and the above comments of the 'Lancet,' that I have not overestimated the value of this system, and that the ideas advanced regarding the more general application, as to private houses, villages, etc., are very similar to those entertained by the editor after a careful consideration of these reports from the Indian government." — *New York Medical Journal.*

STREET DUST LAID BY THE USE OF CHEMICALS.

A patent was taken out in England, last September, by Mr. J. W. Cooper, relating to the application of a compound of deliquescent salts to the prevention of dust upon roadways. This season, extensive experiments have been made in the Parish of St. Marylebone to test the value of the invention, and the results seem very favorable. It is estimated that it costs 500,000 dollars per annum to water the streets of London, and, notwithstanding this enormous outlay, the dust cannot be laid. The demand for something more effectual has given rise to the invention referred to. The composition used is from one-half pound to 1 pound of the mixed chlorides of calcium and sodium to 1 gallon of water. The salts are put in the cart and the water is then taken in. By the time the cart is full the salts are dissolved. Although we have had sufficient rain in New York and Brooklyn, as well as in other parts of the country, the season in England has been remarkably dry, and consequently very unfavorable to the development of the principle upon which this invention is based, namely, the retention of moisture by the mixed chlorides. The reports, however, are remarkably favorable. It produces a most important effect upon the surfaces of macadamized roads, hardening and concreting the material in such a manner that when it is perfectly dry no dust arises from the passage of ordinary traffic. The light dust always found upon a dry road surface, watered with plain water, is not to be seen. The surface remains firm with the absence of detritus. The roads are thus rendered more durable, while, the chlorides being anti-putrescent, a sanitary advantage is gained, at the same time that economy in the use of water is secured, — important considerations in all large cities.

By the present system of deluging, three applications daily are scarcely sufficient in warm, dry weather to prevent the dust from blowing, whereas one application of Mr. Cooper's composition at intervals of two or three days will, it is said, effectually accomplish this object, and at a much less cost.

The dust in the large rooms of warehouses and similar buildings might, doubtless, be effectively controlled by adding a little of these salts to the water used.

The shopkeepers, along the streets where this composition has been used, have given their testimony in its favor. They state that, instead of having their shops filled with dust, they can scarcely see a particle, and on Sundays, while other streets are smothered in dust, they rejoice in immunity from this nuisance.

The chlorides used are cheap, and obtainable in large quantities. The chloride of calcium has not been in large demand heretofore, but can be manufactured to any extent. There seems no practical difficulty in the use of these salts, and we hope that a trial of them will be made in this country. The city of Calcutta, in India, is about to test the method. The dust is said to be intolerable there, and of a most damaging nature to clothing, etc., as the roads are made of brick, easily pulverized by the feet of horses and the wheels of vehicles. — *Scientific American, etc.*

THE ELECTROLYSIS OF WATER.

A curious, and, if correct, important paper on the electrolysis of water hàs been published by M. Bourgouin. Pure water, he states, is never decomposed by electrolysis, whatever the strength of the battery employed, or however long the attempt may be persevered in. Sulphuric acid or an alkali is always added to enable, it is said, the water to conduct electricity. His experiments, however, go to show that these bodies perform a more important part than mere conducting agents. When potash was employed, he observed that the amount of hydrogen disengaged was always proportional to the amount of potassium carried to the negative pole, and his opinion is that it is a hydrate of potassium, $K\,HO_2$, which is decomposed. Similarly, in the case of water acidulated with sulphuric acid, he believes that a hydrate, $S\,H_3O_6$, is the body electrolyzed, and that the excess of water takes no further part in the action than to continually replace that removed from the compound named. — *Mechanics' Magazine.*

EXTRACTION OF SULPHUR.

An entirely new process is just reported to have been introduced into Italy by M. Brunfaut, a Belgian. The average composition of the sulphur-stone of the Romagna is, for every 100 parts, 30.60 of sulphur, 26.80 of lime, 41.20 of alumina and silica, and 1.40 of water. By the ordinary method of extraction, only 10 of the 30 parts of sulphur are obtained. There is, therefore, a loss of upwards of 20 per cent., which, of course, must influence not only the profits, but also the price of the article. These defects in the system appear to have been completely obviated by M. Brunfaut, who is said to have obtained a yield of 25 per cent. instead of 10.

As already observed, the sulphur is contained only in a state of mixture in the Romagna stone, and, not being in chemical combination with any substance, is easily separated by fusion. The melting-point of sulphur being extremely low, fusion may be effected by hot air or by steam, instead of in kilns or even heaps, where the excess of heat converts a large portion of the substance into sulphurous acid. Taking advantage of this property of sulphur, M. Brunfaut employs an apparatus which consists of a horizontal cylinder containing an Archimedean screw throughout its whole length. The cylinder is made to revolve more or less slowly, according to the nature of the mineral to be treated. The sulphur ore is poured in through a funnel at one end of the cylinder, and when it has sufficiently undergone the action of the apparatus it is led out at the other end. The temperature in the cylinder is maintained by hot air or steam, which is introduced under a pressure of 3 atmospheres. By this machine 150 cubic metres of the mineral are reported to be disposed of in 24 hours. This economical method of extracting sulphur from its minerals is a matter of great importance to Italy, which is so rich in that valuable substance.

TO ELECTRO-PLATE PAPER OR OTHER FIBROUS MATERIAL.

A mode has been devised for depositing copper, silver, or gold, by the electric process, upon paper or any other fibrous material. This is accomplished by first rendering the paper a good conductor of electricity, without coating it with any material which will peel off. One of the best methods is to take a solution of nitrate of silver, pour in liquid ammonia till the precipitate formed at first is entirely dissolved again; then place the paper, silk, or muslin, for one or two hours in this solution. After taking it out and drying well, it is exposed to a current of hydrogen gas, by which operation the silver is reduced to a metallic state, and the material becomes so good a conductor of electricity that it may be electro-plated with copper, silver, or gold in the usual manner. Material prepared in this manner may be employed for various useful and ornamental purposes.

POISONOUS HOSIERY.

The "British Medical Journal" publishes the following interesting note on Arsenic in Aniline Colors from Professor Wanklyn, of the London Institution. It indicates clearly enough the source of skin-poisoning in magenta-colored socks: —

"It is generally known that some of the old crude magenta cake and liquor which was in the market some few years ago, shortly after the first bringing out of the dye, was largely contaminated with arsenic. But it is not generally known, even to chemists, that much of the beautifully crystallized magenta used to consist of arseniate of roseine, being not, properly speaking, contaminated with arsenic, but actually consisting of an arsenical compound. In the early part of 1863 (assisted by Mr. Robinson, who was my assistant at that time), I made an examination of the beautifully crystallized magenta which was being manufactured in one of the largest coal-tar color works in Europe, and found it to be arseniate of roseine, apparently chemically pure."

SWEET PRINCIPLE OF FROZEN POTATOES.

Dr. Adolph Ott has been examining frozen potatoes for the purpose of confirming or disproving the truth of the common theory that the sweet principle of frozen potatoes is due to the conversion of starch into sugar. After a long series of experiments, he concluded that this sweet principle was caused, during the freezing and thawing, by the sap bursting the cell and thus destroying vitality; at the same time decomposition sets in, which, though retarded by the cold, is not entirely arrested; the more so as at the season most likely to freeze, and especially during a snow-storm, there abounds that powerful oxidizing agent, ozone. The outer portions, no doubt, are first attacked by it, and may thus be transformed into diastase, a body possessing the power of converting a comparatively large quantity of starch first into dextrine, and then, at the temperature of 140° to 170°, as in the process of cooking, into sugar.

ON THE FORMATION OF THE DIAMOND.

Researches on this subject have lately been made by Messrs. Goeppert and D. Brewster. The black diamond of Bahia is, according to Mr. Goeppert, a mixture of amorphous carbon and diamond. M. Liebig's experiments on its combustion also agree with this statement. It often happens that the diamond incloses other crystals; iron pyrites, particularly, has been noticed in it by Mr. Hartwig. Sir David Brewster calls attention to the microscopic cavities existing in this as well as in other gems, as in the topaz and emerald. These cavities are found to be often very numerous in certain dark diamonds; they, thus dispersing the rays of the light, are therefore of no value in jewelry. Mr. Goeppert remarks that the diamond must originally have possessed a certain plasticity; we notice, in fact, in a diamond belonging to the Emperor of Brazil, the impression yet of a sand grain. The black as well as the crystallized white ones bear also the signs of analogous impressions produced by foreign bodies. Some investigators believe they have recognized the cellular tissue of plants in the ashes resulting from the combustion of this gem. Mr. Goeppert, however, has not yet detected with certainty any traces of organization, neither in the diamond nor in its amorphous form, the plumbago. As to the question so often discussed, whether the diamond be formed by Plutonic or Neptunic action, the latter naturalist is of the opinion that the first hypothesis is scarcely admissible, experiments having shown that the diamond is changed into a kind of coke whenever exposed to the intense heat of a galvanic battery. The second hypothesis, attributing its formation to Neptunic action, is sustained by the authorities of Newton, Brewster, and Liebig, being also that which is best in accordance with all that is known about the gneiss, itacolumite, and the metamorphic rock in which it is found. The character of these rocks, however, does not allow us to attribute to them a Plutonic origin. — *Cosmos.*

The origin of the diamond has been a subject of much speculation, as the circumstances under which it is found in nature afford no clue to the process of its formation.

Lately, Prof. Simmler, of Switzerland, has added a new theory to the many existing ones. The diamond often incloses cavities, which in some instances contain a gas, in others a liquid. Sir David Brewster, who had given much attention to the subject, found, in investigating the nature of the liquid, that its refractive power is less, but its expansive power greater, than that of water. In comparing the results obtained by Brewster with those calculated for other liquids, Simmler found the numbers for the expansive and refractory power of the liquid referred to, to coincide singularly with those for liquefied carbonic acid. But other facts, observed by different savans, tend to prove also the presence of this agent in the coating of the most valuable of gems. We mention the bursting of such crystals, when exposed to heat, the frequent occurrence of two liquids in the cavities, wherefrom the one behaves like water towards heat and light, and the other like liquid carbonic acid. On one occasion it was observed that the liquid contents, in a quartz crystal which was dashed to pieces, were scattered around with a great noise, burning holes in the handkerchief wound around the hands of the experimenter. The acid content itself had disappeared. Upon these observations Prof. Simmler establishes his theory. If carbon, as he supposes, is soluble in liquid carbonic acid, it would then only be necessary to subject the solvent to slow evaporation, — the carbon would thereby be deposited, and by taking proper care assume crystalline forms. In evaporating quickly, the so-called black diamond might perhaps be produced, which in the state of powder is largely used for polishing the colorless diamond. Though the liquid referred to has never been subjected to chemical analysis, the formation of liquid carbonic acid in the interior of our globe may nevertheless be considered as highly probable. In the gaseous form, we know it to be evolved in immense quantities from fissures, volcanoes, and mineral springs. When, now, this gas is produced in the cavity of a rock which is free from fissures, it will finally be compressed so highly that it will assume a liquid form by itself. Certain rocks may be considered strong enough to resist the expansive force of this agent. Let, now, carbon be present: if the same is soluble, it will be taken up and deposited again while the carbonic gas is escaping through some newly formed cracks or fissures. — *Scientific American.*

At a recent meeting of the scientific department of the Silesian Society, Prof. Göppert read the following contribution upon this subject which we here translate: —

" In the year 1864, in a paper entitled 'Upon Inclosures in Diamonds,' which was honored with a prize by the Holland Society of Sciences in Haarlem, I discussed the various theories respecting their formation, the pyrochemic and the Neptunic, together with the arguments pro and con. In view of the inclosures to be met with in diamonds, the nigrescence and the coke-like formation produced in them by combustion, and the conduct of the so-called black diamond when subject to a similar process, and finally by reason of their occurrence in and with Neptunic formations, I pronounced myself in favor of their Neptunic origin, without however finally disposing of the question as to their possible organic origin, but merely giving some specimens which might hereafter be turned to account. These specimens consisted of faithful representations of several inclosures contained in various diamonds of my collection, which not only bore resemblance to rounded and parenchymatose plant-cells, but might, not improperly, be compared to algæ and fungi. Although well acquainted with the more frequent formations produced in diamonds by bubbles, cracks, and flaws, and consequently thoroughly aware of the difference, still I have not yet ventured to declare these other formations to be of organic origin, or even to designate them by a systematic name, but contented myself with calling the attention of investigators to them. They merit such attention all the more, since, very recently, the so-called primitive clay slates, even gneiss, which accompany diamonds, have, through the discovery of organic remains (I need only call to mind the *Eozoön Canadense* in the lower gneiss of Murchison), been drawn more and more into the group of palæontological strata. Delesse, in an interesting article on the occurrence of nitrogen and organic compositions in the earth's crust, published in the journal of the German Geological Society in 1860 (Vol. XII., p. 429), has discovered the like in a great number of minerals, as in quartz, fluor-spar, emerald, the loadstone, calc-spar, also in granite, porphyry, diorite, melaphyr, serpentine, trap, basalt, hornblende slate and itacolumite, the supposed matrix of the diamond. The supposed, I say, since Tschudi has recently and correctly drawn in question its natural occurrence in itacolumite, and even declared its flexibility, that much-admired property of this remarkable stone, to be not original, but imparted to it by heat. Gustav Bischof ('Text-book of Physical and Chemical Geology') pronounces himself in favor of the aqueous origin of the diamond. Prolonged investigations have recently led me to examine a rhomboidal diamond, in which I observed for the first time (what bears especially upon the question of aqueous origin) dendrites formed of extremely delicate blackish grains, just as they frequently occur in chalcedony, jasper, and other minerals formed by watery process. Of still greater importance are two diamond crystals with green-colored inclosures, which I discovered in the Royal Mineralogical Cabinet in Berlin, and which were submitted to my examination in the most generous manner by Prof. Rose. The first one, weighing 263 milligr., contains a great number of accurately round grains of a uniform green, and scarcely compressed; even in those places where they lie close together, they do not run into one another, nor flatten one another, but preserve their rotundity. This involuntarily reminds us of an alga, a *Palmellacea*, like the *Protococcus pluvialis*, which indeed it resembles exactly. The second crystal, 345 millgr. in weight, displays a similar alga-shape of a like green color; the grains are not so round, but rather drawn out, often hanging to one another like the links of a chain, often occurring singly or in pairs. These last appear then joined originally to one another by a bridge-like prolongation, then subsequently united into some larger body; these forms, resembling the structure of the lower algæ, occur too frequently to be set down as casual formations, even although the definite shape does not stand out so unmistakably as in the Protococcus in the previous diamond. I must confess to the opinion that we have here only a filling out of the organic form, and that the green color, notwithstanding its similarity with that of the Palmellaceæ and other of the lower algæ, is due to minerals. Among the algæ known to me, it reminds me most of the *Palmoglœa macrococca* (Kützing), described by A. Braun in 1849. — *American Athenæum.*

MANUFACTURE OF ARTIFICIAL DIAMONDS.

The French publication, "La Propagation Industrielle," publishes a description by M. Caliste Saix of his method of producing colorless, colored, or black diamonds. The system is based on the principle that when a current of chlorine or of hydrochloric gas passes through cast iron in a liquid state perchloride or protochloride of iron is formed, both of which vaporize, the carbon contained in the cast iron remaining in both cases perfectly intact, because the chlorine cannot directly unite with it. The crystallization of the carbon is then within the general rule, for in a body which is dissolved and capable of crystallization, crystallization takes place each time that the dissolving agent evaporates, the size of the crystals depending always on the slowness of the operation. 1st. To obtain colorless diamonds, a current of dry chlorine must be brought to the bottom of the crucible containing the cast iron, by means of a bent tube of china or fire-clay. No organic coloring matter resists the action of chlorine, so that the perchloride of iron in evaporating leaves the carbon to become a colorless crystal. 2d. When it is desired to give the crystal a blue, green, pink, or yellow tint, it is only necessary to mix with the cast iron certain metallic oxides in sufficient quantity, such as those of chromium, cobalt, and others, or their salts, which will give these colors. 3d. To obtain black diamonds, hydrochloric gas must be brought to the bottom of the crucible in the same manner as for colored or colorless diamonds. Protochloride of iron will be formed, which is volatile, but in this case the carbon will remain black, in consequence of the presence of hydrogen. This explains the fact of all diamonds having the same chemical and mineral properties, and why in nature the black diamond is found in the greatest quantity, because its formation in alluvial soils requires only the presence of sulphuric acid and marine salt, whereas the others require the presence of particular oxides which are often wanting. To obtain all these varieties of diamonds special furnaces are not necessary; the crucibles must be covered to prevent the oxidization of the cast iron, which might change the carbon into carbonic oxide, and diminish, in consequence, the yield of the operation. These crucibles should be provided with a small tube reaching outside the furnace, which will enable the chlorides resulting from the reaction to be gathered. When the liquid cast iron has been almost completely evaporated out of the crucibles, the diamonds can be removed without disturbing the crucibles, and by means of solvents any cast iron which might be adhering to them can be removed; the operation of cutting will thus be shortened, for there will be no more oxidized particles to remove, and the crucible will be ready for a fresh operation. According to M. De Saix 1 kilogramme of cast iron will yield at least 60 grammes of diamonds. The cost price of the colorless diamonds will be about 20f. per 60 grammes, which, at the current price, would be 75,000f. The cost of the black diamonds will be under 5f. per 60 grammes, representing a value of 14,200f. — *Scientific American.*

CRYOLITE AND ITS PRODUCTS.

This remarkable mineral, partially transparent, of a vitreous lustre, and brittle texture, is a fluoride of sodium and aluminium, containing: —

13	per cent.	aluminium.
34	"	sodium,
53	"	fluorine.
100		

It is found in an immense deposit in Greenland, at Iviktout, at the head of Arksut Bay, near Cape Farewell. The first discovery was made by one of the missionaries, who carried a specimen with him to Copenhagen. Its true composition was determined by Vauquelin.

There is a bed 80 feet thick, and 300 feet long, at the above-mentioned place.

It is frequently associated with the salts of metals; and beautiful crystals of galena, or sulphide of lead, chalybite, or brown spathic carbonate of iron, resembling spar in lustre, copper pyrites with silver, iron pyrites, etc., are found therein, arranged in masses segregated from the white, transparent, ice-like cryolite.

The Pennsylvania Salt Company introduced to our country this valuable material.

They are now devoting their attention to the preparation of caustic soda, carbonates, and other salts of soda, sulphate of alumina, etc.

Soda is obtained from cryolite by simply mixing with lime, and subjecting to heat. The fluorine combines with the calcium, forming fluoride of calcium; while the remaining metals absorb oxygen from the air, and become alumina and soda. Carbonic acid is then passed through the solution, forming with sodium a carbonate of soda, which remains suspended, while the alumina, being insoluble, is deposited at the botton of the vessel. The carbonate of soda is deprived of its acid by means of lime in the usual manner, and thus rendered caustic, and fitted for the use of the soap-maker.

One hundred pounds of cryolite yield 44 lbs. dry caustic soda;

or 75 lbs. dry carb. soda; or 203 lbs. crystal carb. soda; or 119½ lbs. bicarb., and 24 lbs. alumina.

The sulphate of alumina contains 2.82 of sulphuric acid to 1 equivalent of alumina; therefore, this is more than a neutral salt, which is very desirable for manufacturers of paper, calico printers, etc. It is also entirely free from iron, another very important characteristic.

There is another very important use to which cryolite can be applied. By a fusion of 1 part of cryolite with from 2 to 4 of pure silex, a beautiful glass is formed, susceptible of mould and polish, and capable of being manufactured into an endless variety of useful and ornamental articles, and probably many utensils for chemical and pharmaceutical use will be made of it. The cost is, at present, from 10 to 20 per cent. higher than ordinary flint glass. The ware seems to be stronger than glass. — *Druggists' Circular.*

THE METAL CERIUM.

M. Wöhler has published the following facts concerning the metal cerium. The metal itself was obtained by the following process: A solution of the brown oxide of cerium in hydrochloric acid was mixed with an equivalent quantity of chloride of potassium and of chloride of ammonium, and the whole evaporated to dryness. The mass was then transferred to a platinum crucible, and heated till the whole of the chloride of ammonium was volatilized and fusion obtained. The fused mass was poured out, coarsely powdered, and mixed while still warm with fragments of sodium, and introduced into an earthen crucible previously heated to redness. When the contents had again fused and the excess of sodium volatilized, the crucible was removed from the fire; the deep gray resulting mass was filled with little metallic globules. In a second experiment a large piece of sodium was thrown into a red-hot crucible containing chloride of potassium, and then the coarsely powdered chloride used before. In operating in this way, a larger proportion of metallic globules was obtained, some of which weighed 50 to 60 milligrammes. These metallic globules appear to consist principally of cerium. The color of the metal is intermediate between the color of iron and that of lead. The metal is lustrous when polished; it is malleable. Its density is about 5.5 at 12°. Exposed to the air it loses its lustre, and becomes slightly blue. It feebly decomposes water at 100°. Hydrochloric acid dissolves it with energy; concentrated nitric acid converts it into clear brown oxide; the dilute acid dissolves it. By evaporation a white salt is obtained which leaves, after calcination, a brown oxide, insoluble in nitric acid and in dilute sulphuric acid. Concentrated sulphuric acid slowly dissolves this oxide, forming a yellow solution which shows the reactions of ceric salts. Hydrochloric acid dissolves this oxide with disengagement of chlorine, forming a colorless solution. When a globule of cerium is heated by the blow-pipe to dull redness, the metal inflames and burns vividly, forming brown oxide; but upon submitting a globule suddenly to a very high temperature, it burns with explosion, sending out bluish sparks. Cerium powder can inflame below 100°.

THE NEW METALS.

The "Boston Journal of Chemistry" says: We presume but comparatively few of our readers have had opportunities of examining the new metals brought to light by spectrum analysis. The two most remarkable, cæsium and rubidium, are strikingly like the metal potassium; and so greedy are they for oxygen, it is necessary to keep them constantly immersed in pure naphtha. The expense of eliminating these rare and sparsely disseminated metals is so great that their cost is marvellously high. A specimen of rubidium in our possession cost us at the rate of more than 7,000 dollars a pound, or 1 dollar the grain. These two new alkaline metals were discovered by Bunsen, a few years ago, while experimenting upon some mineral waters with the spectroscope. By no other method of analysis could they have been discovered. In examining the waters, he observed some bright lines he had not seen in any other alkalies which he had investigated. He felt certain that these lines indicated a new metal or metals, just as Adams and Leverrier, from the perturbations of the planet Uranus, were convinced of the existence of Neptune. The amount present in the substance examined could not exceed the one-thousandth part of a grain; hence, the quantity held in the water was infinitesimal. To obtain a manageable quantity, Bunsen evaporated 40 tons of the Durkheim Spring water, and from this vast amount obtained of cæsium only 105 grains of the chloride, and of rubidium 135 grains! How few know anything of the magnitude of the labors of chemists engaged in research! Since the discovery of the new metals in the spring-water of Durkheim, they have been found in many other springs, in mica and other old Plutonic silicates; also, in the ashes of beet-root, tobacco, coffee, and grapes. The mineral lepidolite contains considerable rubidium, and most of the specimens in the hands of chemists were obtained from that mineral. We cannot predict for the new alkaline metals any very great practical use in the arts.

The other new and interesting metals which we find in our collection are lithium, thallium, and indium. The first of these is of white color, and fuses at 180°. It is the lightest metal known, being almost as light as cork. Before spectrum analysis was discovered it was supposed the lithium salts were very rare; but the wonderful spectroscope reveals their presence in almost all waters, in milk, tobacco, and even in human blood. A very strange plant is the tobacco-plant. How singular, that atoms of the rarest and most remarkable of all the metals — cæsium, rubidium, and lithium — should be found in this pungent weed! When volatile lithium compounds are heated in flame, they impart to it a most magnificent crimson tinge; nothing in ordinary pyrotechny can compare with it. If one six-thousandth part of a grain of lithium be present in a body, the spectroscope shows it when it is volatilized, or burned.

SUMMARY OF CHEMICAL NOVELTIES.

Carbonization of Wood. — M. Gillot, in a memoir to the French Academy of Sciences on this subject, says the only condition essential for the production of good charcoal is, that the operation shall proceed slowly. The decomposition of wood commences at about the boiling-point of water. During the decomposition, the production of carbonic acid causes a development of heat in the retort greater than that out of it, when the heat applied approaches 300° C. Too rapid an increase of internal heat gives rise to the formation of tar and gaseous products, diminishing in a corresponding degree the useful accessory products, as well as the yield of charcoal. The condensed products contain the largest proportion of acetic acid (about 28 per cent.) when the temperature of the oven is 218° C. In this way a given amount of wood will yield about two-thirds in weight of charcoal, and 7 or 8 per cent. of acetic acid.

Electric Gas Signal. — A Berlin mechanic has invented an ingenious apparatus for giving an alarm in case of the presence of carbonic oxide or coal gas in a room. It consists of a galvanic battery with a bell and a glass tube filled with liquid chloride of palladium. This metallic salt is extremely sensitive to the pressure of carbonic-oxide gas. A small quantity of the gas will at once throw down some of the metal from the solution, and this precipitate collecting in the bottom of the tube establishes a connection in the current of electricity, and the violent ringing of a bell will warn the sleeper of his danger.

Bronzing Cast Iron. — The following is a method of giving cast iron the appearance of bronze without coating it with any metal or alloy: "The article to be so treated is first cleaned with great care, and then coated with a uniform film of some vegetable oil; this done, it is exposed in a furnace to the action of a high temperature, which, however, must not be strong enough to carbonize the oil. In this way the cast iron absorbs oxygen at the moment the oil is decomposed, and there is formed at the surface a thin coat of brown oxide, which adheres very strongly to the metal, and will admit of a high polish, giving it quite the appearance of the finest bronze." — *American Artisan.*

Process for Covering Iron and Steel with Copper without a Battery. — This process, due to Herr Graeger, is described in a recent number of the "Polytechnisches Notizblatt." The objects are first well cleaned, and then painted over with a solution of protochloride of tin, and immediately afterward with an ammoniacal solution of sulphate of copper. The layer of copper thus produced adheres so firmly to the iron or steel, that the different objects can be rubbed and polished with fine chalk without injuring the deposit. The tin solution is prepared with 1 part of crystallized chloride of tin, 2 parts of water, and 2 parts of hydrochloric acid;

the copper solution, with 1 part sulphate of copper, 16 parts of water, ammonia sufficient to redissolve the precipitate formed when it is added. Zinc and galvanized iron can be treated, according to Boetger, directly by the copper solution, without using the tin salt.

Action of Water of Lead.—Professor Boetger, inquiring into the cause of the action of distilled water on lead, has found it to be due to the presence of carbonate of ammonia, and not, as is usually ascribed, to the air dissolved in the water. After having been boiled for a time, distilled water will not attack the lead until after a considerable exposure, when a reabsorption of ammonia and carbonic acid from the air, where they are always present, may be supposed to have taken place. Boetger has further found that the alloying of the lead with a small amount of tin protects the former from being acted upon, and this fact suggests the advantage of purposely introducing a little tin into the metal from which lead piping is to be manufactured.

Combustion.—The perfect combustion of 1 ton of anthracite coal, or of coke, requires over 5,970 pounds of oxygen, derived from about 340,000 cubic feet of air at ordinary temperature, equivalent to a column 1 foot square and over 64 miles in length. This calculation is based upon the supposition that all of the oxygen of the air is made available; but in practice it is found necessary to introduce twice the quantity of air that by calculation would be sufficient.

In the conversion of 1 part of solid carbon into carbonic oxide, there are involved 2,473 heat units. In the conversion of the carbonic oxide thus obtained into carbonic acid, there are involved 5,607 heat units, making 8,080 heat units in all, of which the first or imperfect combustion yielded but 31 per cent. of the obtainable heat; so that to limit the supply of air, so as to cause the exclusive production of carbonic oxide, would necessitate the use of three times as much fuel as would be required to do the same work were it properly burned.

Galibert's Apparatus Improved.—This patent hood, by means of which any person can penetrate into poisonous atmospheres without danger, has been described in "Annual of Scientific Discovery" for 1868, pp. 83, 84. While communication is kept up with the external atmosphere, the wearer of the apparatus is obliged to rebreathe the air expired by his lungs, and the latter soon becomes surcharged with carbonic acid. M. Galibert now obviates this difficulty by providing a receiver, into which he puts potash, the effect being to absorb the poisonous gas and make the expired air again fit for respiration.

Preparation of Oxygen and Chlorine.—In a paper communicated to the Academy of Science, M. A. Mallet stated that between 200° and 400° F., and in presence of steam, protochloride of copper absorbs oxygen from the air almost instantaneously to form an oxychloride, which parts with its one atom of chlorine at a higher temperature. So that oxygen gas, or chlorine gas, can be prepared at will, and in as large proportions as we wish, the same protochloride of copper serving over and over again.

Alcohol from Wood. — In the process of making paper from wood, as practised in Europe, round disks of wood are first subjected to the action of hydrochloric acid to dissolve the spongy cellulose. This latter has, until lately, been a waste product, but is now converted into alcohol in this way: The wood is boiled for 12 hours in hydrochloric acid, diluted with 10 times its volume of water. The acid liquid, which is charged with grape sugar formed from the spongy cellulose, is then withdrawn, the excess of acid saturated with lime or chalk, and a small quantity of yeast is added, the temperature being kept at about 68° F. Fermentation soon ensues, and when bubbles of carbonic-acid gas are no longer evolved, the liquid is distilled to obtain the alcohol.

Gas-proof Cement for Laboratories. — Sorel's cement of basic chloride of zinc, when properly applied, is safer and better than the common lutings employed for preventing the escape of noxious gases, as, for instance, in the preparation of chlorine. For this purpose, commercial zinc-white is mixed in a mortar with one-half its bulk (or an equal weight) of fine quartz sand, and then rubbed up with an equal weight of chloride of zinc solution of 1.26 specific gravity (30° Baumé). — *Dingler's Journal.*

Harmless "Pharaoh's Serpents." — A new method of making the chemical toys called Pharaoh's Serpents has been suggested by Vorbringer. The black liquor, which results as a useless product when coal oil is purified with sulphuric acid, is treated with fuming nitric acid. The dark-colored resinous matter which swims on the surface is then collected, washed and dried, when it forms a yellowish-brown mass, having about the consistency of sulphur which has been melted and poured into water. When this is ignited it undergoes such a wonderful increase in bulk that a cylinder 1 inch long will give a snake about 4 feet in length.

Chloride of Silver. — Prof. Morren has observed some curious reactions of chloride of silver when in presence of chlorine. Moist chloride of silver recently prepared with an aqueous solution of chlorine, when enclosed in a glass tube, gradually becomes blackened when exposed to light, silver being reduced and chlorine liberated. On the sealed tubes being placed in darkness, the liberated chlorine would recombine with the silver, again forming white chloride of silver. This decomposition and recomposition might be effected indefinitely. So also of bromide of silver and other salts.

Test for a Free Acid. — Dissolve chloride of silver in just sufficient ammonia to make a clear solution. If a little of the test be added to ordinary spring-water, the carbonic acid present in the latter will neutralize the ammonia and precipitate the chloride. The above forms a good lecture experiment, the test being a very delicate one.

To Remove Aniline Colors. — Instead of powdered metallic zinc, which simply converts them into compounds of zincaniline, without always rendering them soluble in water, Dangeville and Gautin employ a solution of permanganate of potash, with some dilute sulphuric acid, thickened, if required, by clay or gelatinous silica, and followed by a bath of sulphurous acid.

Thymic Acid. — This acid, obtained from the essential oil of thyme, has been proposed as a succedaneum of carbolic acid or creosote. It emits no disagreeable smell, and is powerfully antiseptic. Its composition is $C_{20}H_{14}O_2$. In a concentrated form it may take the place of nitrate of silver; and, as an antiseptic, it should be dissolved in 1,000 parts of water, with the addition of a little alcohol.

New Alloys of Lead and Tin. — Two new alloys are described, containing less tin than ordinary pewter, which are not acted upon by boiling acetic acid or by salt water, and may therefore be used for some kinds of utensils. The first alloy contains 1 part of tin and 2.4 parts of lead. It has a density of 9.64, and melts at 320° F. It is made by first melting the lead, and, after skimming it, adding the tin, by stirring it constantly with a wooden stick. In the mean time the lead is prevented from settling to the bottom. The second alloy consists of 1 part of tin with 1.25 of lead. It is less malleable and more brittle than the first.

Artificial Magnetic Oxide of Iron. — M. Sidot has communicated to the Academy of Sciences a paper "On the Artificial Production of Magnetic Oxide of Iron." This he does by introducing a small platinum disk, filled with colcothar, into a porcelain tube, situated in a direction parallel to that of a dipping-needle. After keeping the tube at a temperature a little below a white heat for about an hour, the colcothar will be found transformed into a grayish metallic oxide, the particles of which are strongly agglomerated together. This mass possesses the property of polar magnetism.

Action of Colored Rays on Plants. — An examination of the tabulated results obtained by M. Cailletet shows that the calorific rays as well as the chemical rays are without action on the dissociation of carbonic acid by plants. It would seem, from an inspection of these results, that the colors the most active in a chemical point of view (in regard to the coloration of chloride of silver, for example) are those which favor the decomposition of carbonic acid the least. Yellow induces the largest decomposition, and red next; violet and blue affect it but little. With green light, whether from the color contained in vegetables, or from solutions or colored glass, the action is peculiar. Under this influence the decomposition of the carbonic acid is *nil;* a new quantity of this gas is, on the contrary, produced by the plants.

Rhœdine. — A new alkaloid, named rhædine, has been discovered by Hesse, in the red poppy and in opium. It is soluble in water, alcohol, and ether, crystallizing from the last in white prisms. Ammonia precipitates it in white crystalline flocculi, bichloride of mercury gives a white amorphous precipitate, chloride of gold a yellow precipitate, and strong acids decompose it in the gold, giving a purple solution.

Tiers-Argent. — This beautiful white alloy consists of two-thirds aluminium and one-third silver. It is now made perfectly homogeneous, and is easily fabricated. Its hardness and lightness are valuable qualities in table furniture. Spoons, forks, goblets, and salvers, made of this material, are rapidly coming into use in Paris.

A New Thallium Mineral. — A selenide of copper, silver, and thallium has been found in Norway and analyzed by M. Nordenskiold. It contains 17 per cent. of thallium.

Minerals of Newfoundland. — Recent investigation has proved that the island of Newfoundland possesses mineral treasures in large variety and abundance. Since the discovery has been made, the project has been revived of building a railway from St. John's across the country to the western shores of the island. The projectors of the road have secured a tract of land 20 miles in width, and extending over the whole length of the contemplated route, the land being wonderfully rich in copper ore of the very best quality. The railroad will open up the entire inland country, and render it accessible for mining operations.

Minerals of California. — Professor Whitney reports that of the 64 elementary substances existing in nature, so far as known to chemists, there are but 36 which have yet been proved to occur in California in mineral combination, and 23 elements are wanting on the Pacific coast. Of these, a few are extremely rare, but the absence of others is surprising. Fluorine, a substance of very general distribution, in its most abundant source, fluor-spar, seems entirely wanting in California, although it may yet be discovered in the micas. Taking the whole Pacific coast, from British Columbia to Chili, the following facts appear: The paucity of species, considering the extent of region as compared with other parts of the world; the remarkable absence of prominent silicates, especially of the zeolites; the wide spread of the precious metals; the abundance of copper ores, and comparative absence of tin and lead; the similarity in the mineralized condition of the silver; the absence as vein-stone of fluor; no mineral species peculiar to the coast.

Iron in Algeria. — The mineral wealth of Algeria is represented to be inexhaustible. At the iron mine Makta-el-Hadeel, near Bône, the mineral in some places crops up above the surface of the ground, and is worked in immense, crater-like cuttings to a depth of 100 feet. About 200,000 tons of ore, yielding 65 per cent. of pure metal, are annually sent to France from these mines.

Copper in New Hampshire. — Professor Hitchcock, in a recent public lecture, said there was enough copper ore in Gardner's Mountain, New Hampshire, to supply all the United States for 200 years, the metalliferous vein extending for 5 miles and having an average depth of 500 feet.

Manganese in California. — According to the "Mining Journal," black oxide of manganese has recently been found in great quantity in a mine on the coast range of mountains in California. Several hundred tons are ready for shipment at San Joaquin City.

Artificial Gems. — The base of these gems, as patented by the superintendent of the Royal Porcelain Works at Berlin, is a flux obtained by melting together 6 drachms carbonate of soda, 2 drachms burned borax, 1 drachm saltpetre, 3 drachms minium, and 1½ ounce purest white sand. To imitate in color the following minerals, add to the flux the ingredients named in connection with each gem: Sapphire — 10 grains carbonate of cobalt; Opal

— 10 grains oxide of cobalt, 15 grains oxide of manganese, and from 20 to 30 grains protoxide of iron; Amethyst — 4 to 5 grains carbonate of peroxide of manganese; Gold Topaz — 30 grains oxide of uranium; Emerald — 20 grains protoxide of iron, and 10 grains carbonate of copper. — *Chemical News*.

Magnesia Crucibles. — According to the "Mechanics' Magazine," a patent has been taken out in France for making crucibles from magnesia, which forms the best materials for crucibles to melt platinum, iron, or steel in. They are moulded by pressure, and are then exposed to the heat of an oxyhydrogen flame, by which they are brought to a semi-pasty condition, when the magnesia acquires its greatest density, cohesion, and hardness.

Arsenic in Bismuth. — Dr. Gunning has shown that the metallic bismuth of commerce almost always contains arsenic. This is interesting in a medico-legal point of view, and also may explain many obscure affections of the skin, mucous membranes and other organs, in persons who make free use of the various cosmetic powders containing bismuth.

New Source of Thallium. — A new source of this rare mineral has been discovered in the flue-dust obtained from a sulphuric acid works in Holland, where pyrites from Suhrort is burned. This flue-dust contains about 1 per cent. of thallium.

Acetylene. — According to Rieth, the imperfect combustion of coal gas, which takes place when the flame of a Bunsen's burner has gone down so as to burn within the tube, has been found to be a rich source of acetylene. The escaping gases are collected by means of a funnel placed over the burner, and connected with an aspirator. The quantity of the silver compound of acetylene obtained from one burner in 12 hours amounted to 100 grammes. — *Zeitschr. f. Chem.*

A NEW PROCESS FOR PRESERVING FOOD.

At a recent meeting of the Massachusetts Institute of Technology, Dr. Sim, of Charleston, S. C., gave an account, with experiments, of his new process for preserving meats.

Putrefaction is nature's process for returning organic to inorganic matter, and this is effected by dialyzation or change in the proportions of the gases of which the former is composed. In meats this is brought about, as generally admitted, by the action of minute animalcules, whose germs float in the air and permeate the animal tissues. Soon after death come the monads and the bacteriums, which commence the process. These require oxygen, and, having taken this, they die. Next come the vibrios, which do not require oxygen for their development, and under their influence putrefaction goes on rapidly. If, therefore, we can prevent the vivification of these germs, we prevent or arrest putrefaction.

Sulphurous-acid gas will do this, but it is evanescent and cannot be fixed. Though theoretically the best, it is not available in practice, being effectual only while it is in contact with the material to be preserved. Carbon is also a powerful anti-putrescent; but it injures the external appearance of the meat and attracts oxygen. In his process the sulphur and the carbon are combined in the bisulphide of carbon, in which both elements are fixed, thus securing the advantages of both, with the disadvantages of neither. No animalcules can come into existence under its influence.

The material is exceedingly cheap, much more so than salt, the estimated expense being one-tenth of a mill per pound of meat preserved. To produce it, it is only necessary to burn sulphur in a close retort, and pass the fumes over glowing charcoal, when the escaping gas may be used as such, or may be condensed into a liquid. He places the meat in a vat or chamber, from which the air is exhausted, by machinery if need be, which is then filled with the gas. He preserved in this way, in September last, at Charleston, S. C., with the thermometer in the shade at 92° F., a whole sheep with the skin on. This meat 4 months after was found to be in a perfect state of preservation. The process goes on best at a temperature of 100° F. to 104° F., and is therefore best adapted for warm climates, where it is most needed.

As usually met with, this gas is very fetid, but it can be prepared without disagreeable odor. If necessary, the protosulphide can be used, which has rather an agreeable odor. But even with the bisulphide, this gas will volatilize at 104° F. in a few minutes, so that the meat is perfectly free from unpleasant odor or taste after cooking. It everywhere permeates the muscular fibre, dissolving the fat, and carrying the oil through the whole tissue, giving a rich taste relished by many epicures.

This process differs from that of Prof. Gamgee (described on pages 75, 76 of this volume), in that the latter begins where his ends; what comes away from his apparatus being the carbonic-oxide and sulphurous-acid gas which Prof. Gamgee uses, — the latter process being principally useful where the air is exceedingly dry.

Fish may also be preserved by immersion for one minute in a solution of bisulphide of soda, made by the action of sulphurous-acid gas on carbonate of soda, with one-tenth of 1 per cent. of carbolic acid.

GEOLOGY.

METAMORPHIC ACTION.

Prof. David Forbes, in "Journal of the Chemical Society," June, 1868, classifies the facts on this intricate subject under six different sections.

1. By pressure alone. — Alterations by compression and induration, often inducing cleavage, as in clay-slates. This metamorphic change is truly mechanical; but occasionally a slight amount of chemical change (combination apparently) has taken place, which possibly might have arisen from the indirect conversion of mechanical into chemical action.

2. By heat alone. — Many soft beds, like shales and clays, become strongly indurated and converted into porcelanite, etc., in near contact with basaltic dikes. Beyond the mere expulsion of water, the change is similar to the baking of stone-ware. Such rocks, *in situ*, are found generally to be more compact also from pressure at the same time.

3. By heat, in conjunction with chemical action and crystallization. — Thus, if a calcareous and ferruginous shale or clay be subjected to a heat much below fusion, whether in nature or artificially, we have a complete change in its appearance and mineral composition, produced by the recombination of its constituents, and the formation of new minerals, such as epidote and garnet, both of which are silicates of alumina, iron, and lime. This will explain the common occurrence of such minerals in the rocks at the point of contact with igneous eruptions, as most of the sedimentary rocks contain these constituents. When constant, but not necessarily great, pressure is added, very striking conversions take place, often due to recrystallization. To a similar cause may be attributed many of the metamorphic crystalline limestones and marbles, when the contact with igneous eruptions may have heated them sufficiently to bring about such molecular changes.

4. By aqueous action, either inducing crystallization, by introducing or dissolving out certain mineral substances, by forming hydrated compounds with others, or by effecting chemical changes through the agency of the gases or solids, or both, held in solution in the water, all of which effects may be more or less assisted by heat and pressure. Thus, the structure of organic limestone may be obliterated, and this be converted into crystalline rock, as the

veins of crystallized calcite in modern coral reefs. Infiltration of water holding carbonate of lime in solution will account for the formation of calcareous sandstones, grits, and tuffs, and the filling up of the pores of many vesicular rocks and lavas with carbonate of lime; the reverse effects would follow from such rocks being subject to the action of waters which could dissolve out such bodies previously existing in the pores of rocks. Certain zeolites or hydrated silicates may have been formed by the water entering into chemical combination with previously anhydrous silicates. Many magnesian limestones and dolomites appear to have been thus formed from limestones of organic origin by the action of solutions containing magnesia. Other limestones have been converted into iron-stones by the analogous reactions with solutions containing iron, as in the Cleveland iron-stones.

5. By gasolytic action, — as of vapors and gases, at times strongly acid, as seen in solfataras and fumeroles, in decomposing and reconstructing rocks; thus are limestones often converted into gypsum, kaolin, and clays derived from felspathic rocks, and many compounds of boracic acid formed.

6. By a combination of two or more of the above agencies; in some of the older deposits all appear to have combined, either at once or at different times. Many mica schists appear to have been originally micaceous sandstones, changed by long-continued gentle heat and pressure, causing recrystallization; so quartzites are often recrystallized and indurated sandstones, or sandstones cemented by gelatinous silica.

Although he admits that hydrothermal action has taken part in these metamorphic changes, he does not regard this, or the combined effects of enormous pressure, heat, and water, as the grand cause of metamorphism. He concludes that these changes in the older strata have, in the main, been effected while these rocks were in a perfectly solid condition, by what may be termed moleculo-chemical action, or a combination of chemical force and molecular movement, which may have been brought into activity by any one or more of the above agencies.

TEMPERATURE OF THE EARTH'S CRUST.

However different may be the opinions of physicists as to the condition of the internal nucleus of the globe, all are probably agreed that there is an actual increase of temperature as we go downward to an unknown depth. The occurrence of strata in an unaltered state, supposed to have been buried beneath newer strata to a depth of several thousand feet, is no argument against this view; for, at an average rate of increase of 1° F. for every 60 feet of depth, the boiling-point of water would not be reached under 12.720 feet, a temperature under which it is doubtful if metamorphism would take place in ordinary strata, and a depth beyond which we rarely can fix the original position of rocks. Experimental evidence, derived from the water of artesian wells, coal-seams, and fissures in mines, and from observations made during the sinking of mining shafts, points to the conclusion of a remarkable uniformity in the increase of temperature as we penetrate the earth's crust.

The surface of the basin of the artesian well of Grenelle, near Paris, is 119 feet above the level of the sea, and the borings extend to the depth of 1,794.6 feet from the surface; the water from the lower greensand formation is at 81.95° F., an increase of 1° for every 59 feet. The boring at New Saltzwerk, in Westphalia, 231 feet above the level of the sea, penetrates to a depth of 2,281 feet from the surface, or 2,050 below the level of the sea, — probably the greatest relative depth ever reached; the temperature of the brine is 91.04° F., and, as the mean annual temperature there is about 49.3°, we may assume an increase of 1° F. for every 54.68 feet. This boring is 487 feet deeper than that of Grenelle, and the temperature of the water is 9.09° higher. Other artesian wells give an increase of 1° for 55 and for 57 feet.

A great source of error in the case of mines is the heat from the spontaneous combustion of pyrites. In a colliery near Sunderland, Prof. Phillips found an increase of temperature of 1° for every 60 feet, at a depth of 1,590 feet, and 1,449 below the sea level; at the Rose Bridge Colliery, near Wigan, taking the invariable temperature at 50° at a depth of 50 feet, the increase was found to be 1° for every 58.3 feet.

The most elaborate and extensive are the observations of Mr. W. Fairbairn, at the Astley pit of the Dukenfield colliery in Cheshire, embracing a period of 10 years (1848–59), and a depth of 2,151 feet from the surface. From 52 recorded observations, with an invariable temperature of 51° at a depth of 16½ feet from the surface, the temperature at the bottom of the pit was 75.5°; an increase of 24.5° in 2,040 feet, or 1° for every 83.2 feet; the rate of increase was nearly as great at the lowest depths as at any portion of the descent.

The observations of Humboldt prove that the increase of temperature is independent of altitude of the place, or of the density of the air.

The temperature of the "invariable stratum" of Humboldt approximates to that of the mean annual temperature of the place, and its depth is regulated, according to him, by the latitude (increasing from the equator to the poles), by the conducting power of the rock or soil, and by the amount of difference between the temperatures of the hottest and the coldest seasons. At Greenwich, the mean temperature is 49.5°, and that of the invariable stratum about 50.5° at a depth of about 50 feet from the surface. For ordinary purposes 50° F. may be taken, at a depth of 50 feet, as that of the invariable stratum for the greater part of central England. In France, a depth of 86 feet and 53.3° are taken.

FOSSIL TREES.

There exists in the vicinity of Cairo, although but little known to European visitors, and still less to the Arabs in general, a petrified forest, which presents features of great attraction to the geologist and antiquary. Owing to the intense heat of the sun, the expedition to this curious natural feature of the country is best made at night-time. Leaving the city by the Gate of Nasr, and travelling in an easterly direction, the tourist reaches the "Tombs of the Caliphs." These sepulchres are small mosques, unique relics of bygone splendor, left altogether to the ravages of time. After passing them, a brief interval reveals to notice, here and there, fragments of petrified wood, — the advance guard of the forest, — which, however, is still some distance off. Bearing uniformly to the east, and surmounting and descending numerous sand-hills, the promised-land is gained at last, and a land more desolate and more barren it would be difficult to conceive. The term "petrified forest" may perhaps seem a misnomer when it is stated that there are neither trees nor leaves. The fragments, to all appearance, are stones, only outwardly resembling wood, and in myriads of pieces are scattered half buried in the sand. One of the most remarkable circumstances is that the most accurate search, the most rigid scrutiny, fails to detect the least vestige of arable land, the smallest oasis, which could have afforded an origin to these mutilated relics of timber. Occasionally a trunk is found riven in two, as if split by the heat. The largest of these specimens measures 10 feet in length, and has a diameter of 12 inches. One would naturally expect that the species or description of timber to which these petrifactions belonged would be identical with that met with at present in the country. The reverse is the fact. The oak, the beech, the chestnut, and others, are distinctly recognized, but scarcely a single specimen can be discovered of the palm, the sycamore, or the fig-tree. Not only does the specific gravity of the specimens vary, as is always the case with timber, but the original color is well preserved. All the tints are plainly perceptible, from the light Naples yellow to the deep red, brown, or even black. The perforations produced by the passage of insects through the bark are clearly visible, and a gummy secretion has been found in some of the holes made in this manner. — *The Engineer.*

Prof. J. S. Newberry, at the 1868 meeting of the American Association for the Advancement of Science, read a paper "On Two new Fossil Trees, the oldest known," found by Rev. H. Hertzer in the Devonian rocks of Ohio.

Last year several interesting specimens of animal fossils were found near Delaware, Ohio, where also some fossil trees have been found. These are all from the Devonian rocks, and on a horizon below any before known to have furnished any fossil flora. Low down in the Hamilton have been found some algæ and land plants. Below these have been found some specimens of fossil wood. Some were trees 2 or 3 feet in diameter, belonging to a class embracing our pine. The fossil referred to in the paper was corniferous. In the corniferous limestone has been found a log 18 feet in length, belonging to the flora of the carboniferous age, not represented in our flora. This class included the lepidodendra and sigillaria. The black slate of Ohio covers a bed of corniferous limestone which appears in the islands in Lake Erie, and constitutes part of the upper Helderberg in New York. On the surface of this limestone are found these fossils. The specimen under discussion was exhibited; the scars of leaves which had fallen from the tree were very distinct. Such trees were evidently water-floated to the location where these fossils were found. They probably originated farther to the north, where are some regions which have been above water since before the Silurian age. Traces of the ancient shore are easily discernible even as far as the south shore of Lake Superior. This fossil is of an order of plants which was near the first that appeared on the land, but which, nevertheless, is a very high form of gymnosperms. The earlier flora cannot be so easily traced, but we know more of the cycads and the peculiar flora of the triassic. Algæ flourished during all the Silurian period, but the land flora is more recent, and these fossils are the oldest and largest known.

ON NEW FOSSILS FROM THE LONGMYND ROCKS OF SWEDEN.

Dr. Otto Torrell, Professor of Geology at the University of Lund, in Sweden, well known for his researches in the fauna of the northern seas, exhibited and described, at the 1868 meeting of the British Association, a series of slabs marked by the impressions of various land plants known to geologists by the name of *Chondrites*. The substance of his remarks went to show that he had these fossil plants from a formation much older than any from which fossils have hitherto been obtained. The rocks from which they were derived were of an age similar to those of the Longmynd rocks in Wales. The under side of many of the slabs were pitted with the markings of rain-drops; and the conclusion which he came to, was, that the character of the plants and the meteorological markings upon them indicated that they had been deposited under shallow water conditions. This he corroborated by showing that a bed of shingle or conglomerate was associated with them, which he judged to have been part of an old sea-beach. The same slabs were marked by the trails of marine worms that had crawled over them. The cast of some of these worms were distinctly to be seen on the surface of the slabs.

The only markings that had hitherto been found in Silurian rocks were produced by plants occupying the lowest position in the animal kingdom. But here we had, much lower down in geological formation, remains of vegetable life of a very much higher position. These plants certainly belonged to the intermediate section of the vegetable kingdom, as they had got all the characters that belonged to true monocotyledons. There was no doubt there were here the remains of very considerable flora. They had been scattered on the surface of the mud, and been covered by a superimposed deposit. The vegetables had then decayed, and left no trace whatever, except their casts, showing in the general form of the leaves and organization a plant which very nearly resembled the common flag of the garden and the river.

Prof. Harkness entered into a somewhat elaborate comparison of these deposits in Sweden, with the earliest fossil-bearing formation in England, with the view of conveying some idea of the immense antiquity of the former. We had now, he said, to pass through 48,000 feet of strata from the existence of land plants known up to the present period, to the existence of the land plants which Mr. Torrell had made known to us. It would be impossible to give any estimate of the time when these rocks were formed,—it was too remote to be measured by human conception. When we consider how slowly deposits take place, and the successive strata of rocks which have come into existence since the plants in question flourished, we can form some idea of the value of Mr. Torrell's discovery.

These rocks were really at the basis of the Cambrian system, or the primordial rocks of Barrande, and older than the oldest rocks of Murchison's Silurian formation.

FORMATION OF DENDRITES.

Dr. Emerson Reynolds read a paper, before the Royal Geological Society of Ireland, on the formation of dendrites. He had some years since noticed that, when solutions of salts were placed upon a plate of clean glass, and the glass placed between the poles of a Rhumkorff coil, the salts gradually worked over the surface of the glass in beautiful moss-like forms, which in many cases were characteristic of the compound contained in solution; the state of dilution, at the same time, having some considerable influence. The author proposed to call these "electric cohesion figures." To produce them we will say that a drop of a solution of cyanide of potassium is put in the centre of a plate of glass, which is then placed upon a sheet of tin foil. One pole of the coil (it is immaterial which) is then brought into contact with the foil, and the other pole is placed in the centre of the drop; immediately on passing the current the solution begins to creep over the surface of the glass in moss-like convolutions.

The dendritic markings on minerals the author believed were formed under a similar condition. He exhibited a beautiful manganesous dendrite taken out of the museum. It was a conchoidal limestone slab, and in his opinion illustrated this electrical explanation conclusively. There was orginally a flaw in the limestone which was exactly at right angles with the plane of cleavage.

Through these flaws, as was evident by the marks, the manganesous solution had percolated, and had perhaps ultimately been the means of making the stone part in two, not however in the direction of the flaws, but in the plane of cleavage. The dendrites which were formed upon the surface in this case were produced from the well-known fact that two surfaces at the instant of their separation are in opposite electrical conditions.

This phenomenon may be illustrated to a certain extent by inserting a drop of the fluid into the interstices of a plate of mica, and then on suddenly parting the plate the dendritic forms are shown. To fix them, the author dusts some finely dried pigment over the surface of the still moist plate, and then fixes this by some transparent varnish.

FOSSIL CONTENTS OF MINERAL VEINS IN THE CARBONIFEROUS LIMESTONE.

Mr. Charles Moore read a paper, at the 1868 meeting of the British Association, upon the above subject, in which he said his attention had been called to it from the fact that the mineral veins in many instances contained organic remains, by a study of which it was not only possible to arrive at the age of the veins in their several districts, but also to some extent the physical conditions associated with them at the time they received their contents. After referring to his published views on the veins occurring in the carboniferous limestone in the Somersetshire and South Wales district, he gave the results of his daily examinations of 134 different samples derived from the mines of Cumberland and Yorkshire. Of those 134 samples, he had found organic remains more or less abundantly in not less than 80, — a fact sufficient to show that, as a general rule, they might be found in almost every vein if a careful examination be given to its contents. Among the organic remains, chief interest would attach to the presence of *Valvata* and other fresh-water shells, often in great abundance and in districts wide asunder, showing most conclusively a connection between the north of England mines and lodes of fresh water which must have found their way into the veins of some neighboring source. Of vertebrata, he had obtained teeth and scales of *Petalodus*, *Ctenoptychius*, etc., etc.; foraminifera were generally very rare, while entomostraca of several species were the most constant organisms, encrinites excepted.

GLACIAL ACTION IN MAINE.

Dr. N. T. True, of Bethel, Me., at the 1868 meeting of the American Association, read a paper on "Phases of Glacial Action in Maine at the Close of the Drift Period." His theory, which was drawn from observation of the remarkable formations known as "horse-backs," which are to be found in every part of the State, is summed up in a continental elevation, followed by ice, then a subsidence, followed by heat and the melting of the ice.

Large basins worn in the hard granite are found, while the pieces of rock which have been detached from the ledge present the appearance of having been torn off by an immense pressure, which was undoubtedly produced by icebergs moving by glacial force over the face of this country. The basins were probably worn in the hard granite by this same force acting for a long time in one particular place. Some idea of the length of the glacial period may be obtained by comparing these cavities with those worn in blocks of marble by constant action of water and gravel under a heavy pressure; and, judging by such a basis, it could not have been less than 10,000 years that the coast of Maine was under immense icebergs, and undergoing the change which it now presents. In certain parts of Maine, and extending even into Canada, large holes are found which were evidently formed by this same pressure, just previous to the decline of the drift period, and in the commencement of the glacial period.

LAKE BASINS.

Prof. Newberry, at the 1868 meeting of the American Association, presented an abstract of a paper on "The Surface Geology of the Basin of the Great Lakes and the Upper Mississippi Valley." He hoped to give some information which would aid in working out the great problem of the drift. The drift formation has been investigated most generally from the top downward. This product of the glacial period in this region has not received sufficient attention. Fragments of limestone from islands in Lake Superior show glacial scratches. Sometimes the furrow is very deep, — effects commonly produced by glacial action. This is the proper source of the drift formation; upon this different kinds of material rest. Boulders are found 500 miles from their native rocks. Sometimes the clay is fine and stratified, and again it contains gravel and some boulders; above this is a bed of boulders and gravel, which is the glacial moraine. The valleys of the rivers were excavated by the glaciers to a depth far below their present level. Sometimes shafts are sunk 150 feet before these beds are reached. There was doubtless once a river-connection between Lakes Erie and Ontario. Lake Erie was formerly only a river, — the ancient river-beds in the vicinity being from 100 to 150 feet below the present level of the streams. At Louisville there was an apparent exception, as there were rock-bottoms in the river, but the city occupies the site of the ancient river-bed. Sometimes there are two bluff formations of different ages. All this clearly indicates that formerly the country was more perfectly drained; that is, that the continent was more elevated. When these valleys were excavated, the drainage was free to the ocean, similar to the condition in California; and the rivers, by their great erosion, wearing away the hard rocks. The origin of the Niagara and Hudson Rivers was evidently glacial. The ancient beds of the rivers on the Pacific coast were far below their present level, showing great land elevation. It is not certain that the continental elevation was sufficient to afford a temperature essential to the formation of the glaciers, which were afterwards melted and left the material of the drift. The glaciers were not unbroken, so that some varieties of formation are found. No glacial action can account for the copper and granite formations, but there is no other reasonable theory concerning the boulders found in the region of the lakes.

ORIGIN OF THE PRAIRIES.

Col. J. W. Foster read a paper, at the 1868 meeting of the American Association, on this subject. He said that, wherever we examine a continental mass, we ordinarily find a wooded belt along the shores, succeeded as we advance inland by grassy plains, and graduating in the interior into inhospitable deserts. Whenever we study the annual precipitation of moisture, in connection with the laws of temperature, we find that, wherever the moisture is equable and abundant, we have the forest; wherever it is unequally distributed, we have the grassy plains; and, whereever it is mostly withheld, we have the inhospitable desert. The varying supply of moisture, then, is sufficient to account for the diversity of vegetation modified to some extent by the physical features of the country, altitude above the sea, and the extremes of heat and cold. A distinguished botanist has undertaken to trace analogies between the formation of the prairies and that of the peat swamps, in the first volume of the Illinois geological reports. It was a theory which presupposed a humid climate, a level country, with imperfect drainage, and with a surface dotted over with lakes and sheltered from the winds, where the peat-producing plants could grow, — conditions none of which obtain where the prairies assume their grandest proportions. It is evident, therefore, that we must resort to other and different causes to explain the phenomena of these grassy plains. Other physicists would attribute the formation of the prairies to the mechanical or chemical composition of the soil, — a theory equally untenable, when we reflect that the surface of these treeless plains may vary in every degree between drifting sands and impervious clays, and that the efflorescences of soda and gypsum which are the evidences of an arid climate at one extremity of the continent would become fertilizing agents at the other. The theory, very much in vogue before the laws of climatology were fully understood, which attributes the formation of the prairies to the annual fires lit by the Indians, is deserving only of passing notice. If these regions were once wooded, we should expect to find the remains of an arborescent vegetation entombed in the sloughs, where they would be capable of indefinite preservation. If their treeless character was due to the annual fires, we ought to expect to find similar tracts east of the Alleghanies. In traversing the great forest adjacent to Lake Superior, where, owing to the resinous nature of the trees, the fires at times rage with unabated fury, consuming even the turf, until quenched by drenching rains, he had seen large areas thus burnt over, but never saw a grassy plain which could be traced to such a cause. In order to fully comprehend the origin of these vast savannas, and to trace that origin to the operation of known laws, it becomes necessary to consider the varying distribution of moisture in connection with the geological distribution of plants. North America may be divided into five zones of vegetation, founded not so much on its botany as on its physical features. 1. The region of mosses and saxifrages. 2.

The densely wooded region. 3. Alternate woods and prairie. 4. Vast grassy plains, where the trees are restricted to the immediate banks of the streams. 5. Vast arid plains, often bare of vegetation, and covered to some extent with saline efflorescences.

From latitude 60° on Hudson Bay, and thence extending north-westerly as far as the Arctic Ocean, lie the "barren grounds" so well described by Richardson. They are treeless, and the simpler kinds of vegetation abound, such as lichens, mosses, and fungi. Below the "barren grounds" we enter upon a forest belt, which stretches continuously to the Gulf of Mexico. The prairie slope has its greatest transverse expansion on the Missouri, and narrows as it goes north. In the temperate zone, the western side of the forest belt would bear south-east, passing west of the head of Lake Superior and striking the west shore of Lake Michigan, whence it is protracted south-west into eastern Texas. Clumps of spruce fir form its outlines to the north, while its southern extension embraces the magnolia and the palmetto. With reference to the forest range, as determined by lines of latitude, and therefore by the vicissitudes of summer and winter temperature rather than the varying supplies of moisture, it may be stated that many of the Canadian types, following the course of the Alleghanies, reach as far south as Virginia, and even Georgia, where they intermingle with forms purely subtropical. While the geographical range of arborescent forms is limited in their northern and southern range by the conditions of temperature, their eastern and western range, taking the Alleghanies as the axis, is limited by the conditions of moisture, and their limits are more circumscribed by the latter cause than by the former. The eastern rim of the Mississippi valley contains many characteristic trees which are but feebly represented where the prairies commence, and disappear altogether beyond the Missouri. On the other hand, vegetable forms are not represented in the eastern margin, which attain their full development as we approach the base of the Rocky Mountains. These changes are wholly independent of isothermal lines, but dependent on the varying supply of moisture.

In the zone of alternate wood and prairie, we include the region between the eastern shore of Lake Michigan and the eastern slope of the Mississippi basin in Iowa, latitude 42° north, longitude 95° west, and thence the western boundary is protracted a little west of south toward the mouth of the Rio Grande. This line is far from being well defined, since the trees follow all of the great valleys of the Mississippi and Missouri to within 500 or 600 miles of the Rocky Mountains. It is in this region that the grasses become predominant over the forest. That the limits of the forest were not more extended in former times is evident from the fact that the sloughs yield no entombed trunks of trees, which in other regions are preserved for an indefinite period of time. The differences in the retentive power of moisture in the soil give to the eastern line of the prairie region an irregular outline, which may be likened to a deeply indented coast, far-entering bays, projecting headlands, and an archipelago of islands. What are known as "oak openings" indicate the transition from the densely wooded region to the treeless plains. The trees stand as an artificial park, shading a greensward devoid of underbrush, so that the traveller may ride or drive in any direction. This characteristic he had noticed almost continuously from Green Bay to the western borders of Arkansas. The trees appear dwarfed and sickly, the extremity of the limbs is often dead, while the main body is covered with foliage, and the trunks when felled are found to be more or less decayed. The change in the character of the grasses and herbaceous plants is more marked even than in the trees. The cactus-plant forms one of the most noticeable plants of the prairie. These plants are the pioneers of a marked change in a vegetation which finds its full development still further in the interior of the continent, and may be regarded as the unerring index of a change in the condition of humidity in the atmosphere, rather than in the mechanical texture of the soil.

The fourth division of the country extends between the Missouri River and the base of the Rocky Mountains. As the traveller advances from east to west, he begins to find increasing signs of dryness in the atmosphere. The rain-fall is insufficient for the cultivation of the crops, and the diurnal changes of temperature are too abrupt to permit the growing and maturing of the subtropical plant. The soil is sandy and porous, the surface in places is covered with incrustations of soda and gypsum, and the streams are rendered unpalatable by reason of the solution of these salts in their waters. The vegetation indicates a similar change of climatic conditions.

The Rocky Mountains form a well-marked division in the climatology of the United States, as well as in the fertility of soil and the distribution of plants. While on the eastern slope we have immense grassy plains, large accumulations of detrital materials, and a gently rolling surface, on the western slope we have large tracts of sandy wastes, of rocky surfaces bare of covering and intersected by numerous and deep cañons, so intricate as to bewilder and impede the explorer. The great basin and the Colorado desert occupy the region between the Rocky Mountains and the Sierra Nevada from the head of the Gulf of California as far north as latitude 42°, and in many respects present physical aspects not elsewhere recognized in North America.

It is a noticeable fact, that while on the Atlantic slope the precipitation of moisture is pretty equally distributed over the four seasons, the tendency to unequal precipitation, comparing spring and summer with autumn and winter, begins to manifest itself on the prairies, and as we enter the plains it becomes still more marked, — the fall, and especially the winter, being the dry season. Having shown, by a series of elaborate calculations, the comparative rain-fall in the different divisions of the continent in each season of the year, he concluded by expressing his belief that a study of the physical features of this country, in connection with the prevailing wind, and the consequent distribution of moisture, and also in connection with the lines of equal temperature, will justify us in drawing the following conclusions: 1. That these great changes in the geographical distribution of plants, under nearly equal lines of temperature, are not due to the mechanical texture of composition of the soil, but to the variable supplies of moisture; that in the winds, as the agents in the distribution of that moisture, we have an adequate cause to explain the phenomena of forest, prairie, and desert.

EAST ANGLIAN GEOLOGY.

At the 1868 meeting of the British Association, the President of the Geological section, Mr. Godwin Austen, opened the proceedings with an address, in which he said Suffolk and Norfolk, which, geologically as well as ethnologically, formed one region, were part of the slope of the North Sea basin, for the North Sea valley was a true physical depression compared with its breadth, and the depth of the North Sea was exceedingly small. The channel running parallel with the coasts of Essex, Suffolk, and Norfolk had a maximum depth of only 180 feet, so that a change to that amount of depression of sea-level would lay bare the whole of the sea-bed from the coast of Northumberland across to Jutland. A depression of 120 feet would extend the great Germanic plain nearly to our area. A deep submarine trough had been traced at a mean distance of about 50 miles from the coast-line of Norway. Across the line of greatest depth the change was abrupt. This curious feature was just what would have been produced by the subsidence of the whole of the southern portion of the Scandinavian region, together with 50 miles of area around to a depth of 600 or 700 feet. There were good grounds for supposing that such had been the process; and the geological history of the basin seemed to supply the precise date of the subsidence in question. It was the depression of the Scandinavian mass along the line indicated which produced the channels of the Skaggerach and the Cattegat, and opened a communication from the North Sea into the Baltic depression.

Over the whole of the European area there is a region which presents broad expanses of water-worn detritus, sands, and loams, often placed at considerable elevations above present water-levels, which, from their superficial extent, have caused them to be identified with the component members of another detrital group (the glacial drift) peculiar to another area, from which they are distinct as to conditions and mode of accumulation. A line drawn across the European area, occasionally on one side or other of that of north lat. 51, defines the north limit of all this class of detrital accumulations of the Kainozoic period. On the south of this, all these accumulations have their limits. North of this line the detrital accumulations are neither local as to composition, nor have they much reference to surface configuration, although such configuration pre-existed. Over this area, too, are the indications of low temperature and broad alluvia. The distribution of the detritus over this area shows that the expanse of water was continuous, and was marine. Over the British and part of the European area there is a good break in Kainozoic time into pre-glacial and post-glacial. This drift-formation, in one form or another, covers the whole surface of this county, from the sea-level up to the summits of the chalk hills. We have in Norfolk evidence of submergence to the extent of 600 feet and upwards. It was a time when the whole of the British Islands group became submerged, with the exception of a few salient points; and, taking the levels to be derived from these points, together with the general character of the phenomena, we may accept as certain that subaërial glaciation, in all its varied modes of action, had long been at work here prior to that submergence. The change of relative level was not sudden; it proceeded from north southward; and it is in the north that the amount of the submergence was the greatest.

On evidence such as this, the North Sea area, after the period of the early Kainozoic fauna, or true crag, was seen to be passing again to the condition of terrestrial surface. This old depression of the North Sea, like other tertiary basins, again became part of the general European land surface. A long list of animals, some of which ranged over Central and Southern Europe, no doubt including this very district, had left their remains there.

The whole mammalian fauna, from the Norfolk mastodon to the mammoth, seemed to offer itself as an assemblage of the members of nomad tribes which have yet to be reduced to order of time. The general condition of Northern Europe was terrestrial for the whole of the tertiary or Kainozoic period; during that time its conditions as to climate passed from warm to temperate and to arctic. To its close belonged the evidence everywhere recurring, and at every level of its subaërial glaciation and greater elevation.

He said the subdivision of the East Anglian Kainozoic was as follows: pre-glacial, glacial, and post-glacial.

Pre-glacial. — Crag, in Suffolk, is a local agricultural name for any sandy, gravelly soil; but the early geologists and shell-collectors soon found that it was something more; its very perfect shells were recognized as in part agreeing with those of the neighboring seas, in part as unknown or foreign. It was not till 1835 that a subdivision of the crag was proposed by Mr. Charlesworth; and it was amended (in 1838) by the following classification: Upper Crag of Norfolk and Suffolk, — *a.* Without mammalian remains; *b.* Beds with mammalian remains. Red Crag, 150–200 species of marine shells. Coralline Crag, 300–400 species of marine shells. Thus far back Mr. Charlesworth separated the Norwich Crag from that of Suffolk.

The Forest-bed of Cromer (1824) is one of the most interesting points in Norfolk geology; it is the unmistakable indication of a terrestrial surface, antecedent to the period of the "glacial-drift" accumulations. This old land-surface, at Cromer, is exposed at the sea-level; but it extends inland, and has been met with at considerable depths in the offing. The arboreal vegetation buried in these beds comprises the Norway spruce, Scotch fir, yew, oak, alder, — all of them common north European trees. What the Cromer coast-section demonstrates is, that by process of change of level a forestial condition of the surface had been brought down to the sea-margin, that the trees had died, and that mud-deposits had formed, partly under fresh, partly under brackish water lagoons. Subjacent to the "Forest-bed," and covering the surface of the chalk, is a layer of chalk flints; a like accumulation is seen resting on the chalk in numerous other places, as in the sections below this city, and are all referable to the same agency and period. The flints have been dissolved out of the chalk by the action of rain-water, and left *in situ;* they indicate a long period of subaërial conditions; and their formation is coextensive with the whole duration of those conditions; they are, therefore, of the same period as the "Forest-bed." *Glacial.*— More recently the Norwich sections have been subjected to a closer examination; and, according to Mr. J. E. Taylor, these admit of a two-fold division: the upper is a coarse and rubbly accumulation, with well-rounded pebbles of flint; the lower consists of finer sands. A band of white cross-bedded sand intervenes. Such a change in the character of successive beds would not, by itself, have been of much importance; but zoölogically the differences they present are much more significant.

The Rev. Osborn Fisher, in an elaborate paper "On the Denudations of Norfolk," called attention to the denudations upon the land surface, stating that a certain amount of the fine material was being carried into the rivers, and by them deposited at the heads of the broads or in the sea. This denudation, by pluvial action, was undoubtedly greater where the land was under the plough than it would be otherwise. Upon the coast, the sea was reducing the solid surface to a uniform level. Where the land was high it cut away the bottoms of the cliffs, which then foundered down, and the fallen matter was in its turn carried off, and where it was low, the general contour of the coast was being continued by sand dunes or "Marram Hills," so that where the lower end of a valley was submerged, its bottom was being raised seaward, and reduced to a uniform level and continuous coast-line. But when the waves had played their part the action of the sea was not ended. As the sea cut further into the sand the ground laid under water became subject to the action of tides, so as to be kept on the whole at a uniform depth for a given distance from land. If the waste of the shore was prevented by artificial means, the sea was found to deepen rapidly, and the inclination of the bottom from the shore to be increased. This marine action, if considered, did not appear possible to give rise to any very great inequality of surface, but, on the other hand, it must tend to reduce those already existing. All great inequalities of the sea-bottom must either have been caused by the land having become submerged more rapidly than the sea had time to move its coast-line, or else by elevations and depressions taking place beneath the ocean, or, in a few instances, by powerful currents confined by local circumstances to a narrow course. Since the tides deepen the sea below the level to which the waves acted upon the coast, it must follow that the harder rocks would be lowered more slowly than softer, and shoals be formed. It was to such a denudation as just described that the form of the surface of this country might be supposed to be due at the period preceding the deposition of the crag. It might be safely supposed that the sea-bottom, at the period of the crag, consisted of a shoal bottom of chalk, nearly level on the eastern side of our area, while the same stratum rose as dry land to a considerable elevation towards its central and western portions. There was no evidence that the sea at the crag period occupied any part of the present estuary or wash. It was probable, on the other hand, that the chalk must have extended considerably to the westward of its present escapement. Immediately upon the chalk of Thorpe, where the crag rested upon it, was a thick bed of angular flints, which appeared to be the accumulated result of the removal of the chalk intervening between several successive layers. It was amongst these flints that numerous bones, teeth, and tusks of mastodon and *elephas meridionalis* and other mammalia occurred. His opinion was that the chalk to which these flints were due was moved by erosion of currents which were not strong enough to remove the flint. To account for the bones found amongst flints there was the alternative that the chalk formed a land surface on which bones were left, the flints being accounted for by subaërial solution of the chalk. He inclined to Mr. Prestwich's view. At any rate, the sequence of events introduced the deposition upon the crag of a fine clay, most probably formed in an estuary open to the Northern Ocean. To this estuary whales had access, and there was much reason for supposing that it was no other than the estuary of the Rhine and of the Thames, and other rivers which formed tributaries to it. The sides of this estuary next became dry land, so as to allow of the growth of the forest upon the old muddy bottom. He was inclined to think this desiccation cosmical, or at any rate as affecting so large a portion of the earth's surface as not to have left any traces of occurrence in local fauna, or appreciable undulations of the strata. There was reason to believe that the elevated condition of the surface must have lasted for a long period, and it seemed from the fauna of the forest-bed to have been synchronous with a warmer climate than that which preceded or followed it. It was probable that the forest-bed extended to the chalk land as far as the subsoil of clay extended; but it was not probable that vestiges of it would be always preserved. As the land continued to sink lower and lower, the laminated strata of sands, clays, and gravels would accumulate and extend westward, but the forest-bed would not be preserved beneath them except at those levels where it became submerged before the area communicated with the open sea. The close relations of the laminated beds to the crag beds in position would lead one to infer that the coast-line differed little from the coast-line of the crags. The lower boulder clay overlaid the laminated beds. But during the interval between them the sea must have become much deeper, and involved in a system of extensive tidal currents. Ice capable of transporting mineral matter and depositing it at the bottom of the sea occurred under two modifications, as icebergs and as coast ice.

After glancing at the evidence of iceberg action towards the close of the deposition of the lower drift, the formation of which he believed to be gradual, he spoke of the middle drift, when larger masses of chalk were dropped amongst the sand and mud in the deepening sea, thus producing contortions in the stratified deposits. During the period of subsidence intermediate between the deposition of the lower boulder clay and middle clays of Mr. Wood, it was probable that a great amount of denudation took place upon what was now the chalk district of Norfolk. This denudation of the chalk during the period of the middle drift must have been enormous, as shown by the finding of flint boulders in the middle drift.

Prof. Philips said there was a certain fauna below the whole of the glacial deposits which contained a peculiar elephant, the mastodon, and that above this the changes of animal life appeared to be distinctly marked, even of terrestrial creatures. At a late period the reindeer was introduced, and all were aware that the great number of cervine quadrupeds of late years had become to be recognized, so there was a distinction in the race of *Elephas*, of *Bovidæ*, and of *Cervidæ*. All these groups showed that the portion of time has been a long one; that there had been produced in it a variety of forms not seen before; that many ancient forms had died out, so that they were able by the process to connect the earliest period of the deposits, including the crag, with all these. Although each stage had had its own peculiar animals and peculiar points in history, that land and sea were traceable to the present, with some variations. Those ancient animals had their representatives now, and the whole course of geological time from the crag to the present was only one group of deposits, one group of circumstances, one great series of time.

Mr. J. E. Taylor read a paper upon this subject, the general conclusions of which were, that the whole of the mammaliferous bed above the chalk and beneath the crag, as described by Mr. Fisher, was quite distinct from the true crag; a few shells interlocated having found their way when the land surface was lower so as to form the shallow bottom of an estuary; that the total absence of fresh water and land shells in the upper crag, and the predominance of those usually found at a greater sea depth, indicated that this bed was formed under more distinctly marked marine conditions than the lower or fluvio-marine crag. The paucity of shells in the former, and their immense abundance in the latter, was another proof of their separate and distinct conditions. Meantime, the increasing cold was proved by the abundance of northern shells in the upper beds, as compared with the lower. In short, the upper crag was one more intermediate link in the evidence of refrigeration, as proved by the coralline crag upward, and the succeeding glacial series was only the result to which a study of the various crags necessarily led the investigator.

ON THE TERTIARY DEPOSITS OF VICTORIA.

According to Mr. H. M. Jenkins in a paper presented to the British Association in 1868, the most varied section of the marine tertiary beds of Victoria is exhibited on the coast west of Cape Otway, a headland situated south-west of Port Philip Bay.

The cliffs on that coast exhibit for the most part a monotonous continuation of false-bedded, somewhat irregularly stratified, but more or less horizontal calcareous sandstones of post-pliocene age, capped by sand-dunes of very recent date. At irregular intervals, however, the subjacent strata make their appearance, as patches which have escaped the destructive denuding action which has swept away almost the whole of these formations, and has formed the trough in which the false-bedded sandstone was deposited.

He stated that the tertiary deposits were accumulated in a trough of mesozoic carbonaceous sandstone between Castle Cave and Cape Otway; the tertiary beds were afterwards contorted and then denuded; and the trough, now deeper and probably narrower, was refilled with the post-pliocene false-bedded sandstone.

On the eastern shore of Port Philip Bay the series is even more diversified. It is also of peculiar interest, as Professor M'Coy regards certain of the strata on this side, near Mount Eliza, at Schnapper Point, as belonging to the upper eocene period. So far, however, as his investigation had gone, it had afforded no good evidence in support of this opinion. At the same time it is extremely difficult, at the outset, to decide what characters would entitle an Australian deposit to be regarded as eocene. Nummulites had not yet come under his observation, and the shells have too recent a facies for an eocene fauna, although some of the volutes do recall the species of the Bracklesham beds, and those of the German oligocene deposits.

RECENT GEOLOGICAL CHANGES IN CHINA.

Mr. Albert S. Bickmore, in the "American Journal of Science" for March, 1868, contributes an article on the above subject. The following is an abstract of a portion of the article: —

According to Father du Halde's description of China, compiled about 1725, the city Chantsien (the capital of Corea in 1694), where Kipe (the King of Corea at that time) resided, is the territory of Yungping fu, a city of the first order in the province of Pechili.

Now, supposing this to be true, one may reasonably conclude that the ancient Chantsien and Corea were contiguous, and not separated by a gulf till many ages after. For it is not to be imagined that a prince would fix his residence out of his dominions, especially if divided from them by a wide sea.

In entire accordance with Father du Halde's statements, everywhere there appear evidences of a recent elevation above the sea. A consideration of the charts of the Gulf of Pechili and the Yellow Sea farther show that the true eastern border of this plain is not the present sea-shore, but that this plain continues out under the gulf and under the Yellow Sea, on the north to Corea, and on the south of Shantung even to the Japanese Islands, the Lew

Chews, and Formosa. In other words, this plain extends out eastward to the mountain range which stretches along the proper eastern edge of the Asiatic continent, the true Pacific basin beginning only eastward of the islands just named.

If the north of China were to be raised but 120 feet, the whole Gulf of Pechili would become dry land, and if it were elevated as much more, in place of the Yellow Sea there would be a continuous plain from Peking to Corea, and such a change is now actually going on. At Chefoo, on the northern side of the promontory of Shantung, there is a long sand-pit extending out from the main land to a high headland, and forming the western side of the harbor. On this spit are seen two old sea-beaches as perfect as the present one. The highest is but a few feet above the sea, yet it shows what kind of a change the surrounding area has recently undergone, and this is farther strengthened by the testimony of all the Chinese that "the harbor is slowly filling up."

According to Rev. Mr. Metier, there has been an elevation of 14.1 English feet in 250 years, or nearly 5 feet in a century, of the bed of the Gulf of Pechili. If this area had subsided instead of rising 14 feet, probably one-third of the low, thickly populated parts of China would then be beneath the sea.

In the Nankau pass, and for some distance about the place where it opens out to the plain, there appear large quantities of transported boulders. These were probably borne near to the places they now occupy by an old glacier that once filled up this pass, and brought them down from the neighboring mountains, or perhaps even from the southern borders of the high plateau of Mongolia, on which this river of ice probably took its rise. But a short distance from the mouth of the pass, in every direction over the plain, these boulders completely disappear. Many of them have been gathered by the farmers to make walls of their houses, but as few are to be seen in the clay banks, the question naturally arises, whether the materials that now fill the Peking basin have not been so completely sorted and resorted by the action of the waves, as the land has risen and sunk from the level of the sea, that the larger boulders are mostly resting on the rocky floor of the basin, or at least at a considerable distance below the present surface of the ground.

As we followed the flanks of the mountains southward, we came to a remarkable depression in the plain, evidently the bed of a lake that had recently been drained off, not over the plain toward Pekin, but through some rent in the mountains toward the west, into the present channel of the Yang Ho, and along the course of this river to the Gulf of Pechili. Farther down the Yang Ho a small stream comes in on the south-west from a valley where are located the coal mines of Mun-to-kow. This minor valley is bordered with a terrace of 40 or 50 feet in height. Besides these evidences of the late presence of the sea in this region, he was shown at Peking some shells from banks in the vicinity, and believes they were all of the same species as are now to be found in the Gulf of Pechili.

All these changes have occurred without especially attracting the notice of the people, but it has been far otherwise with the Yellow River, whose irregular wanderings and destructive floods have gained for it the well-merited title of "China's Sorrow."

All rivers, after they have worn out their channels to a certain depth, have a tendency to deposit in their own beds a part of the mud and sand they are bearing along, and this tendency is greatly increased by preventing them from overflowing their banks by artificial levees or dikes. The Po in this way has raised its bed until the surface of its water is above the tops of the houses of the peasants, and it has already once deserted its old channel and formed a new one, and this is in short the whole history of the Yellow River. When it had filled up its old channel to the south of Shantung and succeeded in making a breach through its artificial banks, it followed very nearly its previous course north of Shantung to the Gulf of Pechili. The whole plain through which it flows in the lower part of its course being of alluvial origin, and completely intersected by streams and canals, its waters would readily find a lower channel which their momentum in coming down from the higher level of their old bed would enable them to quickly enlarge. The elevation of the land along the sea-coast, at the rate of 5 feet a century, would have a tendency to render its current more sluggish, and consequently the quantity of sediment deposited in its own bed greater than if it remained stationary or was somewhat subsiding. But this tendency may have been partially counteracted by an equal or greater relative elevation of the area along its upper course, and it is perhaps worth remarking, in this connection, that one of the latest changes that has taken place where the Asiatic continent joins that of Europe has been one elevation, and that the Aral Sea, the lakes east of it being merely remnants of one great internal, depressed sea, whose bed has probably undergone a considerable elevation.

The last change in the course of the Yellow River occurred when the Taiping rebels were approaching and threatening Peking, and is supposed to have been caused by a breach made either by them, or, as is more probable, by the Imperialists, to arrest the progress of their formidable enemies. All accounts agree that this change is complete, and that its old bed is dry; but this is merely another way of stating as fact what has just been assumed, namely, that the river continued in its old channel until that had become as high or higher than the surrounding country.

Probably no other river within historic time has wandered so far and so frequently from its old channels as this Yellow River, but also probably no other river on the whole globe flows out on to a plain of such wide extent at right angles to its own course, and, at the same time, of such a perfect and continuous level.

At Foochow and about the mouth of the River Min, he believes there is an area that has for some time been slowly subsiding. According to the Chinese, what is now the navigable branch of the river, between the city and the foreign settlement, was some 900 years ago too shallow for junks and large boats.

In the south of China, Dr. Legge states that along the East

River, he has seen a large bank of shells filled with specimens of shells which he believes will prove to be of living species.

Passing from the continent to Formosa, Castle Zelandia, a fort built by the Dutch in 1634, on what was then an island, is now some distance back from the river and in the centre of the city of Taiwan fu; also at Takao, recent crabs and recent shells are found at a height of 1,111 feet above the present level of the sea.

Passing over to Niphon, we find on the western side of the Bay of Yedo, a plateau some 200 feet high, its top as level as if made by the hand of man. A short journey from Yokohama back to Kanasawa, hence across to the Bay of Kamokura, and up the Tocaido to Kanagawa, shows that all this area is also of very recent marine origin.

North of Niphon, on the Island of Yesso, terraces line the northern shore of Tsugar Strait and Volcano Bay, and what has already been described in Corea, again appears there, but on a much grander scale. The greatest height to which he has been able to trace the recent action of the sea is 1,180 feet. This was found on the flanks of the mountains north of Hakodadi.

All these facts considered in connection with the dry beds of friths and bays along the Siberian borders of the Arctic Ocean, and the remnants of the old gulf that once washed the eastern flanks of the Ural, give some idea of how the Asiatic continent has increased her area within the later geologic times.

THE UPPER MISSISSIPPI.

Gen. Warren, of the U. S. Engineers, read a paper, at the 1868 meeting of the American Association, on certain features of the Upper Mississippi.

He had been struck by the immense excavations made by the river in the Silurian rocks; effects which could not be produced by the present stream, even when swollen by the greatest rains. Some parts of the bed for 200 miles are granitic. Above the Minnesota on the Mississippi is a region which is evidently an extensive lake, which extends to Lakes Winnipeg and Winnipiseogee.

Lake Winnipeg is about 650 feet above the ocean level, while some parts of this old lake bed are 1,000 feet above the sea, — according to Mr. Hines.

The question arose how the outlet was changed from a northern to a southern one. The glacial epoch could hardly account for it. Probably there was a continental oscillation which caused this great change. When the bed of the lake was raised the water flowed over toward the north and south, wearing away the adjacent formations. The evidence of a northern depression is shown by the conformation of the great lakes, the outlet of Lake Michigan formerly having been at the south end. Lake Winnebago anciently was much larger than now, and had a different outlet. It was thought that this continental oscillation was still going on, causing a depression on the Atlantic coast, and extending from the Mississippi to Greenland, tending to elevate the south-western and depressing the north-eastern portion of the continent. The waters of the ancient lake were not sufficient to cut out the channel of the Mississippi. The whole middle region, from the Gulf to the Arctic region, was once covered by a sea, the subsidence or withdrawal of which is indicated by the series of small lakes in Nebraska. During the cretaceous period this area was under water, and the streams from the land east ran west, and the Mississippi was not then formed. These ancient rivers ran in beds older than themselves, but the glacial period obliterated all these features. The glacial drift extends probably as far south as Keokuk, where is found a glacial moraine, 100 miles south of the limit of boulders, as given by Prof. Whitney. The modified drift covers the whole region as far as the Missouri River, beyond which no traces of the glacial action are found. The source of supply of the glacial moisture must have been on the south, and probably the glaciers met the waters of the gulf. The glacial action of the Rocky Mountains never extends more than 50 miles from their base. The action of the great northern glacier made the water-courses almost parallel; the Lower Mississippi resulted from its withdrawal, and marks the former limit of the continent. The difference of level of the Mississippi and Missouri Rivers, in the same latitude, was 400 or 500 feet. The bluffs at Dubuque, Grand Rapids, and some other places, show the effects of the erosion of the river in its formation at the glacial period.

GEOLOGY OF RUSSIAN AMERICA.

W. H. Dall, in a letter from St. Michaels, Russian America, dated August 13, 1867, and published in the "American Journal of Science" for January, 1868, says: "Starting from Fort Youkon and going down stream, we have on either hand low land sparsely wooded with spruce, poplar, birch, and willow, with low hills in the distance, gradually increasing in height and coming closer to the river, where they finally come together 225 miles below Fort Youkon; and the river which previously has been very winding, full of sloughs and large islands, and from 3 to 9 miles wide, here becomes narrow, deep, and rapid, with one channel. These mountains are known as the 'Ramparts,' and come close to the water's edge, having an imposing appearance, though probably not more than 1,500 to 2,500 feet high. They were entirely composed of azoic rocks, of which a silvery greenish rock of talcose appearance, but very hard, predominates. Quartz in seams, slates, and quartzite rock are abundant; and a rock resembling granite, but with a superfluity of felspar and no mica, is rare. The slates generally have a north-westerly dip.

"True granite appears only once, near the termination of the Ramparts, and forms a ledge extending across the river, and making a rapid,—not, however, a dangerous one. Fifty miles or less below the rapid the Ramparts terminate, and the Tananá River comes in. From the end of the Ramparts to Koyoukuk River, 250 miles, the right bank presents in their order, conglomerate, quartzite, bluffs of yellow gravel, blue talcose slate, conglomerate, hard blue slates, and quartzose rocks, blue sandstones, and a soft green rock (Plutonic) with light stellate spots in it. Granite is very rare, and mica also. I have found 5 specimens of obsidian on the beach, and just above the Ramparts, pebbles of Niagara limestone with its characteristic fossils. From the bend we find the following strata: blue sandstone (unfossiliferous), brown sandstone in beds at least 500 feet thick, containing vegetable remains in some layers, and rarely casts of mollusca, all, as far as I have collected, lamellibranchs. Thirty miles below the bend is a small contorted seam of coal between 2 thin layers of shale, containing very poor vegetable remains, and underlaid by the brown sandstone, which also overlies the blue sandstone, which in its turn I think covers the blue slates. The coal seam is very limited, being on the extreme point of a bluff, and the greater part of it has been denuded. The fossils are very poor, vegetable, and resemble fuci. The coal is of good quality, bituminous, non-caking, and leaves a gray ash; the seam is 16 inches wide.

"The sandstones continue down the river some 45 miles, more generally with a north-westerly dip, and always in gentle undulation, sometimes continuous for miles, and often broken short off. Below, the rocks for 300 miles are slates and eruptive rocks of a pink color, sometimes containing spathose minerals. The formation changes at the Russian mission from hard blue slate to a volcanic rock, full of empty almond-shaped cavities; but certain parts of the rock are quite solid; it is black, and contains minute crystals of olivine (?). It is roughly columnar on Stuart's Island, Norton Sound, in five-sided columns on the beach. From this to the sea, the banks are mostly low, but when they approach the river they are invariably blue, hard, slaty sandstone, or sandy slate, the rock passing from one into the other imperceptibly. This formation extends to St. Michaels, nearly where the above-mentioned volcanic rock takes its place, and continues up the shore of Norton Sound some 30 miles, when it is replaced by the hard slates and sandstone, and I have followed them up for 30 miles more to Unalákleet River.

"The entire country is sprinkled over with remains of pliocene animals, *Elephas*, *Ovibos moschatus*, etc. (?). Beds of marl exist near Fort Youkon, consisting of fresh-water shells still found living in the vicinity. The Kottó River, emptying into the Youkon above Fort Youkon, is held in superstitious dread by the Indians, on account of the immense number of fossil bones existing there; the Inglutálic River, emptying into the Norton Sound, has a somewhat similar reputation.

"I have carefully examined the country over which I have passed, for glacial indications, and have not found any effects attributable to such agencies. My own opinion, from what I have seen of the west coast, though yet unproved, is that the glacier field never extended, in these regions, to the westward of the Rocky Mountains, although small single glaciers have existed, and still exist between the spurs of the mountains which approach the coast. No boulders, such as are common in New England, no scratches or other marks of ice action have been observed by any of our party, though carefully looked for. I shall examine the crests of the accessible mountains for traces."

HEIGHTS OF THE PRINCIPAL VOLCANOES.

	Feet.		Feet.
Gualatierra, in Peru,	22,000	Fusiyama, Niphon,	12,450
Sahaira,	22,000	Erebus, Antarctic Continent,	12,400
Cayambi,	19,625	Volcano of Tahiti,	12,200
Cotopaxi,	19,408	Terror, Antarctic Continent,	12,000
Arequipa,	18,000	Peak of Teneriffe,	12,000
St. Elias,	17,900	Etna,	11,870
Popocatepetl,	17,737	Mayon, Philippine Islands,	10,540
Pichincha,	15,900	Hualalai, Sandwich "	10,000
Agua, Guatemala,	14,900	Awatschka, Kamtschatka,	9,750
Fuego, "	14,700	Fojo, Cape de Verds,	8,100
Cartajo, Costa Rica,	14,000	Pico Island,	7,618
Demaverel, Asia,	14,000	El Viejo, Nicaragua,	7,000
Mauna Kea,	13,800	Monotombo, "	6,500
Mauna Loa,	13,760	Hecla,	5,000
Volcanoes of Java,	12,700	Vesuvius,	3,932

ON THE OCCURRENCE OF THE MASTODON UNDER THE BASALT OF CALIFORNIA.

In the "American Journal of Science" for May, 1868, is an article by Prof. Silliman, in which the evidence is given leading to the conclusion that the mastodon existed prior to the great volcanic disturbances and outpourings of lava which occurred throughout the Sierra Nevada Mountains during, or at the close of, the epoch in which the deep-lying placers were produced. This epoch of volcanic activity has been regarded as marking the period of the pliocene, dividing it from the post-pliocene and existing epoch by a well-marked horizon. Among the animals whose remains have been found in this ancient auriferous detritus of California, preceding the epoch of volcanic activity, are the rhinoceros, a hippopotamoid, an extinct species of horse, and a species allied to the camel. The remains of mastodon and elephant are found abundantly in the superficial detritus of the gold region, over an extensive area, but, until now, have never been identified as occurring under the basalt, which covers the ancient gold drift, and forms the characteristic ranges of the "Table Mountains."

Near Jamestown, in Tuolumne county, extensive explorations have, for 14 years, been made in the deep-lying gold detritus, by tunnels driven in beneath the basaltic capping, at a level low enough to open the bed of the ancient rivers, in the channels of which rests the gold-bearing gravel. These tunnels are, in some cases, more than 3,000 feet in length, and from 200 to 300 feet below the nearly level surface of the basalt. Under the basalt is a mass of stratified, almost horizontal, generally thin-bedded, detrital matter, alternating with clay and argillaceous zones, the thinly laminated beds containing often vegetable stems and impressions of leaves, indicating deposition in quiet water, while other portions are made up of coarse, gravelly masses, compacted often into a firm, coherent mass. From the ancient river-bed to the top of the basaltic capping of Table Mountain is not less than 300 feet.

It is beneath this mass of matter, partly aqueous and partly volcanic in its origin, that the remains of mastodon have been found. He gives a letter from Mr. D. T. Hughes, stating that the remains of mastodon were found in a tunnel 1,650 feet in under Table Mountain, and 4½ feet above the ledge or bottom slate, imbedded in a stratum of sand overlying a deposit of gold-bearing gravel, and scattered over a space 20 feet long by 10 or 12 feet wide. Most of the bones were very soft, and the tusks, which measured over 7 feet in length, much decayed; the teeth were well preserved.

From Mr. Hughes' description and accompanying drawings it is concluded that "there is no room to doubt that the bones discovered are those of the mastodon, and it appears probable that nearly the entire skeleton of a full-sized animal was entombed in the sands resting immediately upon the ancient auriferous gravel beneath the Table Mountains, and, of course, anterior in age to the period of volcanic activity and overflows of lava which have hitherto been considered as marking the close of the pliocene era,—a catastrophe which appears to have exterminated the other members of the pliocene fauna. If the mastodon survived the catastrophe which exterminated the hippopotamus, rhinoceros, tapir, etc., and continued through the post-pliocene to the appearance of man, it yet remains to be proved that man was his companion prior to the dawn of the existing epoch."

According to Prof. Silliman ("American Journal of Science," Sept., 1868), four molar teeth of mastodon were found in the same geological horizon as the alleged Calaveras skull. They carry the mastodon down to a lower level than has before been assigned to it in California. "It has been the belief hitherto that the great catastrophe of the volcanic outpourings which buried the Table Mountains of Calaveras and Tuolumne counties in California had extinguished all the pre-existing races, and that the mastodon had never been certainly discovered below that horizon. This view is no longer tenable, and the mastodon is here conclusively shown to reach quite to the base of the deep-lying gold placers; and, if the Calaveras skull stands the test of subsequent investigation, man was his companions in those early days."

FOSSIL MAN.

Signor J. Cocchi, in a recent work on "Fossil Man of Central Italy," describes the post-pliocene and recent deposits of this region, and the pliocene strata of the Val d'Arno and Val di Chiana, with the fossil mammals, mollusks, and plants obtained from the latter. The recent deposits he divides into modern, consisting of various alluvial formations, and an ancient alluvium yielding obsidian implements. The post-pliocene deposits are divided into upper and lower, the former comprising the loess as its upper member, without fossils or human remains, but probably belonging to the reindeer period; and, as its lower member, various deposits known as the diluvium, containing remains of *Bos primigenius* and *B. trochoceros*, with stone knives. The lower post-pliocene strata are divided into an upper portion, consisting of ferruginous conglomerate, etc., without human remains, but otherwise containing similar fossils to the underlying deposit. The lower portion consists of lacustrine clays of great thickness, with layers of peat toward its upper margin, containing bones of *Elephas primigenius*, *Cervus euryceros*, *Bison priscus*, and a species (probably new) of *Equus;* it has also yielded stone implements, and a human cranium, the latter from the plain of the Aretino. At last, a fossil cranium has been discovered associated with remains of extinct animals in a true stratified deposit; and, whether this deposit be termed lower post-pliocene, or anything else, there seems little room for doubt that the cranium was imbedded contemporaneously with the remains of *Elephas primigenius*, etc., and that man lived in Italy contemporaneously with those animals.

The fossil skull of Calaveras County, Cal., is alleged to have been found in a shaft sunk in the auriferous gravel of Bald Mountain, in September, 1866, at a depth of about 130 feet, and beneath several beds of volcanic matter interstratified with auriferous gravel. The shaft was soon after filled with water, and so it now remains. In the calcareous tufa surrounding the skull were found two human metatarsal bones, the lower end of a fibula, part of the ulna and sternum; also a fragment of a human tibia, too small for the same individual, and a shell of *Helix mormonensis* (now living in the locality). It evidently belonged to an old person. The geological horizon in which it is said to have been found is pliocene or post-pliocene.

ANCIENT FAUNA OF FRANCE.

From an examination of the ancient moraines of the valley of Argelez, in the Pyrenees, MM. Martins and Colomb have come to the conclusion, that, during the quarternary period an immense glacier filled this great valley, extending even into the plain; that its length was 53 kilometers, the average slope of its surface 0^{m}, 138, and its terminal moraine was arrested at an altitude of about 400 metres. The climate, and consequently the fauna, was of necessity very different from the present one; and M. Lartet gives the following list of the principal mammals and birds, extinct, existing elsewhere, or still found in the region, which lived in the south-west of France during the quarternary period; it will be seen that it is the fauna of a cold country, zoölogy confirming the data of geology.

Extinct animals: *Elephas antiquus* and *primigenius; Rhinoceros Merkii* and *tichorhinus; Bos primigenius; Cervus megaceros; Ursus* *spelæus; Felis spelæa; Hyæna spelæa* and *striata; Grus primigenia.*

Animals which have migrated elsewhere: *Bison europæus; Ovibos moschatus; Cervus tarandus; Capra ibex; Antilope rupicapra* and *saiga; Arctomys marmota; Spermophilus*, allied to *S. Parryi; Felis lynx; Strix lapponica; Tetrao lagopus, albus*, and *urogallus; Pyrrhocorax alpinus.*

Animals still living in the country: *Castor europæus; Gypaëtes barbatus; Milvus regalis; Falco tinnunculus; Buteo cinereus; Hirundo rupestris; Corvus corax* and *pica.*

Elie de Beaumont is of the opinion, however, that the phenomena of this basin are as well, and even better, explained by the action of diluvian currents than by that of a vast glacier. — *Comptes Rendus, Jan.*, 1868.

QUATERNARY DEPOSITS.

In the "Proceedings" of the Geological Society of London, Mr. Tylor attempts to disprove the conclusions of Mr. Prestwich, on the relative age of the quaternary deposits, and the epoch and manner of the excavation of the valleys on whose sides they rest. He selects the well-known and typical Amiens gravel for this purpose, and draws these two principal conclusions: 1. That the surface of the chalk has assumed its present form prior to the deposition of any of the gravel or loess now found resting upon it. 2. That the quaternary deposits indicate a pluvial period, just as the northern drift indicates a glacial period.

FAUNA OF THE BRAZILIAN BONE-CAVES.

According to Prof. Reinhardt, during the post-pliocene epoch Brazil had a very rich mammalian fauna, of which the present one may be called a mere fraction, as many of its genera, even families and sub-orders, have disappeared, while very few have been added. This fauna had the same peculiar character which now distinguishes the South American fauna from that of the Old World, the extinct genera belonging to groups and families to this day characteristic of South America. Only two genera, the extinct mastodon and the living horse, belong to families now limited to the eastern hemisphere. All the mammalian orders were not in the same degree richer in genera in former times than now. The *bruta, ungulata, proboscidea*, and *carnivora*, have relatively suffered the greatest losses; while some orders, as the bats and the monkeys, number even more genera now than formerly. This fauna differed much more from the modern one, and was especially more rich in peculiar genera, now extinct, than the corresponding fauna of the Old World. The scantiness of great mammals in the present South American fauna, compared with that of the eastern hemisphere, did not exist in the pre-historic fauna; the post-pliocene mastodonts, macrauchemiæ, and toxodonts of Brazil, and its gigantic sloths and armadillos, rival the elephants, rhinoceros, and hippopotami, which, during the same period, roamed the soil of Europe. — *Geological Magazine.*

VOLCANIC EMANATIONS.

The eruption of Vesuvius in January, 1868, confirms the observations of C. St. Claire Deville, on the order of succession of volcanic emanations. 1. Dry fumerolles: at the commencement of the eruption the emanations are neutral, the air being very poor in oxygen, and depositing almost exclusively alkaline chlorides, soon covered with a thin layer of chloride or oxide of copper. 2. Chlorhydrosulphurous emanations: in a few days, and in the coldest portions, chlorhydric and sulphurous acids appear, accompanied by watery vapor; the carbonate of ammonia, seemingly of two different origins, is naturally transformed into the chlorhydrate; in general, sulphydric and carbonic acids and carburetted hydrogen have not appeared. 3. Sulphurous, and 4. Carburetted emanations. Observations at Vesuvius and Etna have confirmed this order of succession.

THE GOLD FIELDS OF VENEZUELA.

According to a paper read before the Lyceum of Natural History of New York, by Mr. R. P. Stevens, Venezuela is divisible into three grand hydrographical basins, each of which represents distinct geological eras and holds its respective gold-field.

The first, and oldest known, is the hydrographical basin of the Caribbean Sea, and is separated from the Orinoco basin by the Coast Range of mountains. This range is the prolongation eastwards of the Cordillera Occidental, and geologically, is of the same age as that of the main Andes; namely, miocene tertiary, — that is to say, these mountains are understood to be of several ages in their uplifts, the later being as late as the beginning of the tertiary. Fossils indicating this position have been found at Carupano, Maturin, and other points on the main land, and on the Island of Trinidad, according to R. L. Guppy. The central axes of these mountains are metamorphic, and probably metamorphosed paleozoic. Gold, silver, copper, lead, and other ores are found in their rocks.

In the absence of positive data, and reasoning by analogy from other portions of this range, the auriferous veins are as late in time as the Silurian, according to Prof. Forbes.

The hydrographical basin of the Orinoco is filled with much older rocks; namely, crystalline mainly; so far as known to our party, they are gneiss and gneissoid; save in the vicinity of Ciacoa, where tertiary obtains, no other rock has been seen.

A section from the Orinoco, from the village of Las Tablas, southward to the summit of the Imitaca Range, reveals only gneissoid rocks.

Gold has occasionally been found in the streams flowing from these mountains, also along the Caroni, the largest southern affluent of the Orinoco, and along the Paraguay, a tributary of the Caroni, no valuable gold veins or deposits have ever been discovered. These rocks seem to conform to the general law; namely, to be barren of productive gold veins. The Essequibo hydrographical basin is the true gold-bearing portion of the rocks of Guiana. So far as known, the rocks of this basin are as follows: Gneiss on its northern rim (Imitaca Mountains); a few leagues south are low ranges of quartz and porphyry, Santa Cruz, Charapa, and Chagunemul Mountains. On their flanks are seen hornblendic, silicious, and argillaceous slates. Gneiss with domes, or vast expansion of quartz veins succeeds. As we progress southward these domes of quartz form a very striking feature of the landscape. They are more abundant east of the Caroni River and south of the Imitaca Mountains than any other portion of the country visited. They are always in sight. One is constantly winding around them or crossing some low portion of them. Sometimes their outcropping rocks remind one of a distant cemetery with its slabs and monuments of white marble. The gneiss decomposes and then presents a mottled appearance, red, purple, grayish, and white in color. Dikes of granite, or more properly, syenite, appear at intervals. Approaching the valley of the Yuruary River — the northern affluent of the Essequibo — bands of white and light-drab limestone are seen with the gneiss, and near Guasipati a band of itacolumite appears.

After crossing the Yuruary River, hills and low mountains of metamorphosed or semi-crystalline hills rise a thousand or fifteen hundred feet above the valley.

These mountains trend N.N.E. or S.S.W. They are composed of the following rocks: Brecciated schists, altered sandstones, quartz, and porphyry, a local rock of the aluminous family known as blue-stone, and talcose schists. The porphyry, in many instances, is but a highly metamorphosed condition of the more silicious portions of talcose rocks. Talc and bluestone is the country rock of the gold veins of this portion of the Essequibo basin. Beside the rocks already described, there lie between the sources of the Yuruary and the Caroni a low range of hills running north and south which are composed of very black gneissoid schists and more solid rock dissimilar to the grayish gneiss of the Imitaca. These are older in geological time than the Imitaca, for the latter trend east and west and abut upon them, while these trend north and south.

In the Mocupio valley gold is found under the following modes or conditions: —

1. In the sands and gravel beds of the streams of the valley.

2. In paydirt beds on bed-rock in the alluvial of the valley, and in the clays derived from the breaking down and decomposition of the country rock of the veins.

3. In quartz veins under different conditions, as follows: *a*, in pure white quartz in granules and nuggets; *b*, in rusty and ochraceous quartz invisible to the naked eye; *c*, in thin bluish and gray-

ish threads and films of talc in the quartz; *d*, in crystals of sulphide of iron mechanically mixed with the pyrites; *e*. attached to the walls of decomposed and removed crystals of pyrites; *f*, in the ochre resultant of such decomposition; *g*, in thin, film-like scales on the face of fissure walls; *h*, in masses cementing fragments of gangue rock together.

4. In the foot and hanging walls of veins, the "cacasjo" of the country.

There are two systems of veins, one running north-east and south-west, the other east and west. In both of these there is a variation of from 10 to 30 degrees. Which of these systems is the oldest we have not yet determined.— *Scientific American.*

PETROLEUM IN THE CAUCASUS.

According to Prof. Von Koschkull, of Tiflis, Russia, the petroleum region surrounds the whole range of the great Caucasus in the tertiary rocks, in their three subdivisions. Especial attention has been given to petroleum springs in the north and on the shores of the Caspian. The Persians have used it for many ages for various purposes. The wells are 20,000 in number, and from 2 to 100 feet deep. The oil flows into the pits with water, and is daily skimmed off. Some of this oil is very light in color and gravity; some is brown, and is finally reduced to asphaltum formations. In 1865, the American method of boring for oil was introduced into the Caucasus. A well, at the depth of 40 feet, gave a flow of 22,000 kilogrammes of oil daily. The temperature of the oil is 3° R. One jet was 60 feet in height. The oil has been purified and used to great advantage.

COAL IN NEBRASKA. BY. F. V. HAYDEN.

During the geological survey last season, the greatest interest was felt in this question by the people, from the fact that nearly all the State is a treeless prairie. Even a bed of coal, of moderate thickness, at a reasonable depth, would be of inestimable value, and the solution of this problem seemed to be the most important one of the survey. It is now known that all the carboniferous rocks of Nebraska belong to the upper coal-measures, and that these rocks occupy but a small area in the south-eastern portion.

It is now pretty well proved that, in the upper coal-measures of the West, there are no workable beds of coal, and that, while thin seams occur in many places, they never attain a thickness of more than 2 or 2½ feet.

Near Nebraska City, on the Missouri, an outcropping, about 8 inches thick, has attracted some attention.

This seam has been wrought by drifting a distance of 300 yards or more, and several thousand bushels of pretty good coal have been taken from it. At Brownsville, there is a seam of coal probably holding a lower position than the one at Nebraska City, which is accompanied by several species of coal-plants peculiar to the upper coal-measures.

At Aspinwall, in Nemaha Co., two seams of coal were met with. At Rulo, 15 or 20 miles below Aspinwall, and at Tecumseh, Johnson Co., thin seams of coal have been worked.

Different outcroppings of coal were worked in various portions of the State, because their existence seemed to the people to promise better things. The consequence has been that much more money has been spent in the useless search for coal in Nebraska than the cost of a geological survey for years.

In aid of the solution of the problem whether there are within the limits of the State of Nebraska any workable beds of coal within accessible distance of the surface, the following conclusions are the result of the examination of these rocks during the past season. It has been accurately determined that rocks of the carboniferous period occupy only a small portion of South-eastern Nebraska, and that these rocks are of the age of the upper coal-measures, permo-carboniferous and permian. At Omaha, a boring of nearly 400 feet in depth was made without passing any important seam of coal. At Nebraska City a boring was made nearly the same distance with the same result.

At Atchison and Leavenworth, Kansas, and at St. Joseph, Mo., where the upper coal-measures are several hundred feet lower than at Nebraska City or Omaha, borings were made about 400 feet with no better success.

Mr. Brodhead, a geologist attached to the Missouri State Geological Survey, studied with a great deal of care a series of beds of the upper coal-measures in Northern Missouri, which he regarded as 2,000 feet in thickness, without finding a seam of coal more than 2 or 2½ feet in thickness.

The upper coal-measures of the West are regarded as the barren coal-measures, while all the workable beds of coal are confined to the lower coal-measures. It is plain that all the carboniferous rocks of Nebraska pass beneath the more recent formations westward to be disclosed again by the uplifting of the Rocky Mountain ranges. We find the carboniferous limestone all along the margins of the Rocky Mountains on either side of the axis of elevation. On studying these fossils we find that so many of them are identical with the species found in what we know to be the upper coal-measures along the Missouri, that we do not hesitate to pronounce them as of the same age. Indeed they are simply the western extension of them, thinning out and gradually losing all the thin seams of coal and shale and nearly all the beds of clay and loose sands, leaving for the most part massive beds of limestone.

It seems more than probable that coal in paying quantities will never be found within the limits of the State of Nebraska. If this statement is true, it is a very important negative truth not only to Nebraska, but also to very large portions of Iowa, Missouri, and Kansas. We already know that the carboniferous rocks do not exist in Dacotah Territory at all, so that along the Missouri River there is a very large district, of wonderful fertility, almost treeless and destitute of mineral fuel. This fact at once directs our attention to the lignite formations in the region of the Rocky Mountains. It is to be hoped that the general government will see the importance of making appropriations for their careful examination at an early day.—*Am. Jour. Sc. Arts* (2), 45, p. 426.

EXPLORATIONS IN GREENLAND.

Mr. Whymper read a paper on this subject before the British Association, in 1868, from which the following are extracts:—

Through the labors of Prof. Heer, of Zurich, we know that the present treeless coast was, during the miocene period, possessed of foliage very far from an Arctic character. On the spot where now the largest shrubs have a maximum diameter of scarcely an inch, not only firs, birches, and poplars grew, but oaks, beeches, chestnuts, planes, walnuts, hazel-nuts, the vine, and the magnolia flourished. Then came the glacial condition of the country, with subsequent changes in temperature and elevation of surface. The peculiar climate of Greenland is due chiefly to the ocean currents.

There were also proofs of a much colder climate having once existed in these regions, as well as of the much warmer climate at a still more remote period. There was no doubt that at that period, which was called the glacial period, the glaciers were much more extensive than they are now. In Norfolk and Suffolk we had the shells which lived in a sea which was decidedly of an arctic character. Mr. Whymper, when he went to Disco Island, collected fossil plants about 100 feet above the level of the sea, and other fossils on the main land about 1,200 feet high. He also found fossil shells which had been pronounced by Dr. Torrell, of Sweden, to be arctic shells. It proved that that part of Greenland had been submerged, in the glacial period, to the depth of 500 feet. With regard to the fossil plants, they belonged to the lower miocene period. With reference to how this change had taken place, he adhered still to the opinion that the probable cause of it consisted in the altered distribution of land and sea since the miocene period. Of one thing we were quite certain, that as there had been some slight changes of physical geography, as shown by these shells, even within the period of living species of shells, so there had been changes in physical geography since the miocene period, which had been on a scale so much greater that the shape of our continents and the position of our oceans had been greatly altered. At that time the marine currents, which are capable of carrying water from the equatorial to the polar regions, must have been perfectly different.

ERUPTION OF MOUNT ETNA.

The "London News" says: "It is not merely that Mount Etna has again broken forth into eruption, but that the new outburst is characterized by a violence and intensity indicative of the wide extent of the region of disturbance beneath the crater. For 9 hours, on the night of December 8–9, the mountain was vomiting flames and lava to a prodigious height. Stones and burning matter were projected from the crater, and so high did some of these projectiles reach, that the sand and smaller stones fell even over Messina, or to a distance of upwards of 40 miles from the cone.

"The lava flowed in every direction from the crater, devastating the surrounding country. After the second great outburst the eruption became somewhat less active; but that the mountain is far from being likely soon to sink to rest is evidenced by the fact that deafening detonations still continue to be heard. If any further evidence were wanting of the magnificence of the scale on which Etna is now erupting it would be found in the fact that the news we have received comes from Valetta, which is upwards of 120 miles from Etna."

GREAT VOLCANIC ERUPTION AT HAWAII.

History and tradition record no such commotion on Hawaii as occurred in March and April, 1868. On March 27th, numerous slight earthquake shocks were felt in Kau, in the southern district of the island; on the 28th they became more frequent and energetic, extending to Hilo and to Kona on the west, and on this day fire and lava poured down the south-east slope of Mauna Loa, and from a huge rent near the summit crater Mokuaweowes. The quaking of the earth was most fearful in Kau, and it seemed that all the fires of the mountain and of Kilauea were struggling to force their way down to the ocean from their subterranean caverns. The sea of lava must have been enormous, working underground in numerous ducts, under a tract many miles broad; it was evident that Kilauea and the mother-mountain, Loa, were acting in concert. On April 2d a terrific shock occurred, rending the earth in all directions over Kau and Hilo, prostrating trees and dwellings, and continuing for 3 minutes. Soon after this the sea rose 6 feet above high-water mark. Between Kapapala and Keaiva, about 26 miles from Kilauea, the earth suddenly opened, and a mass of earth, stones, and mud, without fire, was thrown up 2 or 3 miles long and as many wide, and from 4 to 15 feet thick, burying people, houses, and cattle. At the same time there arose a tidal wave 15 to 20 feet high, caused probably by a submarine disgorgement of lavas into the sea. The wave was fiery red, from the eruption of igneous matter for 15 miles along the coast. For 4 or 5 weeks before the eruption there were heavy and continuous rains, carrying a vast amount of water into the subterranean streams and reservoirs; the descent of such quantities of water to the rising columns of lava probably hastened and intensified the catastrophe. Many lives were lost and much property destroyed.

At Kau, on April 2d, after a fearful earthquake, an immense torrent of molten lava burst out from the top of the bluff, rushing across the plain below, and overwhelming everything in its course.

It passed over a distance of about 3 miles in as many minutes, and then ceased.

An eruption broke out on Mauna Loa on March 27th, the lava running down the sides of the mountain in four streams, in a southerly and easterly direction. On the 28th the flow had gone about 10 miles due south from its source, and on the 29th had advanced 15 miles further. Near Kahuku a lava stream burst out from a crater about 10 miles up the mountain, on the morning of April 7th, and in the afternoon of the same day from a new one several miles lower down, the stream running 5 miles to the sea. This river of fire was from 200 to 800 feet wide, and, as the descent was 2,000 feet in 5 miles, the statement that it ran 10 to 25 miles an hour will not be doubted. The eruption lasted 5 days. On the evening before the eruption the ground throughout the district was covered by a shower of fine sand and light pumice-stone, of a light yellowish color, probably coming from some vent-hole near the summit-crater. The tidal wave here rolled in over the tops of the cocoanut trees, probably 60 feet high, completely annihilating several villages.

The source of the disturbance was evidently directly beneath Mauna Loa, and not far, if at all, below the level of the part of the ocean's bottom lying within the Hawaiian seas, and the phenomenon was therefore eminently a local one. The submarine rocks of the island are everywhere cavernous, and must all have cavities filled with water from the superincumbent ocean. Mauna Loa, though nearly 14,000 feet high, and 3,000 square miles in area, has only 1 or 2 surface streams over more than three-fourths of this area. The greater part of the moisture which falls annually on these cavernous lavas becomes subterranean. The vertical channels of the mountains, filled by the rains, must have brought immense hydrostatic pressure upon the deep water-chambers; the water may thus have been forced deeply into the hot rocks, and, there, suddenly converted into steam, have caused new fissures, with attendant earthquakes, and have opened passages to hotter fires; thence came vaster rendings of the mountain and severer shocks, and, as a natural sequence, all that subsequently took place.—*American Journal of Science, July*, 1868, *and Jan.*, 1869.

THEORY OF VOLCANOES.

From the observations of Mr. W. T. Brigham, in "Memoirs of the Boston Society of Natural History," vol. I., part 3, on the volcanoes of the Sandwich Islands, it appears that, although the craters of the group occur along a line supposed to be a line of fissure, as in other regions, the major axes or directions of the craters were parallel to one another at an angle of 26° from the trend of the group; in other words, the supposed volcanic fissure trends N. 64° W., the major axes being north and south. Following out this idea he ascertained that the major axes of craters are always at right angles to the mountain chains in which they are situated. He concludes that the theory of an unequally contracting crust, causing certain portions to fall below the general level, opening rents at the boundaries, and forcing up molten matter to the surface, satisfies the known condition of volcanoes better than any other.

VOLCANO OF SANTORIN.

This volcano, described in the "Annual of Scientific Discovery" for 1866–67, p. 266, has lost none of its intensity during the more than 2 years of its existence. Detonations and explosions every 4 or 5 minutes occur, with the ejection of many incandescent rocks and large quantities of ashes, the latter sometimes containing red particles, probably oxide of iron. The smoke from George Island is always very abundant, forming a column often 4,000 or 5,000 feet high. Flames are also abundant around its summit. Occasional minor explosions occur at other points, even at the bottom of the sea, with considerable development of smoke and flame. George Island is constantly growing, its top, covered always with scoriaceous and glowing lava, having attained a height of 420 feet. The new surfaces present to-day an area of about 1,000,000 square metres. Estimating the mean depth of the sea here at 93 metres, and the mean height of the surface above the sea at 32 metres, we should have a mass of 135 million cubic metres, without reckoning the large amount of lava which has flowed beneath the sea, as the present result of the eruption.

THE GREAT EARTHQUAKE IN SOUTH AMERICA.

The recent terrible earthquake in South America seems to have ranged from Port Conception, on the southern coast of Chili, to Quito, the capital of Ecuador, just below the equator. It must be classed among the most terrible convulsions of the kind ever known on the American continent, the only parallel to it being the earthquake in February, 1797, when the whole country between Santa Fé and Panama was destroyed and 40,000 people buried in an instant.

The destruction of Arequipa, a city numbering 119,000 inhabitants, was, save the destruction of Arica, and Iquique on the coast, the most appalling scene presented by the earthquake in Peru. It is thus described by an eye-witness: —

"About 4 minutes past 5 P. M., last Thursday, the 13th of August, a slight movement of the earth was noticeable here by persons who chanced to be seated; there was no rumbling. In about 8 to 10 seconds more, the movement became strong enough for persons not seated to notice. This movement gradually increased in strength until, after about 30 seconds, pieces of timber began to fall from the houses. In about a minute all were satisfied that a great earthquake was at hand. Then began a terrible rumbling, similar to the noise of an avalanche; every one ran to the open spaces. It seemed as if the earth was about to open; the earth shook and every structure swayed to and fro from north to south. It seemed in my own house as if the walls were about to meet and smother us. In about 3 minutes the soil shook so that it was almost impossible to hold one's feet. The strongest buildings began then to cast off stones, bricks, pieces of wood, etc., and the weakest began to fall, almost all of them level with the ground. In about 5 minutes from the first movement the whole city was enveloped in clouds of dust and darkness, and resounded with the crash of falling buildings. There is not one house left standing in Arequipa.

"Thus the work of the Arequipenos for 300 years has been destroyed in a few minutes; it will take 500 years to do the same work over."

At Lima, the capital of Peru, as at Callao, the neighboring port, the shock was terrible, but the damage comparatively slight. A writer gives the following account: —

"The duration of the movement was about 3½ minutes, and the shock, instead of following the usual vertical motion, appeared to be lateral, and, consequently, was regarded as all the more dangerous. The aspect of the city during the movement was truly exciting. Every one in Lima, at the first coming of the shock, always seeks the protection of an arch, or the threshold of a door is selected as a safe refuge, and on this occasion these favored spots were much occupied.

"In an incredibly short space of time the great public plaza was filled with frightened men, women, and children; the houses shook visibly, and the high towers of the cathedral swayed to and fro like a ship's mast in a storm. The great length of the shock was particularly alarming; but fortunately no damage took place in this city."

The terrible scenes at Arica are thus described by an eye-witness: —

"The hour was that when by custom most of the inhabitants had just closed their daily labors and were at their homes. The instant the startling indications of an earthquake were felt there was a general rush for uncovered spaces. The streets became a scene of terror. All the houses in the city trembled, then they surged, and some of them fell to pieces with crash after crash. At this juncture, when the undulations were active, the earth opened in several places in long and almost regular lines. The fissures were from 1 to 3 inches in width. The sensation was distinct as though something was rolling underneath. From every fissure there belched forth dry earth like dust, which was followed by a stifling gas. Owing to the demolition of buildings and the general destruction of all kinds of property, and the dust belched forth as well as that set in motion by the general tumult, a dense cloud formed over the city and obscured the light. Beneath the cloud was the gas which severely oppressed every living creature, and would have suffocated all these if it had lingered longer stationary than it did, which was only about 90 seconds. The undulations were 3 in number. Each succeeding one was of greater magnitude than the former. When the undulations ceased, the cloud of dust ascended and dispersed, and light was restored. Then quakes at short intervals succeeded, as though subterranean explosions or collisions were taking place.

"At this time, people from all parts of the city fled to the hills, amidst falling stones and timbers, which descended from swaying walls and broadly-rent buildings just on the eve of crumbling into perfect ruin. Some were struck dead by the falling materials, and others were maimed, while all were made to stagger from side to side like people in a state of intoxication.

"As the rush for the hills continued, and stones and materials of all kinds were falling, and houses and parts of these were crashing, numerous people were struck down and either killed or dangerously hurt."

A most notable circumstance occurred at Lima, which is worthy of note. The atmosphere, immediately after the first shock of earthquake, was so charged with an electric fluid, that in passing the hand through the hair or shaking one's clothes, sparks, as if from burning tow, would escape in great abundance. This phenomenon lasted for some time and produced much alarm.

At half past 5 o'clock, that is 17 minutes from the cessation of the initiatory shock, the first wave was experienced. These waves for a short period followed each other with great regularity and rapidity. The experience of those in the U. S. Steamship "Wateree," at Arica, was peculiar. The water retired from the shore, and then, unlike the regular pulsation or roll of the sea, rose from beneath, placing the ship, as it were, poised on the apex of a cone-like hill. This wave fell as suddenly as it rose, the steamer meantime shaking like a leaf in the wind; and then commenced a series of tidal rollers, first moving in grand masses toward the shore, and next retreating until those on the ship could see the ground of the roadstead from their anchorage to the shore.

The vessel was swung and thrown hither and thither like a cork, and finally, on the ninth movement of the waters, — the earth trembling without cessation, while the sky overhead was exceedingly clear and not a breath of wind stirred, — was driven from her moorings and carried, losing one anchor and chain and taking the other with her, over the shore line and across the railroad, the track of which was destroyed some distance inland, and finally left on an elevation of about 12 feet on an otherwise level plain immediately north of the city, which was, previously to the earthquakes, exceedingly fruitful. It is now covered with sand several inches, and in some places feet, in depth.

Captain Gillis estimates that there were in all 11 great tidal waves experienced on the 13th of August.

Subsequent soundings have shown that, while the shore lines have not been disturbed, where the depth of water in the roadstead was upwards of 30 fathoms, it is now, in some places, less than seven.

During the whole of the 13th of August, and even while the city was falling to pieces and the sea rising in enormous waves, — in one instance, as was shown by subsequent examination, 43 feet and 5 inches above high-water mark, — the air was perfectly calm and the surface of the waters of the sea and port of Arica were like burnished silver.

For ten days subsequent to the 13th of August, shocks of earthquake — sometimes as many as 50 to 60 between sunrise and sunset — were frequent.

A tidal wave occurred in the harbor of Yokohama, August 15th, the day after the earthquake in South America.

For further details see "American Journal of Science" for November, 1868.

THE USE OF EARTHQUAKES.

From an article in the "New York Times," the following abstract is taken: —

It is a matter of observation that everywhere around the coast-line of every continent, the sea is constantly at work warring against the land, crumbling away its edges, grinding it to powder, and carrying the detritus away and spreading it out over its own bottom. This process is slow, but it goes on forever, and the result is that in time (that is, in the secular time in which geology works) the structure of continents is entirely worn away, and new ones are formed out of the ruins of the former ones. It is quite certain that our present land was formerly the bed of the sea, and that continental masses once reared their forms where now rolls the ocean.

It is the earthquake and the volcano which place themselves in opposition to this destructive tendency; so that we may regard the igneous agents as in constant antagonism to the aqueous agents, — the latter laboring incessantly to obliterate the land, while the former are equally active in restoring it. What are these igneous agents, and what is their source?

It is a fact perfectly assured that, in proportion as we descend into the earth, the heat augments, and the deeper we go the hotter the earth is found to be. This increase is estimated at about a degree of the thermometer additional warmth for every 90 feet of additional depth; or about 58° per mile.

Now, though geology does not say that there may not be a solid central mass in the interior of the earth, — "kept solid in spite of the heat by the enormous pressure," — it does say that an immense range of terrestrial phenomena compels us to conclude that beneath the crust of the earth there is a sea of liquid fire, on which the continents and the land underneath the ocean are floating. This central fire is not only incandescent matter, but it is matter in a state of energetic elasticity, continually reacting upon the structure of the earth, and making itself felt more or less palpably, — sometimes producing violent undulatory motions, and at other times breaking through the crust, and vomiting forth lava and the central fluid. The former of these commotions are styled earthquakes; the latter, volcanoes. There is little doubt that they have a common origin, and, as has already been observed, it is their function to counteract the levelling effect of water, partly by heaping up new matter in certain localities, and partly by deepening one portion, and forcing out another of the earth's envelope.

In a paper, as profound in its views as it is luminous in its statement, Sir John Herschel has indicated the philosophy of these divulsions and upheavals, and we cannot do better here than epitomize his statement. The land, as has been seen, is perpetually wearing down, and the materials are being carried out to sea, — thinning towards the land, and thickening over all the bed of the sea. What must happen? If the continents be lightened, they will rise; if the bed of the sea receive additional weight, it will sink. It is impossible but that this increase of pressure in some places, and relief in others, must be very unequal in their bearings; so that at some place or other this solid floating crust must be brought into a state of strain, and if there be a weak or a soft place, a crack will at last take place. When this happens, the land goes down on the heavy side, and up on the light side. This is exactly what happens in earthquakes. We should naturally expect that such cracks and outbreaks would occur along those lines where the relief of pressure is the greatest, and also its increase on the sea-side, that is to say, along or in the neighborhood of the sea-coast, where the destruction of the land is going on with most activity. Now, it is a remarkable fact in the history of volcanoes that there is hardly an instance of any active volcano at any considerable distance from the sea-coast, while it is to be observed that the favorite sporting-places of earthquakes are the regions covered by the great chains of volcanic cones.

That earthquakes operate to raise the land-masses is not a mere matter of speculation, but a fact of repeated observation. In 1822, in a single night (Nov. 19), the whole coast line of Chili for a hundred miles about Valparaiso, with the mighty chain of the Andes, was hoisted at one shock from 2 to 7 feet above its former level, leaving the beach below the old low-water mark high and dry. In 1819, in an earthquake in India, in the District of Cutch, bordering on the Indus, a tract of country more than 50 miles long and 16 broad was suddenly raised 10 feet above its former level. And again, in 1538, in the convulsion which threw up the Monte Nuovo, the whole coast of Pozzuoli, near Naples, was raised 20 feet above its former level, and remains so permanently upheaved to this day. There are hundreds of the like instances on record, and no doubt, when we come to get full scientific accounts of the late convulsion, it will be found that parts of the coast of South America have been raised above their former level.

Such is the way in which earthquakes do their work, and they are always at work. According to Humboldt, there is not a day in which the earth is not shaken by these commotions; so that the state of perpetual movement is the normal condition of the surface of our globe, and, if we had apparatus sufficiently sensitive, we should doubtless detect this constant movement. And, indeed, already astronomers complain that their instruments betray by inexplicable perturbations the instability of the crust that supports them.

It is true that over by far the larger part of the globe these agitations are either slight or else absolutely imperceptible, so that we consider the greater portion of the earth as motionless; but there are other countries that have again and again been rudely shaken by violent and destructive convulsions. These are the true regions of the earthquake and volcano, and modern physical geography has made such progress as to mark off a certain number of extensive districts or zones in which the shocks are simultaneous. Among these may be mentioned the Atlantic district, that of Central Asia and that of the Pacific Ocean.

SUMMARY OF GEOLOGICAL FACTS.

Niagara Falls. — Some geologists predict a great change in the character of these falls. The hard limestone over which the water passes is slowly wearing away, and the current in some places about 800 yards above the Canadian fall has obtained access to the soft shales underneath, which are rapidly eaten away. It has been surmised that a subterranean stream of water is now pouring into the gulf below the falls, and that the "Horseshoe" shelf will ere long be undermined and destroyed. When this occurs the falls will be converted into a rapid, and the great mass of water will be diverted from the American to the Canadian shore.

Cretaceous Sea in Italy. — Prof. Seguenza has shown that the middle cretaceous deposits of Central Italy correspond completely with the cretaceous rocks of Algeria, of the zone of *Ammonites Rothomagensis*. As showing the similarity of geological conditions, he says that of 44 species of Italian fossils, 43 occur also in the African formation. He seems justified, therefore, in the conclusion that the middle cretaceous sea extended from Central Italy to the Province of Constantine.

Gold-fields of South Africa. — Gold has been extensively discovered in Africa, between 17° and 21.30° S., and about 400 miles from Pretoria, the nearest point of civilization in the S. African Republic of Transvaal. The Kingdom of Sofala, on the coast, to the eastward of the alleged gold formation, has been considered as the Ophir of Solomon's time. It is stated that the gold is found in quartz veins, and that the fields are of vast extent. The natives from old times have brought gold to the Portuguese in quills; they are said to light large fires to loosen the rock containing visible gold, and then further disintegrate it with their "machetes."

Thickness of the Earth's Crust. — Herr Sartorius von Waltershausen, of Göttingen, from recent calculations, stated before the British Association, in 1868, that he inclined to the belief that the thickness of the earth's crust was 14 geographical miles. He also expressed the conviction that, at the time of the first formation of the seas, the thickness did not exceed 50 metres.

Discovery of a Mastodon. — A short time ago Captain Boutelle, of the United States Coast Survey, discovered on the beach of St. Helena Island, near low-water mark, and not far from where the City of Port Royal has been laid out, the remains of a mastodon buried in the sand, with the bones partially exposed to view. Captain Boutelle at once communicated the discovery to Professor C. U. Shephard, Sr., of the South Carolina Medical College, and that gentleman, with the assistance of Captain Boutelle, recovered the greater portion of the skeleton.

Reptilian Remains in the Coal-Measures. — Mr. J. Thomson has discovered batrachian remains at Hamilton, in Lanarkshire, in the stratum between ironstone and coal, well overlaid by the latter; associated with them were remains of reptilian fishes, peculiar to the coal-measures. A few years ago, geologists would not have expected to find batrachian reptiles in rocks of this age.

Cambrian Fossils. — Mr. H. Hicks has recently discovered, in the strata of the lower Cambrian, a fauna representing species belonging to at least 10 genera, consisting of brachiopods, pteropods, phyllopods, etc.

Vast Numbers of Fossil Fishes. — Dr. A. L. Adams states that, on September 24th, 1867, during a heavy gale from the west, impinging almost straight on to the entrance of Anderson's Cove, on the coast of the Bay of Fundy, enormous numbers of fish were observed floating dead upon the surface of the water, and thrown up in great quantities by the waves. When the gale subsided, the whole surface of the lagoon and its banks was covered with dead fish, to the depth of a foot in some places. It was evident that the shoal had been literally ground to pieces against the rocks by the force of the waves. He refers to the vast quantities of fossil fish found in the Devonian and other strata, which suggested catastrophes allied to the above incident. — *Proc. Geol. Soc.*

Calamites. — According to the recently published researches of Messrs. Binney and Carruthers, the fossil calamites is an actual member of the existing family of *Equisetaceæ*, which contained previously but one genus, that of the common mare's tails of river banks and woods; and nearly a dozen other genera of the plants of the coal-measures may be referred to it. It may prove of some significance that these calamites which, in the coal period, assumed gigantic proportions, and presented many forms and very varied organs of growth, are now represented by only one genus, differing most remarkably from its prototype in size, and the simplicity and uniformity of its organs.

Arctic Miocene Flora. — According to Prof. Heer, forests of Austrian, American, and Asiatic trees flourished during miocene times in Iceland, Greenland, Spitzbergen, and the polar American islands, in latitudes where such trees could not now exist under any conceivable conditions or positions of land, or sea, or ice, leaving but little doubt that an arboreal vegetation once extended to the pole itself. This at present seems to contradict all previous geological reasonings as to the climate and condition of the globe during the tertiary epoch.

BIOLOGY;

OR, PHYSIOLOGY, ZOÖLOGY, AND BOTANY.

MOLECULAR FORCES.

THE following is an extract from the opening address of Prof. Tyndall, before the Physical section of the British Association, in 1868: —

"The tendency on the part of matter to organize itself, to grow into shape, to assume definite forms in obedience to the definite action of force, is all-pervading. It is in the ground on which you tread, in the water you drink, in the air you breathe. Incipient life, in fact, manifests itself throughout the whole of what we call inorganic nature.

"The forms of minerals resulting from this play of forces are various, and exhibit different degrees of complexity. Men of science avail themselves of all possible means of exploring this molecular architecture. For this purpose they employ in turn, as agents of exploration, light, heat, magnetism, electricity, and sound. Polarized light is especially useful and powerful here. A beam of such light, when sent in among the molecules of a crystal, is acted on by them, and from this action we infer, with more or less of clearness, the manner in which the molecules are arranged. The difference, for example, between the inner structure of a plate of rock-salt and a plate of crystallized sugar is thus strikingly revealed. These differences may be made to display themselves in phenomena of color of great splendor, the play of molecular force being so regulated as to remove certain of the colored constituents of white light, and to leave others with increased intensity behind.

"And now let us pass from what we are accustomed to regard as a dead mineral to a living grain of corn. When it is examined by polarized light, chromatic phenomena similar to those noticed in crystals are observed. And why? Because the architecture of the grain resembles in some degree the architecture of the crystal. In the corn the molecules are also set in definite positions, from which they act upon the light. But what has built together the molecules of the corn? I have said regarding crystalline architecture that you may, if you please, consider the atoms and molecules to be placed in position by a power external to themselves. The same hypothesis is open to you now. But if in the case of crystals you have rejected this notion of an external architect, you are bound to reject it now, and to conclude that the molecules of the corn are self-posited by the forces with which they act upon each other. It would be poor philosophy to invoke an external agent in the one case, and to reject it in the other.

"Instead of cutting our grain of corn into thin slices, and subjecting it to the action of polarized light, let us place it in the earth, and subject it to a certain degree of warmth. In other words, let the molecules, both of the corn and of the surrounding earth, be kept in a state of agitation; for warmth is, in the eye of science, tremulous molecular motion. Under these circumstances, the grain and the substances which surround it interact, and a molecular architecture is the result of this interaction. A bud is formed; this bud reaches the surface, where it is exposed to the sun's rays, which are also to be regarded as a kind of vibratory motion. And as the common motion of heat, with which the grain and the substances surrounding it were first endowed, enabled the grain and these substances to coalesce, so the specific motion of the sun's rays now enables the green bud to feed upon the carbonic acid and the aqueous vapor of the air, appropriating those constituents of both for which the blade has an elective attraction, and permitting the other constituent to resume its place in the air. Thus forces are active at the root, forces are active in the blade, the matter of the earth and the matter of the atmosphere are drawn toward the plant, and the plant augments in size. We have in succession the bud, the stalk, the ear, the full corn in the ear; for the forces here at play act in a cycle, which is completed by the production of grains similar to that with which the process began.

"Now there is nothing in this process which necessarily eludes the power of mind as we know it. An intellect the same in kind as our own would, if only sufficiently expanded, be able to follow the whole process from beginning to end. The duly expanded mind would see in the process and its consummation an instance of the play of molecular force. It would see every molecule placed in its position by the specific attractions and repulsions exerted between it and other molecules. Nay, given the grain and its environment, an intellect sufficiently expanded might trace out *a priori* every step of the process, and by the application of mechanical principles would be able to demonstrate that the cycle of actions must end, as it is seen to end, in the reproduction of forms like that with which the operation began. A necessity rules here similar to that which rules the planets in their circuits round the sun.

"But I must go still further, and affirm that in the eye of science the animal body is just as much the product of molecular force as the stalk and ear of corn, or as the crystal of salt or sugar. Many of its parts are obviously mechanical. Take the human heart, for example, with its exquisite system of valves, or take the eye or the hand. Animal heat, moreover, is the same in kind as the heat of a fire, being produced by the same chemical process. Animal motion, too, is as directly derived from the food of the animal as the motion of Trevethyck's walking-engine from the fuel in its furnace. As regards matter, the animal body creates nothing; as regards force, it creates nothing.

"Every particle that enters into the composition of a muscle, a nerve, or a bone, has been placed in its position by molecular force. And unless the existence of law in these matters be denied, and the element of caprice introduced, we must conclude that, given the relation of any molecule of the body to its environment, its position in the body might be predicted. Our difficulty is not with the *quality* of the problem, but with its *complexity*; and this difficulty might be met by the simple expansion of the faculties which man now possesses. Given this expansion, and given the necessary molecular data, and the chick might be deduced as rigorously and as logically from the egg as the existence of Neptune was deduced from the disturbances of Uranus, or as conical refraction was deduced from the undulatory theory of light.

"In affirming that the growth of the body is mechanical, and that thought, as exercised by us, has its correlative in the physics of the brain, I think the position of the 'materialist' is stated as far as that position is a tenable one. I think the materialist will be able finally to maintain this position against all attacks; but I do not think, as the human mind is at present constituted, that he can pass beyond it. I do not think he is entitled to say that his molecular groupings and his molecular motions explain everything. In reality they explain nothing. The utmost he can affirm is the association of two classes of phenomena, of whose real bond of union he is in absolute ignorance. The problem of the connection of body and soul is as insoluble in its modern form as it was in the pre-scientific ages."

ON VITALITY AS A MODE OF MOTION.

According to Dr. Thompson Dickson, in a paper presented to the British Association, in 1868, somatic life, or the life of a complex organism, is merely the sum of the vitality of the countless myriads of cells which together make up the organism; but since in the organic body the cells are collected into special masses, destined to perform various and special functions, so the various vital attributes which in a simple elementary cell are diffused, become in the organized body separate and specially centralized in the especial collection of cells destined for the performance of particular functions.

The evidences that vital potential energy, or the inherent influence which we term the vitality of an organism, is a mode of motion, when collated, may be resolved into three propositions, — showing, first, that it is force; second, that the force is something more than *vis inertiæ*; and, third, that the force is convertible into and correlative with the other physical forces.

1. Vital potential energy is a force, since the only repellent of one force is another acting in a contrary direction, and, as we shall show, every elementary force operating on a living cell or organism meets with vital potential energy repelling or resisting it, therefore vital potential energy, or this intrinsic influence, is a force. 2. This force is something more than *vis inertiæ*, or that

combination of forces which together retain a body in a state of rest, because a merely inert body would be readily overcome by an amount of any force vastly inferior to that which is able to operate upon a living body with impunity; therefore this force is something more than *vis inertiæ*. 3. This force is convertible into and correlative with the other physical forces, because vitality is directly convertible into heat and electricity, and since heat and electricity are convertible into and correlative with all the other physical forces, therefore vitality also is convertible into and correlative with all the other physical forces.

EFFECTS OF LIGHT ON VITALITY.

In a paper addressed to the French Academy of Sciences, Dr. Dubrunfaut examines the effects of light on vegetable and animal life. The researches of MM. Gratiolet, Cloëz, and Cailletet have in a great measure proved that the red rays of the luminous spectrum are those to which the important physiological function exercised by the sun on plants is to be exclusively attributed. The leaves in this case act as analyzers of white light; they reject the green rays, which constitute the physical complement of the red ones; and it is thus the various hues under which the organs of vegetation are seen by us may be explained. If plants were exposed to green illumination only, that would be tantamount to their being in the dark. But this kind of light, which the vegetable kingdom refuses to absorb, is precisely that which is coveted by the animal one. Red, the complementary color of green, is that which, owing to the blood, tinges the skin of the healthy human subject, just as the green color of leaves is the complement of the one they absorb. From this principle, so fully established by experiment, M. Dubrunfaut passes to its practical application to domestic life. All kinds of red should be proscribed from our furniture, except curtains. Our clothes, which in point of fact play the part of screens, should never be green, while this color, on the contrary, should predominate in our furniture, its complementary one being reserved for our raiment. In the same way he contends that the salubrious influence of woods and forests is a luminous and not a chemical effect. In support of these views he mentions cases of patients whose broken constitutions were restored merely by long exposure to the sun in gardens deprived of trees or other obstacles to light; he quotes the instance of four children that had become chlorotic by living constantly in one of the narrow streets of Paris, and that regained their health under the beneficial influence of the solar rays on a sandy sea-coast.—*Scientific American.*

INFLUENCE OF COLD ON THE NERVOUS FUNCTIONS.

According to Dr. B. W. Richardson, the phenomena observed on freezing the animal tissues depend essentially on a change in the condition of the water of the body. By cold the water is changed from a liquid to a solid state. Nerve tissue contains 85 per cent. of water. If we make this water solid, we get all the phenomena of negation demonstrated, — a sort of temporary death. These phenomena may also be produced by heat or the action of alcohol; so that, by congelation on the one hand, and by coagulation or desiccation on the other, we get precisely the same phenomena.

One of the most striking results of experiments on animals in this direction is the local independence of the several portions of the nervous system; every part seems to have its own centre, so that many parts of the cerebrum may be isolated. We may act on one hemisphere, or both, or on the cerebellum, or on the medulla oblongata, or spinal cord; but we do not thereby necessarily interfere with the functions of the other parts of the nervous system. This fact explains many points in connection with diseases of the brain. There is, nevertheless, to be noticed a kind of balance on one part by another; one hemisphere evidently balances the other; the corpora striata balance, and are balanced by, the cerebellum; the medulla is in the same relation with some part not yet precisely determined. One part of the medulla balances a part of the spinal cord connected with respiration, — the former presiding over the inspiratory muscles, the latter over those of expiration. If we freeze the medulla we stop the breathing by arresting inspiration; if we freeze the balancing portion of the cord we arrest the expiratory act. Thus, in the nervous functions there is a balance of opposite powers, just as in the muscular system there is a balance of flexors and extensors. The interest of this in a pathological point of view is evident.

Psychologically, also, these experiments are interesting, as, for instance, in the act of going to sleep in the upright position; sleep begins in the visual organs apparently; as the anterior part of the brain first loses its power, the tendency is to nod, to fall forward, caused by that part becoming inactive, while the posterior parts retain their function of propelling. The same may perhaps be said of the shock which sometimes results from looking down great heights; the shock paralyzes the anterior or thinking part, and the cerebellum retains its power and so gives an impulse forward. One bird shot flying will fall at once, rolling over and over forward, while another turns over many times backward in its descent. Dr. Richardson believes that in the former case the bird will invariably be found shot through the cerebrum, and in the latter through the cerebellum.

When the process of sudden freezing is brought to bear on the whole cerebro-spinal system of a cold-blooded animal, as a frog, every function of life is immediately suspended; it seems a hard frozen mass, and is apparently dead, yet it only sleeps. If heat be taken up by it from the surrounding air, it recovers by degrees, and awakes without injury. By the freezing we have fixed all the water of its tissues, have stopped evaporation, suspended motion, and arrested waste; but we have done no injury that may not be removed by the re-solution of the water and by the re-communication of motion to the particles of water. Nature produces the state called hybernation by a similar simple process, causing inertia by cold and recovery by heat. It will be an interesting study for the comparative anatomist to discover why hybernating animals come so readily under the influence of cold; there must either be some peculiarity of construction which enables the cold to reach their nervous centres, or the nervous centres themselves must be specially susceptible to the influence of cold.

When we have crystallized the water of the nervous matter by freezing, we have reduced it from activity to inertia, and have deprived it of the power to maintain what is called life; when heat is applied, the tissues in the frog are so thin and such good conductors of heat, that the nerve substance is immediately acted upon, and the water becomes fluid. But, in warm-blooded animals, evolving and requiring more heat, their natural non-conducting tissues and coverings retain their heat, and at the same time prevent them from directly taking up heat sufficient to restore instantly the lost heat of fluidity; hence, in chilling their nervous centres, the operation must be so limited as not absolutely to stop respiration and circulation; some spark of their fire-producing apparatus must remain, or the apparent death will be real. In hybernating animals this is the secret of their recovery, — the fire never entirely goes out.

While similar functional disturbance of the nerves is produced by cold, alcohol, or heat, there is this essential difference to be noted: if the nerve be solidified by cold, it will quickly regain its function under the influence of heat; if the nerve be solidified by alcohol, it will slowly and imperfectly regain its function; while, if it be solidified by heat, it will, as far as our present knowledge extends, be destroyed in regard to function altogether.

In addition to previous researches, Dr. B. W. Richardson, in a paper presented to the British Association at the Norwich meeting (1868), dwelt on the question whether frogs, and other frozen animals, respire during insensibility, which he decided in the negative. In proof of this, he said that animals so treated could be placed without harm in gases which would not support life, such as nitrogen and hydrogen, and could be recovered at the precise moment of recovery from the frozen state when respiration was recommencing. The gradual return of heat was a pure restorative, and the facts went toward the explanation of many disputed accounts of freezing.

In relation to the effects of freezing the brain on the circulation, he showed that in warm-blooded animals the reduction of the temperature of the brain produced a gradual slowness of the circulation, and, when the freezing was carried to the base of the brain, intermittence of the heart's action followed, if the operation were continued, by the entire cessation of the heart's movement, — a point of great practical importance, as indicating the influence of the brain on the heart. Whenever the brain was reduced in physical power, as from great fatigue, or shock, or anxiety, irregular action of the heart was almost the necessary result. Most people are conscious of this, and often think, with great alarm, that they are suffering from disease of the heart, when they are laboring merely under temporary exhaustion of the brain.

Under the influence of great cold on the brain and spinal cord, the extreme effect of such active poisons as strychnine could for a time be entirely suspended; raising a hope that in such diseases as tetanus a new mode of treatment might be successfully tried.

Extreme cold will prevent and even remove the rigidity of death; this condition is not due to the process of cooling, but is, on the contrary, quickened by heat, and prevented by cold. By taking an animal already rigid, freezing it and thawing it, the first rigidity will be removed and the body become flaccid. On freezing and rapidly thawing the skin of certain regions of the body, birds present extreme irregularity of movement and other signs of nervous disturbance; by treating in this way the side of the neck, a pigeon for a time walked sideways in the opposite direction. It is a remarkable fact that no hybernating animal has a large brain. — *Med. Times and Gazette.*

CALORIC THE FORM OF FORCE IN NERVOUS MATTER.

The experiments of Galvani and others, on the influence of electrical action on muscular motion through nerve, led, in the early part of this century, physiologists to the belief that in the natural nervous system electrical force is developed, and that the nerve cords from the centres are the veritable conductors of electric currents. This view is still maintained by many with much persistency, and various analogies have been set up between brain force and galvanism. Dr. B. W. Richardson, of England, as long ago as 1860, opposed these views, maintaining that in the animal body there is no arrangement for the generation or liberation of any variety of force except caloric, and that this force, set free in the combustion of blood, is the primary cause of motion in nature, and therefore a primary cause of life, in so far as motion represents life. The strength or the power of motion in animals is in exact relationship to the power of the animal to eliminate and apply caloric. In an animal at rest a certain weight of carbon is converted into carbonic acid, and a certain proportion of water is liberated; in the animal in active motion a greater amount of carbonic acid and visible vapors of water are poured out, just as steam is evolved by a locomotive, as to cause and effect. Says he: "In so far, then, as motion represents life, caloric is the source of living motion. It may undergo modifications in character; now being latent, now sensible; now being rapidly conducted through metals, or other conducting media, now rapidly evolved in series of concentrate sparks. We may call it in these varied forms by other names, — electrical force, —galvanic force; but it is the alpha and omega of them all, — the principle of motion."

He also inferred that the nervous system is in every part a producer of the peculiar force with which it is endowed, as long as it is supplied with blood; and also looked upon the muscular, as well as the nervous, system, as an entire independency, — the muscular system, nourished by blood and charged with caloric as caloric; the nervous system, similarly nourished, and charged with caloric in its electrical modification. If the systems be conjoined, the result of their equilibrium is a simple passive state, while the result of a disturbance of their equilibrium is motion and sensation. These ideas have been confirmed by the experiments or the action of cold referred to in the preceding article (pp. 278–280), the apparent death being changed to life by the restoration of caloric. He draws the following inference in regard to sleep: "I take it that during sleep the exhausted brain, nerve-cord, or entire nervous system, everywhere takes up and stores up caloric, and so continues to take up and store up until it is charged to its full capacity. Then, if I may use such expression, it overflows with force, it spontaneously fills the body, and there is presented that phenomenon of motion which we call 'awakening.' Send other force, vibration from noise or mechanical motion, at any moment through a sleeping body, and you may, through a dynamic act, excite motion, and the body may awake; but by this you have not primed the body with the force it wants for sustained work; you passed a charge of force through it, but you did not charge it. So when my unwound watch is ceasing, I can stimulate it into movement for a moment or so by a moderate blow or shake; but the force is applied uselessly if the mainspring be not recharged." — *Med. Times and Gazette.*

WORK AND FOOD.

The researches of Fick, Wislicenus, Frankland, and others have been given in the "Annual of Scientific Discovery" for 1866, 67, pp. 286–292, and 1868, p. 245; since then Dr. Parkes has found that during a period of work a man excretes less nitrogen than during a period of rest, whether he feeds on nitrogenous food or carbonaceous only. He also finds that after nitrogenous food has been cut off from the system and again supplied, there is a retention of that nitrogen, showing that it is needed to fill up some waste; also that, during the first rest after exercise, where nitrogenous food has not been cut off, there was an increase in the elimination of nitrogen. No theory of the relation of food, muscle, and work can be now tenable which does not account for these facts.

His own view is that, when a voluntary muscle is brought into action by the will, it appropriates nitrogenous matter and grows; the stimulus or the act of union gives rise to changes in the non-nitrogenous substances surrounding the ultimate elements of the muscular substance which cause the conversion of heat into motion. The contraction continues until the effete products of these changes arrest it (as they have been shown to do by Ranke and others), a state of rest ensues, during which time the effete products are removed, the muscle loses nitrogen, and can again be called into action by its stimulus. He does not believe in the efficiency of carbonaceous foods when alone, which recent experiments might seem to indicate. Fick and Wislicenus, he says, drew upon the store of nitrogenous matter in their system when they cut it off in their food, and he maintains that carbon foods can only be efficient in the presence of nitrogenous matter. When a muscle loses nitrogen, fat is probably formed, and thus a muscle, disintegrating during the period of rest, may form a store of fat in its texture, which may become efficient at the next addition of nitrogenous matter as a source of force. The argument as to the oxidation of nitrogenous matter being insufficient to account for work is true enough; but oxidation is not the only chemical change taking place in the blood, as Berthelot has shown; the appropriation of albumen-nitrogen, and its change into muscle-nitrogen, may, and probably does, initiate the other chemical changes in which carbonaceous foods become efficient as sources of force. One thing is to be regretted in all experiments on this subject with human beings, — in them the evolution of cerebral force is as variable as that of muscular force, and cannot be regulated or taken into account. It must, equally with muscle work, modify the elimination of nitrogenous matter and carbonic acid, and yet there appears to be no means of guarding against it as a source of error. The brain may be more active during the period of muscular rest than during muscular exertion. — *Quarterly Journal of Science, January*, 1868.

DEFECTIVE ALIMENTATION.

In an article on "Defective Alimentation a Primary Cause of Disease," by J. H. Salisbury, M.D., Cleveland, Ohio, the following are some of the diseases excited by defective feeding, — Vegetable dyspepsia: This arises from the too exclusive and too long continued use of vegetable, and especially amylaceous and saccharine food. Sooner or later the filamentous stage of yeast vegetation begins, ushering in the acetous fermentation, producing acid stomach, and sour eructations. Yeast plants are rapidly developed in the organ, and every particle of vegetable food that is taken in immediately begins to ferment, the stomach being converted into an apparatus for manufacturing beer, alcohol, vinegar, and carbonic acid. Chronic Diarrhœa: This disease, with the other intercurrent abnormal states that arise from the too exclusive use of a dry, amylaceous diet, may be conveniently divided into three stages, — the incubative, the acute, and the chronic.

The following interesting facts are developed on the microscopic examination of the fæces: 1st. That as soon (after beginning to subsist on amylaceous diet) as gases begin to develop in the intestinal canal, yeast plants begin to develop in the alimentary matters to an abnormal extent. 2d. That this development of yeast plants is evidence of the inauguration of fermentative change in the amylaceous food. 3d. That fermentation and the development of yeast plants continue to increase till diarrhœic conditions are produced. 4th. That a peculiar gelatinous colloid matter, usually in little masses, scattered through the fæces, shows itself to a greater or less extent as soon as the diarrhœa commences; that this matter is present in direct proportion to the severity of the case. 5th. That this colloid matter is not the cause of the diarrhœa, but merely the consequence of certain saccharine and fermentative conditions of the system, in which state the connective tissue of the alimentary walls becomes a proper nidus for its development. As soon as these systemic conditions are overcome, this colloid matter ceases to develop, and disappears entirely from the fæces.

On the "microscopic examination of the urine" in "chronic diarrhœa," he finds that the urine is usually small in quantity, rather high-colored, and deposits, on standing, a tolerable large sediment of pinkish or brick-colored lithates. The disease is not unfrequently accompanied, and followed, also, by obstinate oxaluria and phosphuria. He finds, also, in all three stages of chronic diarrhœa, that sugar is largely present in the fæcal matters, and in the mucous secretions of the alimentary canal. There is evidence that the secretions of the mucous membrane of the alimentary canal, fauces, mouth, and pulmonary surfaces, eventually become saccharine. This is evidenced in the development of torular cells and filaments of penicillium in the viscid layer of mucus lining the whole alimentary canal, and the mucous secretions of œsophagus, pharynx, larynx, trachea, and mouth, in the later stages of the disease.—*Medical Record.*

CONNECTION BETWEEN THE RESPIRATORY PRODUCTS AND FOOD.

M. Reiset presented to the French Academy, in January, 1868, some chemical researches on the respiration of cattle, and the influence of diet thereon; using for his experiments apparatus sufficiently large to allow him to submit to examination the exhalations of calves, sheep, etc. During the respiration of these animals,under the normal conditions, he found a considerable quantity of proto-carburetted hydrogen in the gaseous mixture. When calves were fed on milk only, and deprived thus of vegetable food, the gaseous mixture exhaled resembled more nearly in its composition that exhaled by carnivora; the production of carburetted hydrogen became absolutely nothing. He considers the formation of this gas in the stomachs of ruminants, when upon their natural food, as a phenomenon of incomplete combustion. His conclusion is, that the respiratory products depend much more on the nature of the food than on the species of the animal.—*Comptes Rendus.*

FOOD ESTIMATED IN HORSE POWERS.

Dr. Frankland has made some researches into the calorific values of food. From the calorific value of any article of food it is assumed that its working energy in the human body may be correctly estimated, on the basis that heat required to raise 1 pound of water 1° of F. represents a mechanical force sufficient to raise 772 pounds to the height of 1 foot. This can readily be reduced to horse-powers.

The following table embodies some of the results of Dr. Frankland's computations:—

Actual Energy of 10 Grains of the Material in its Natural Condition, when completely burnt in Oxygen, and when Oxidized into Carbonic Acid, Water, and Urea, in the Animal Body.

	Per cent. of water in material.	LBS. LIFTED ONE FT. HIGH. When burnt in oxygen.	When oxidized in the body.
Butter,	15	14,357	14,357
Cheshire cheese,	24	9,187	8,613
Oatmeal,	15	7,913	7,769
Wheat flour,	15	7,788	7,591
Pea meal,	15	7,778	7,456
Arrowroot,	18	7,731	7,731
Ground rice,	13	7,535	7,424
Yolk of egg,	47	6,761	6,532
Lump sugar,	19	6,616	6,616
Grape sugar,	20	6,476	6,476
Entire egg,	62	4,708	4,507
Bread crumb,	44	4,409	4,246
Ham,	54	3,915	3,317
Mackerel,	71	3,537	3,187
Lean beef,	71	3,098	2,818
Lean veal,	71	2,594	2,314
Guinness' stout,	88	2,123	2,123
Potatoes,	73	2,002	1,969
Whiting,	80	1,787	1,563
Bass's ale,	88	1,530	1,530
White of egg,	86	1,325	1,138
Milk,	87	1,306	1,241
Carrots,	86	1,040	1,026
Cabbage,	89	858	830

It will be understood, of course, that to obtain these results in the animal body, the materials must be completely absorbed, and fully oxidized into carbonic acid, urea, etc.

Estimated in this manner, it may be said that a daily subsistence diet of 2 oz. of dry nitrogenous food, and 13.2 oz. of dry carbonaceous, calculated as starch, and a daily working diet of 6 oz. of nitrogenous matter, and 26 oz. of dry carbonaceous, have the following mechanical energies: —

	LBS. LIFTED ONE FT. HIGH. When burnt in oxgen.	When oxidized in the body.
Subsistence diet,	6,319,783	6,307,078
Working diet,	13,349,405	13,311,290

But the actual working power of the human body does not approach this. In fact, although a man's daily labor has a very large range, as from 300,000 foot-pounds when lifting dung into a cart to 1,500,000 foot-pounds when pushing or pulling horizontally, yet the average is not above 1,000,000 foot-pounds, as will be seen from this diagram:—

Kind of Labor.	Amount of Work in foot-pounds.	Authority.
Bricklayer's laborer carrying bricks,	1,627,200	Mayhew.
Coal whipping,	1,293,600	"
Ascending Faulhorn,	1,074,931	Wislicenus.
" "	933,746	Fick.
Treadmill,	1,008,000	Mayhew.
"	861,156	Ed. Smith.
Turning a winch,	837,760	Coulomb.
Pedestrians (20 miles a day),	792,000	Haughton.
Paving and pile-driving,	788,480	Coulomb.
Porters carrying loads,	732,480	"
Shot drill punishment,	694,400	Haughton.
Average,	967,614	

And even when we add the calculated internal work of a man's body, as the beating of the heart and the movements of respiration, the total of it does not much exceed 1,500,000 foot-pounds a day: —

	Foot-pounds.
External work or actual labor,	967,614
Work of circulation (75 beats a minute),	497,880
Work of respiration (15 a minute),	98,064
Total ascertainable work per day,	1,563,558

It is evident, therefore, that a large portion of our food must escape digestion and absorption; indeed, the thermotic power of the food actually consumed daily, as estimated by the carbonic acid exhaled, and the urea secreted, is not more than sufficient to raise the temperature of 10,000 pounds of water 1° F. This is equal to a force of 7,720,000 pounds lifted a foot high; so that the ascertainable work of the food is about one-fifth of its actual energy, the rest of the power being consumed in molecular movements within the animal body. Helmholtz asserts that the external work should be a fifth part of the mechanical force of the digested food; but labor must be well applied to develop this proportion of its energy. — *Scientific American.*

ON THE RELATION OF HEAT TO MENTAL WORK. BY J. S. LOMBARD, M.D.

The influence of muscular contraction on animal temperature has been very carefully investigated, especially within the past few years; and it has been conclusively proved that a contracting muscle evolves heat. Furthermore, the relation between the heat thus developed and the work performed by the muscle during its contraction has been studied; and it has been shown that the law of the conversion of heat into mechanical work, which has been so firmly established for physics, is equally applicable to living beings; that in these latter, as in our machines, a given amount of chemical action produces less heat when mechanical work is done than when it is not, a portion of the heat being, in the former case, expended in performing the work.

But the relation between *brain-work* and heat still remains undecided, no light having as yet been thrown upon this subject.

The object of the investigation related in this article was to determine the effect of different mental states upon the temperature of the head, this being the first step toward the elucidation of the problem in question. For this purpose thermo-electric apparatus of a very delicate description, and arranged with special reference to the experiments in view, was employed.

The experiments now to be given were all made upon myself, and have extended over the space of a year. They are, however, but a part of those which have been made in that time, many having been withheld for further examination.

The object of the first series of investigations was to study the temperature of the head, while sitting quietly by myself, with no special mental occupation.

Under these circumstances, it was found that while the temperature of the head was in some instances quite steady, in others it was very variable, rising and falling often with great rapidity. The variations were slight, not amounting, as a rule, to more than a hundredth of a degree of Centigrade; but still they were very marked, if some other portion of the body was taken as a standard of comparison; thus the temperature of the leg or arm varied, if at all, within much narrower limits.

What the exact cause of these irregularities was, could not be determined with certainty; but the conclusion arrived at from a great many observations was, that this variability of temperature was connected with certain conditions of the mind. It was found that, in those cases in which the temperature was steady, the mind was, as a rule, in a more or less torpid state, such as persons are apt to fall into after a hearty meal; while in the cases in which variability of temperature existed the mental condition was one of much greater activity. The effect of a transition from the former to the latter condition was frequently shown, under the following circumstances: —

It often happened, when the mind was in the state of inactivity mentioned, that one or more persons would enter the room in which the observer was seated, and a short conversation ensued. The subjects of conversation were of no particular interest, and required no reflection; but, nevertheless, in a few moments the temperature, which had previously been steady, would begin to vary, rising and falling, but with a general upward tendency.

This change was not due to the muscular exertion of talking, for it manifested itself when the observer took no part in the conversation, — merely listening to the words of others, and saying nothing himself. Nor was it owing to any effect produced upon the circulation by modification of the action of the heart, for in this case other portions of the body would have been influenced likewise, whereas it was found that the head alone was affected, other parts situated full as favorably, if not more so, for feeling any such influence, exhibiting little or no change of temperature. Whatever the cause was, it certainly appeared to have its seat in the head. In all these experiments, changes of position, or any other disturbing cause, were carefully avoided.

Pursuing these experiments farther, it was found that *anything that aroused the attention* was capable of causing a greater or less rise of temperature on the part of the head, over and above that of the rest of the body. Various sights and sounds had this effect; and, indeed, it could be produced in a great variety of ways.

In the next place, the effect of the exercise of the higher reasoning powers was investigated. The results of these experiments were as follows: —

1. Mental action of this sort caused a rise of temperature on the part of the head, which varied very much in different cases; the highest rise noticed did not exceed the twentieth of a degree.

2. The temperature of the extremities fell, sometimes only slightly, but at other times very decidedly, — a half or a quarter of a degree of Centigrade, for example. This fall was doubtless owing, in part, to the absence of muscular exertion consequent upon sitting still, but not entirely so, for mere immobility, without mental exertion, did not produce an equally great effect.

The most striking effects of all were produced by the reading aloud, or the recitation of poetry. The rise of temperature in this case was not due in any appreciable degree to the muscular exertion involved, for mere mechanical recitation produced no effect; but the moment the interest of the speaker began to be awakened the temperature rose.

Although the action of the heart was frequently more or less modified, yet this could not account for the rise of temperature, inasmuch as other parts of the body ought, in such a case, to have shared equally in the rise, whereas it was the head that was chiefly, if not solely, affected. Reading or reciting to one's self gave similar results, and often even in a more marked degree.

The success of these experiments must depend, in a great measure, upon individual peculiarity; and with many persons they would doubtless fail. *Real emotion* must be awakened to produce the rise of temperature. Where this condition of the mind existed, out of more than a hundred observations I have never known a failure.

The rise of temperature in this series of experiments was the highest noticed in all the observations given in this article; a few minutes' recitation producing a greater effect than several hours of deep thought.

In conclusion, I would say that, as regards the particular regions of the head in which the elevation of temperature was most marked, it was generally found that the best results were obtained just above the occipital protuberance. This statement applies to all the experiments that have been related. In the last-mentioned series of observations it was not unfrequently found that the temperature of the forehead *fell*, while that of the back of the head *rose;* but for what reason I have not yet been able to determine. — *New York Medical Journal.*

RELATION OF THE CHEMICAL CONSTITUTION AND PHYSIOLOGICAL ACTION OF MEDICINE.

At one of the recent meetings of the Royal Society of Edinburgh, a very interesting paper was read by Drs. Crum Brown and T. R. Fraser, upon the influence of direct chemical addition upon the physiological action of substances.

In order to arrive at any accurate knowledge as to the influence which chemical constitution exerts upon physiological action, it would appear to be desirable to take substances having a very definite and energetic physiological action, and then to perform upon them a chemical operation having for its object the promotion of a definite change in the constitution, and to examine the modification which the physiological action has undergone. Such has been the plan the authors have pursued. The bodies which they have chosen for examination are the more active of the vegetable alkaloids, and the chemical operation, of which they have studied the effect, has been the direct addition of iodide of methyl. It was shown by How that, when iodide of methyl acts upon strychnia, brucia, morphia, and other alkaloids, it adds itself to them, and beautiful crystalline bodies are produced which differ considerably in character from the salts of the alkaloids.

It is well known that doses of strychnia, varying from one-twentieth to one-thirtieth of a grain, rapidly produce in rabbits most violent convulsions, and in a few minutes kill the animal; the phenomena produced being a localization of its action on the cord. It was found that 12 grains of iodide of methyl-strychnium, when administered (by subcutaneous injection) to rabbits weighing 3 pounds, produced no effect whatever. Fifteen grains produced symptoms, and 20 killed; but the animal died with symptoms altogether different from those produced by strychnia. In place of violent and spasmodic convulsions and muscular rigidity, the appearances were those of paralysis with complete general flaccidity. The spinal motor nerves were either paralyzed, or speedily became so; and, instead of the speedy occurrence of muscular rigidity, the muscles remained flaccid, contractile, and alkaline for several hours. In short, by the addition of iodide of methyl to strychnia, the toxic properties of the latter are diminished about 140 times; and the body produced possesses the physiological action of curare; namely, paralysis of the end-organs of the motor nerves.

Similarly, Brown and Fraser have discovered that the toxic properties of brucia, thebaia, and codeia are immensely diminished by the addition of methyl; and that the bodies produced, instead of being, as all three of these alkaloids are, strongly convulsent, possess, on the contrary, the physiological action of curare. Morphia, as is well known, possesses both soporific and convulsent properties; its toxic action is much diminished by the addition of iodide of methyl; its convulsent action is destroyed, but its soporific action remains.

PHYSIOLOGICAL AND THERAPEUTICAL ACTION OF CAFFEIN.

The "Archives de Physiologie" for Jan.-Feb., 1868, contains a paper on this subject, by Dr. M. Leven. The following are the conclusions he draws from his experiments: —

Caffein appears to directly stimulate the heart. When first absorbed the circulation and respiration are accelerated, the pulse is more frequent and firmer, and the secretions more active.

The central nervous system, the brain and spinal cord, and the nerves are stimulated.

The muscular system of the life of relation and that of organic life contract violently.

The muscles of the former system are affected with trembling or with general contraction. The fibres of the stomach, of the intestines, and of the bladder also contract.

At a later period after absorption of caffein, the action of the heart is lessened; the frequency and firmness of the pulse diminished; the muscular system becomes exhausted, but is not paralyzed. The nervous system also suffers exhaustion.

Caffein does not entirely extinguish reflex action, nor the functions of nerves and muscles.

It acts as a poison on different animals in different doses; it may be given to man in the dose of many grammes without injury.

It is readily eliminated from the system, and remains in it only a few hours.

He further states that caffein, like alcohol, diminishes the secretion of urea, but increases the quantity of urine excreted. It diminishes the waste of the organs, and economizes the tissues.

With two litres of coffee daily, the Belgian miners undergo, without substantial food, excessive muscular exertion. The caravans which traverse the desert are supported by coffee during long journeys and lengthened privation of food. It is known that some old persons are almost exclusively nourished by coffee. — *Am. Jour. of Med. Sciences.*

APHASIA.'

According to Dr. Fabre, of Marseilles, a fourfold division is made of this disease. In the first variety or degree the patient forgets words; in the second, he loses voluntary control over their formation; in the third, he ceases to understand their meaning; finally, all these conditions may coexist in the most complex form of aphasia.

The loss of the faculty for written language, which is so remarkable a secondary phenomenon of aphasia, also exists in four degrees. In the first, the patient loses all recollection of written letters or words, but is able perfectly well to copy models placed before him. In the second, he is unable to write, even when understanding what he wishes to transcribe. In the third case, he has lost the faculty of reading; and if he tries to write, although he succeeds sometimes in forming the letters well, he cannot co-ordinate them into words. Finally, all understanding of written or spoken language may have been completely abolished, while the rest of the intellectual faculties remain completely intact.

In the first class, there are various degrees of forgetfulness. Some patients forget proper names, or the greater number of substantives, and express their meaning by circumlocution. Thus, instead of asking for a pen, they demand something to write with. Others cannot construct a complete sentence. In the second class, the patients pronounce words differently from what they intend, and, although conscious of their mistake, and irritated by it, they are unable to rectify it. After this simple perversion of language comes real impotence; the patients express all their meaning with the same word, or even syllable, often utterly devoid of sense. With these patients the movements of the tongue are perfectly free, and there is not a trace of glosso-labio-pharyngeal paralysis.

In the third category, the functional trouble is less grave as regards the mechanism of speech, and more serious in respect to intellectual disorder. The patients cease to understand the meaning of their own words, and, when they wish to say one thing, express a meaning directly the opposite.

In the most complete cases of aphasia, from the testimony of certain physicians who have been affected by it and recovered, the intelligence is still perfectly intact. Thus, Rostan observed his own case, and mentally prepared a clinical lecture upon it. Whatever difficulty is encountered in intellectual exertion is not a cause of the aphasia, but a result, on account of the loss of signs necessary to give precision and support to thought.

M. Fabre inclines entirely to the opinion that, in the majority of cases, the left frontal lobe is the seat of the disease. Four or five cases have, however, been reported, in which a destruction of both the anterior lobes was unaccompanied by any symptom of aphasia. In these cases, however, the posterior part of the lobes was nearly intact. Moreover, M. Fabre suggests, although the faculty of speech be specially localized in this part of the brain, that in case of need other portions might sometimes supplement its action.

Again, autopsies of aphasic patients have not unfrequently revealed lesions of various parts of the encephalon, other than the frontal lobe. But it is easily conceivable that the fibres from this locality, in passing through diseased portions of brain substance, should become affected, even though their centre remained healthy. In this case the cause of the aphasia would be no indication of the seat of the faculty of speech. It is presumable, moreover, that there exist varieties in the lesions, to which the clinical varieties correspond. In permanent aphasia the lesion generally consists in softening, especially such as results from obliteration of the middle cerebral artery. Such obliteration frequently determines a hemiplegia at the same time, on account of the distribution of the artery to the corpus striatum. In cases of sudden hemiplegia, M. Fabre considers that the coincidence of aphasia alone permits the diagnosis of obliteration, instead of hemorrhage, as the cause of the accident.

Transitory aphasia either depends upon neuroses, as hysteria or epilepsy, or is attributed to congestions. But M. Fabre is inclined to rule out this last circumstance, and substitute obliterations of artereoles, which cause a temporary derangement of the nutrition. After a while the development of collateral circulation renews the nutritive activity of the region, and the patients recover.

No therapeutic indication can at present be based upon this fact of arterial obliteration as the most common cause of aphasia, but it may tend to prevent the trial of useless or untimely measures. —*Medical Record.*

DIETETIC SALT.

Dr. Lankester aims to supply necessary, but frequently overlooked, articles of diet, by means of his dietetic salt. This compound is a proposed substitute for ordinary table salt, chloride of sodium being a notable constituent; but, in addition to this, which is far from being the sole or even most important inorganic constituent of our food, we have phosphate of lime, chloride of potassium, sulphates of potash and soda, with smaller quantities of magnesian and iron salts. The argument for their use is very strong. Leaving out the large proportion of epidemics, almost all the common diseases are directly traceable by physicians to dietetic errors; and those that certainly are due in part to deficiency of inorganic food form by no means a contemptible list. Scurvy is known to arise from a deficiency of the salts of potash. Scrofula and consumption, rickets and softening of the bones occur when the phosphates of lime and other bases are deficient. Anæmia, chlorosis, and a variety of nervous disorders are the result of an absence of iron, and are at once cured by the use of this agent as a remedy. In such cases the medical man is in the habit of prescribing medicines containing these agents; and there can, therefore, be no doubt that the habitual use of these substances in the food, in the same way as common salt is employed, would be a means of preventing the occurrence of a large number of diseases. The quantities of the saline ingredients employed, in addition to common salt, are so calculated that they shall be supplied in the same proportion by its use, as they exist in the human blood, and are got rid of in the body.

EXCRETION OF CARBONIC ACID AND ABSORPTION OF OXYGEN.

Pettenkofer and Voit have presented to the Academy of Munich a communication on the difference of the excretion, in the human subject, of carbonic acid and absorption of oxygen by day and night, during rest and labor. The new arrangement of their great respiratory apparatus easily admits of a division of 24 hours' investigation into two periods.

The subject for observation, a sound, strong watchmaker, 28 years of age, and of 60 kilogrammes weight, entered the apparatus July 31, at 6 A. M., and remained in it till August 1, 6 A. M. The time from 6 A. M. till 6 P. M. is understood to be day, the rest night. The man took, at his regular meal hours, medium quantities of his usual food whose elementary composition had been carefully made out. He occupied himself in reading and in cleaning a little watch; he went to bed at 8 P. M., and slept well until 5 A. M. His condition was perfectly normal during the investigation.

The excretion of carbonic acid amounted, during daytime, to 58 per cent., during night to 42 per cent.; the absorption of oxygen during daytime to only 33 per cent., during night to 67 per cent. The excretion of urea, as has been known heretofore, is always greater during day than during night.

On the day of rest, the excretion of urea, in both daily periods, was in exact proportion to the excretion of carbonic acid; there was excreted of both 58 per cent. during day and 42 per cent. during night. Most surprising is the antagonism in the excretion of carbonic acid and the absorption of oxygen between the two daily periods, even with all possible avoidance of muscular exertion, on July 31. This shows that mere waking, and the impressions experienced by the senses in that state, have an influence on the consumption of material serving to produce the processes of life.

This antagonism is still greater when the day of labor is included in the comparison; the excretion of carbonic acid and the absorption of oxygen by day and night are then in exactly inverse proportion. The carbonic acid was excreted at the rate of 69 per cent. during day, 31 per cent. during night; the oxygen absorbed at the rate of 31 per cent. during day, 69 per cent. during night.

For daytime, while awake, we therefore produce a great deal of carbonic acid at the expense of the oxygen absorbed during rest and sleep. The will finds the material prepared for its spontaneous movements.

So much oxygen as is used up in excess during one day, so much is taken up for compensation during the following night, and as long as this takes place the body is prepared in the morning for new labor. In comparing the total of the two days of experiment, it appears that, on the day of labor, there were 373 grammes of carbonic acid more excreted than on the day of rest, and 246 grammes of oxygen more absorbed; — 373 grammes of carbonic acid containing 271 grammes of oxygen, there is only a difference of 25 grammes of oxygen used in excess of the amount taken up from the air.

It is certainly not by accident that the oxygen excreted with the carbonic acid of the night after rest, as well as after labor, approaches very nearly the amount of oxygen taken up from the air on the preceding day.

From the result of the excretion of water it appears that, after a fatiguing labor, a man not only gets momentarily into perspiration, but perspires the following night more than after a day of quiet.

The investigations show positively that the absorbed oxygen is never directly used for oxidation down to the last products of combustion, but that there are intermediate stages of oxidation by which the oxygen is retained in the body for hours before it reappears in the form of carbonic acid and water, — a fact which previous experiments on marmots during winter sleeps have demonstrated.

The discovery of Voit, made 6 years ago on the dog, that with the greatest muscular exertion there is not more albumen decomposed than with perfect rest, has been confirmed by the experiments of July 31 and August 3, made on man. On both days, so different in regard to muscular exertion, there was not more nitrogen excreted through the kidneys and bowels than an amount contained in the food that had been taken. There is, however, an intimate connection between the amount of the albumen of the food and the exhibition of spontaneous muscular force. Experiments of Henneberg indicate that the poorer the food in albumen, the less the stock of oxygen that can be accumulated during night, so that more oxygen has to be taken up in daytime, even when the whole consumption in the 24 hours is less. — *Med. Repertory.*

PULMONARY CONSUMPTION.

Dr. William Budd, an eminent London physician, gives the following as the principal conclusions to which he has been led, regarding phthisis or consumption, and tubercle: 1. That tubercle is a true zymotic disease of a specific nature, in the same sense as typhoid fever, scarlet fever, typhus, etc., etc. 2. That, like these diseases, tubercle never originates spontaneously, but is perpetuated solely by the law of continuous succession. 3. That the tuberculous matter itself is (or includes) the specific morbific matter of the disease, and constitutes the material by which consumption is propagated from one person to another, and disseminated through society. 4. That the deposits of this matter are therefore of the nature of an eruption, and bear the same relation to the disease as yellow fever, for instance, bears to typhoid fever. 5. That by the destruction of this matter, on its discharge from the body, by means of proper chemicals or otherwise, seconded by good sanitary conditions, there is reason to hope that we may eventually, and possibly at no distant time, rid ourselves of this fatal scourge.

The grounds on which Dr. Budd founds these views are: 1 The pathology of consumption, which he thinks shows a specific cell proliferation. 2. Indisputable instances of personal contagion. 3. The geographical distribution of consumption, the disease extending to newly discovered peoples in proportion to their intercourse with Europeans (for instance, the South Sea Islanders, the North American Indians, and the African, among whom consumption was unknown when they were first visited by the whites, though it has since proved extremely fatal). 4. The relation of consumption to high and low levels is the same as that of ordinary zymotic, epidemic, endemic, and contagious diseases. 5. Consumption prevails extensively in convents, harems, monasteries, penitentiaries, just as do the zymotic diseases. Dr. Budd says that the idea first occurred to him in 1854, and his investigations since have confirmed him in this hypothesis, for which he claims the superiority over all others, that it explains all the facts of consumption.

According to Dr. Crisp, in a paper read before the British Association, in 1868, "On the Statistics of Pulmonary Consumption, in England and Wales," it appears to follow the march of civilization, and its prevalence has a direct connection with population, and the artificial habits and the vitiated atmosphere in which they live. The returns show that the death-rate corresponds with the density of the population; that the general mortality in England and Wales is at the rate of 24.47 per thousand; that in the healthy and more thinly populated districts the rate is only 17.53 per thousand; while in the large towns it is 28.01. Among sailors, the most fatal stations as regards phthisis were the western coast of Africa, and the Mediterranean. A dry atmosphere, cold or hot, was most frequent in districts where phthisis was comparatively rare. The causes of phthisis included soil, climate, amount of population, nature of occupation, hereditary predisposition, and the communicability of the disease. There was no doubt that one frequent cause of phthisis was the exposed state of our railway stations and steamboat piers, which people would hurry to reach in order to save a boat or train, and where, having become heated, they were in cold weather liable to a sudden chill.

For further information on the causes, prevention, and rational treatment of this disease, see two papers by Dr. Bowditch in the "Atlantic Monthly" for January and February, 1869.

According to experiments of Dr. Delafield, as stated to the New York Pathological Society, tubercle may be propagated by inoculation from man to animals.

INFLUENCE OF ANÆSTHETICS ON BRAIN AND NERVOUS SYSTEM.

The obvious fact that the motion of the heart and the movements of respiration continue in action while the rest or the body is under the narcotic effect, during anæsthesia, prove that the whole nervous system is not involved, and that the involuntary and semi-voluntary muscular mechanism is also not involved except when extreme and fatal symptoms are developed. What parts, then, are influenced by an anæsthetic? The idea was almost intuitive that the brain was the organ affected, and that the centres of consciousness are those chiefly held in abeyance. But, to prove this as true, experiment was necessary. In proof, Dr. Richardson took a large pigeon, narcotized it deeply with chloroform, and in this state passed through its body, from the head to the foot, a rapid intermittent induction current. The bird instantly rose from the table, extended its wings, opened its eyes, and seemed as if restored; the current was then stopped, and the bird was shown to be as deeply asleep and as powerless as before. Another bird was put to sleep by freezing the brain, and when utterly insensible was subjected to the electrical shock in the same way, when it flew from the table into the room, where, breaking its connection with the battery, it dropped on the floor comatose, motionless, and as anæsthetized as before, in which condition it remained for many minutes.

These experiments demonstrated that the anæsthetic action was localized in the cerebrum. His battery was like an outer brain, which supplied power without intelligence, and which, by the effects of its currents, showed that all the muscular elements were ready for work, and only awaited the order from the brain. What, during the process of anæsthesia, leads to this change in the brain? Is there a chemical action on albumen? Is there pressure on brain matter? Is there deficient oxidation of the blood? Is there contraction of blood-vessels, and diminished supply of blood from that cause? All these hypotheses were experimentally tested and negatived. It was admitted that during extreme anæsthesia there is reduced oxidation and a singular reduction of temperature. These changes are inevitable, because the anæsthetic vapors replace oxygen during their diffusion into blood; but the diminished oxidation is not the cause of the insensibility. In proof of this, Dr. Richardson showed an animal breathing an air in which the oxygen was reduced by addition of nitrogen from 21 parts to 9 parts in the 100, side by side with another similar animal breathing an air in which the oxygen was reduced by the addition of vapor of bichloride of methylene only to about 20 parts in the 100; namely, 4 cubic inches in 500. The result was that the animal in the extremely reduced atmosphere was quite unaffected, while the animal in the slightly reduced atmosphere was in the deepest narcotism. Then a correcting experimental test was adopted, and the bichloride was administered in an atmosphere containing an excess of oxygen, the oxygen being present in double its ordinary or natural proportion; the excess of oxygen exerted no perceptible obstacle to the anæsthesia.

To determine whether there was contraction of blood-vessels under anæsthetics, he had recourse to transparent small trout; through their bodies, with the microscope and the inch lens, the blood-vessels could be seen, and the corpuscles flowing through them. These animals can be narcotized readily by making them breathe water saturated with chloride of methylene or ether. In the narcotized condition, the vessels do not contract, but under the influence of ether, in the later stages, before death occurs, dilation and regurgitation are observed. The latter is noticed also when chloride of methylene is used. With both reagents breathing and vessel circulation cease before the heart's action. He concluded that anæsthetic vapors act directly upon nerve matter, either by preventing the development of force or by stopping conduction. The latter hypothesis is supported by the fact, proved by experiment, that these vapors obstruct the conduction of heat and electricity. — *Med. Times and Gaz.*

NEW ANÆSTHETIC — BICHLORIDE OF METHYLENE.

Dr. B. W. Richardson has recently discovered a new general anæsthetic, which he described and exhibited before the British Association. The general chemistry of the monocarbon series to which this new agent, the bichloride of methylene, belongs, has been given under "Chemistry," on pages 190, 191 of this volume.

The formula of this fluid is $CH_2\,Cl_2$. It has an odor as sweet as that of chloroform, but boils at 88° F., 54° less than the boiling-point of the latter. It rapidly and easily narcotizes animals to perfect anæsthesia, causing scarcely any excitement, and with perfect recovery; it seems to combine the properties of chloroform and ether, but is more readily administered and with more permanent effects than either.

The chloride of methyl, a certain and gentle anæsthetic, exists at ordinary temperatures as a permanent gas. It is very soluble in ether, and the saturated compound is one of the most perfect of anæsthetics; though not very stable, it probably has no superior in the evenness of its action, and in the rapidly produced, profound, and prolonged sleep. Water will take up four volumes of it, and forms a powerful intoxicating drink, palatable with a little sugar, of a very transitory effect. Introduced into the stomach as a soothing and refrigerating drink, and as an anæsthetic for slight operations, it promises to be a useful remedial agent.

Bichloride of methylene is a colorless fluid, more volatile than chloroform, the vapor being three times heavier than air, so that it requires more free administration than chloroform, but less in quantity than ether. Chloroform vapor will not support combustion, stopping oxidation without undergoing decomposition; the vapor of bichloride of methylene supports combustion with a brilliant flame, forming carbonic and hydrochloric acids. This proves that Dr. Snow's theory, that the action of anæsthetics is to arrest combustion in the blood, is not true.

The bichloride of methylene mixes readily with ether, and the two fluids have, within four degrees, the same boiling-point, so that the mixture vaporizes evenly and equally; the difference in the specific gravities of the two vapors is the only objection to the combination. The bichloride also combines with chloroform in all proportions. It should always have a neutral reaction to test-paper, and, to prevent decomposition, should be kept from the action of sunlight. Like chloroform, it in some instances produces vomiting.

It acts evenly on the respiration and circulation, accelerating or retarding both together; this is a valuable property, as a disturbance of the balance between these two systems is one of danger; it probably owes this to the equality of its diffusion through the nervous centres. Compared with chloroform, it requires 1 drachm to 40 grains or minims of the latter; but when the narcotism is well established it requires less to sustain it and less frequent repetition. Experiments on animals of the same age and kind, exposed, under similar conditions, to equal values of the vapors of chloroform, tetrachloride of carbon, and bichloride of methylene, show that the resistance to death will be as 14 to 5 in favor of the bichloride against the tetrachloride, and as 14 to 9 against the chloroform. — *Med. Times and Gazette.*

THE SPLANCHNOSCOPE.

To the ophthalmoscope of Helmholtz, by which the depths of the eye may be explored, — the laryngoscope of Czernak, which reveals the condition of the air-passages, — and the urethroscope of Desormeaux, disclosing the secrets of the urinary canals, — must now be added the splanchnoscope, rendered of practical utility by Dr. Millot of Kiew, by which the human body may be made transparent by light developed within its cavities. By means of the Geisler tube, rendered luminous by electricity passed in a vacuum or through various gases, giving light without heat, this invention has been made possible. Dr. Millot's instrument is Middledorf's improved Geisler tube. He has introduced it by an œsophageal probe into the stomachs of a dog and cat, and enabled spectators to see distinctly every detail of the organ; in the same way the internal membrane of the human viscera has been rendered perfectly visible. The instrument, when further improved, will doubtless lead to very important physiological results.

ON THE TRANSMISSION OF LIGHT THROUGH ANIMAL TISSUES.

At the 1868 meeting of the British Association, Dr. Richardson exhibited a lamp which he had constructed for this purpose. He believed that the first idea that such transmission could be effected was given in Priestley's work on electricity. Of late years research had been made with the microscope in the transparent web of the foot of the frog, and last year Dr. Mackintosh had shown that young trout could be used experimentally, they being sufficiently transparent for the investigation of the action of various poisonous substances. The suggestion of Dr. Mackintosh had been acted upon by the author, and the motion of the heart and of the respiration had been observed by direct ocular demonstration while those organs were under the influences of various bodies belonging to the ethyl and methyl series. This research had led Dr. Richardson to extend the principle further, and he had now advanced so far that he was enabled to transmit light through various tissues of the bodies of large animals. He had thought it was best to begin by testing each tissue separately, and this investigation had been carried out on nearly all the structures of the body which admit of being individually examined. The structure the most diaphanous was the skin; after that, and singularly enough, bone; then thick membranes; next, thin superficial muscles, lung tissue, fat, and the dense tissues of the liver and the kidney. Various lights had been tried, namely, the electric, the oxyhydrogen, the lime, and the magnesium light. For all practical purposes the magnesium light was the best; it was the most convenient to use, and the light had the advantage of penetrating deeply. In the lantern which Dr. Richardson exhibited, the light was also unattended with heat at the point of observation, so that the hand could be put in at the brightest illuminating-point. The additions consisted in a tubular arrangement and a sliding groove. The structure to be examined was placed in the groove enclosed between two disks of perforated wood, and the object was surveyed from the further end of the tube. A thick piece of bone, the flat rib of an ox, was placed in the lantern, and light was distinctly transmitted through it by way of illustration. It might be used for a variety of physiological purposes. Animals whose tissues were thin, such as fish, could be placed in the lantern, and the condition of their circulation and respiration could be carefully studied under the action of various agents. In the human subject, especially in the young, with fragile tissues, the thinner parts of the body could be distinctly rendered transparent; and, in a child, the bones, with a somewhat subdued light, could be seen in the arm and wrist. A fracture in a bone could in fact be easily made out, or growth from bone in these parts. In a very thin, young subject, the movements and outline of the heart could also be faintly seen in the chest, but the light he had as yet employed had not been sufficiently powerful to render this demonstration all he could desire. It would be possible, lastly, to see through some diseased structures so as to ascertain whether, within a cavity, there was a fluid or a solid body.

ON THE PROPER USE OF GRAIN.

The following are extracts from a letter by Baron Liebig, copied into "Dingler's Journal" from the Augsburg "Zeitung": —

"In view of the present distress of the poor inhabitants of Eastern Prussia, it may not be inappropriate to direct public attention to the fact, that grain, by its conversion into flour, loses in nutritive properties; that of rye by 10 per cent., that of wheat by 15 per cent.

"A grain-fruit has a structure similar to that of an egg; as in the last-named the yolk, the portion rich in fat and poor in albumen, is surrounded by a layer of albumen, so in the grain the starchy nucleus is enveloped by a stratum of an albuminiferous substance, which in being ground passes into the bran; and this substance is the most important as a nourishment for the blood.

"Some 2 or 3 per cent. more of bread may be obtained by omitting fermentation.

"Where, as in the question of food for a whole population, the life of thousands depends upon a proper application of the means required for their sustenance, it would seem that some attention to scientific principles is in its place. The same quantity of grain, in the form of bread from meal, will save for every thousand persons one hundred and twenty more from hunger and its concomitant results, than bread from fine flour, freed as the latter is from bran.

"In regard to the greater value as nutriment of bran-bread, it may be mentioned that in the Crimean war the Russian prisoners in the French camp, who were accustomed to the coarse bread, suffered by the use of wheat bread, and a supplementary diet had to be granted.

"The means for preparing bread without fermentation are well known and in constant use in England and the United States, as well as on their vessels. The simplest is the addition to one hundred pounds of meal of a pound of super-carbonate of soda, with an equivalent quantity of some acid, preferably tartaric or cream of tartar.

"I have for several months past been engaged on a thorough investigation of the changes which human food undergoes, as regards its value as nutriment, by its treatment in cooking; among others also in the preparation of bread, and one of the results arrived at is that bran-bread, commonly known as '*pumpernickel*,' cannot be obtained of uniform character or constant nutritive value if made partly by fermentation.

"A number of facts eliminated by the recent Prusso-Austrian war lead to the conclusion that a method of baking which is independent of fermentation, and not apt to produce a bread which is subject to mould, would be of great value, not only for an army, but for the people at large; and the close research into these relations has confirmed me in the belief that bread of such qualities is not procurable except by the use of some chemical means, and that these, if properly applied, furnish bread of higher value than that at present in use, and of a nature which leaves nothing to be desired."

INHALATION OF ATOMIZED FLUIDS.

Dr. Beigel says: "It is confirmed beyond doubt that atomized fluids enter the respiratory tract, and penetrate into the very cells of the lungs; that, therefore, by means of inhalation, remedies may be applied most appropriately and successfully to the organs of respiration." According to him the medicaments which can thus be applied beneficially in the above diseases are, nitrate of silver, 3 to 5 grains to the oz. of water, in inflammatory conditions; nitrate of aluminium, same strength, in inflammation and nervous affections of the larynx and trachea; tannin, astringent and styptic, 1 to 10 grains, as above; alum, 1 to 20 grains; sesquichloride of iron, 5 to 25 minims in an oz. of water; acetate of lead, 3 to 10 grains; sulphate of zinc, 1 to 10 grains; common salt, tincture of opium, liquor arsenicalis, pure water, glycerine, lime-water, and cod-liver oil; also the salts of iodine, chlorine, and bromine.

SEWAGE CONTAMINATION VS. CHOLERA.

Mr. Simon, in his "Report on the Cholera Visitation of 1866," says: "It cannot be too distinctly understood that the person who contracts cholera in this country (England) is *ipso facto* demonstrated with almost absolute certainty to have been exposed to excremental pollution; that what gave him cholera was (mediately or immediately) cholera-contagion discharged from another's bowels; that, in short, the diffusion of cholera among us depends entirely upon the numberless filthy facilities which exist, especially in our larger towns, for the fouling of earth, air, and water, and thus secondarily for the infection of man, with whatever contagion may be contained in the miscellaneous outflowings of the population. Excrement-sodden earth, excrement-reeking air, and excrement-tainted water are for us the causes of cholera. That they respectively act only in so far as the excrement is cholera-excrement, and that cholera-excrement again only acts in so far as it contains certain microscopical fungi, may be the truest of all true propositions; but whatever be their abstract truth their separate application is impossible. It is excrement, indiscriminately, which must be kept from fouling us with its decay.

"The local conditions of safety are, above all, these two: 1. That, by appropriate structural works, all the excremental produce of the population shall be so promptly and so thoroughly removed, that the inhabited place, in its air and soil, shall be absolutely without fæcal impurities; and, 2. That the water supply of the population shall be derived from such sources, and conveyed in such channels, that its contamination by excrement is impossible.

"That cholera is still a terror to Europe shows how scantily such illustrations are yet understood. Even here in England the objects which I have named as essential are at best but rarely fulfilled; indeed, for vast numbers of our population scarcely rudimentary endeavors have been made to attain them. Town after town might be named, with myriad on myriad of population, where there is little more structural arrangement for the removal of refuse than if the inhabitants were but tented there for a night. The case of the water supply is no better, whether it be in private hands or under the control of commercial companies.

"Cholera, ravaging here at long intervals, is not Nature's only retribution for our neglect in these matters. Typhoid fever and much endemic diarrhœa are incessant witnesses to the same deleterious influence; the former annually kills 15,000 to 20,000 of our population, and the latter many thousands more. The mere quantity of this wasted life is something horrible to contemplate, and the mode in which the waste is caused is nothing less than shameful. It is to be hoped that, as the education of the country advances, this thing will come to an end; that so much preventible death will not always be accepted as a fate; that for a population to be thus poisoned by its own excrement will some day be deemed ignominious and intolerable."

FUNGOID ORIGIN OF DISEASES.

Modern investigation points to the cryptogamic origin of many diseases, such as cholera, typhus, malarious fevers of hot climates, dysentery, yellow fever; and further research may show that the so-called exanthemata have a like origin.

The late epidemic of pestilential intermittent fever at the Mauritius, one of the most fatal known, has been evidently connected at the outset with malarious influences, while its spread was aggravated by contagion, by contaminated drinking-water, and by exposure to the emanations from the discharges of infected persons. Such is also the history of yellow fever in its rise and progress, in whatever country it occurs; of epidemic dysentery in its home in India; and of cholera. Each is dependent upon its own peculiar fungus for the train of symptoms which ensue; and this again belongs to that genus or species which the animal and vegetable life of the country where it grows tends to produce.

The investigations of Dr. Schmidt have proved the presence in the Mauritius fever, along the whole intestinal canal, of minute plants of a fungus, the countertypes of similar growth found under the microscope in the water of the Grand River. Rank vegetation, stagnant waters, a polluted atmosphere, or one damp and reeking with the products of decaying animal and vegetable matter, contaminated water, with heaps of human ordure lying near it, are more or less characteristic of the outbreak and spread of yellow fever, cholera, tropical intermittents, and dysentery. We must bear in mind that streams, sewers, drains, and cesspools of towns, which hold in suspense the germs of many a poison may, and doubtless do, contain other ingredients which destroy the vitality of the germs, and thus limit their spread. Myriads of them are rendered innocuous, or their organization destroyed, and new combinations formed out of their elements, by the action of the other ingredients suspended in the same medium.

There is reason to believe that the cholera-breeding fungus is never so abundant as that of most vegetable fungi; the rarity of its appearance, its comparatively limited spread, and its disappearance after a time, are no arguments against its existence, but only show its delicate organization, its easy destruction, and the rarity of the combination of conditions necessary to produce it. It may be that some diseases take their rise in the entrance of the spores of certain species of infusoria, and others in that of the germs of certain genera of fungi. The cells of either, whilst floating in

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the air, must be inconceivably minute; but when introduced into the stomach by the food, or more commonly by the saliva, they there find material congenial to their germination; or, on the other hand, destructive matters may be present. In the latter case they are resolved into their ultimate elements, and, entering into new combinations, cease to be noxious, if they originally were so. In the former, a development probably of the most rudimentary form is produced, and this, though germinating in the stomach, may be as harmless as thousands of its species are, or as poisonous in its degree as its larger brother growing in the field or buzzing in the air. Speedily developed thus far, it now requires other conditions than are to be found in its present habitat, and it as speedily dies; but if possessed of noxious properties, it and its fellows who entered with it have, during their short but active existence, succeeded in poisoning the nutrition of the body. — *Lancet.*

Dr. Joseph G. Richardson, of Union Springs, N. Y., after numerous examinations of human blood, has arrived at the conclusion that living organisms in decomposing beef tea, when ingested, may enter the circulation and increase there; and bases his belief on experiment made on himself, by microscopical examination of his blood at intervals after taking 4 ounces of beef liquid, which, according to calculation, contained 27,000,000,000 of living organisms. He thinks the presumption is strong that other plants beside those noticed by himself, of a more poisonous nature, may thus enter the circulation, "and each constitute the essence, the real *contagium*, of some so-called zymotic disease, as, for example, diphtheria and scarlet fever, small-pox and measles, as declared long ago by Prof. Salisbury, of Cleveland, and recently by Prof. Hallier, of Jena." — *Amer. Jour. of Med. Sciences.*

THE ANTISEPTIC TREATMENT IN SURGERY.

We know from the researches of Pasteur that the atmosphere contains among its floating particles the spores of minute vegetations and infusoria, in greatest numbers where animal and vegetable life abound, as in crowded cities, under the shade of trees, and in the wards of hospitals. The septic energy of the air is in proportion to the abundance of these minute organisms in it, and is destroyed by exposure of these germs to a heat of about 220° F. The character of the decomposition which occurs in a fermentable substance is determined by the nature of the organism which develops it; thus the same saccharine solution will undergo either the vinous or the butyric fermentation, according as the yeast plant or another organism is introduced into it. We cannot refuse to believe, therefore, that the living beings invariably associated with the various fermentative and putrefactive changes are indeed their causes, and not the oxygen or moisture of the air. These minute organisms are the immediate cause of putrefaction, and putrefaction is regarded as the cause of suppuration. This treatment, as recommended by Mr. Lister and others, does not exclude the air from wounds, but applies as a dressing a material capable of destroying the life of the floating particles. He employs carbolic or phenic acid, the most powerful antiseptic known. He uses "carbolic oil," 1 part of carbolic acid to 5 of boiled linseed or other fixed oil; "carbolic lotion," carbolic acid 1 part and water 30 parts; and "carbolic paste," or carbolic oil with whitening, of the consistence of a thick paste. By the destruction of the septic germs by these preparations, the gravest wounds are recovered from with slight and healthy suppuration, and very little constitutional disturbance. — *Lancet.*

NEW THEORY OF VISION.

Mr. S. Rowley, in the "American Journal of Science" for September, 1868, proposes a new theory of vision, of which the following is a condensed statement: "The entire impressions on the retinæ, before becoming objects of consciousness, are projected in space upon surfaces bisecting each other (at an angle greater or less according to the distance) in a plane perpendicular to the plane of the axes, — the component points of each impression being simultaneously referred outward in lines passing from them through a point a little behind the centre of the crystalline lens; but, excepting the expansion and the inversion resulting from the crossing in the eye of the directions of outward reference, undergoing no change of relative position, — the distance between the planes passing at right angles to the optic axis through any two of the successive concentric zones of points, which make up the retinal impression, continuing the same."

HOMOLOGIES OF SOME OF THE APPENDAGES OF THE ANTERIOR VERTEBRÆ OF FISHES.

M. E. Baudelot, "Comptes Rendus," February, 1868, undertakes to determine the nature of the ossicles which in the *Cyprinidæ*, *Siluridæ*, and some other fishes, establish a communication between the anterior extremity of the swimming bladder and the auditory apparatus. Weber long ago considered them as homologous with the bones of the ear of mammals, and gave them, in consequence, the names of *malleus*, *incus*, *stapes*, and *claustrum*. Geoffroy St. Hilaire, who considered the opercular pieces as the bones of the auditory apparatus, regarded the bones in question as parts of the superior arches of the first, second, and third vertebræ. According to Cuvier, he is also said to have made out the malleus and the incus as the ribs of the second and first vertebræ. Mulder, in 1831, concluded that these bones corresponded to the ear-bones of the higher animals, and that the air-bladder was homologous with the membrane of the tympanum. He afterward attempted to show that the so-called malleus and incus are ribs of the first two vertebræ, and the stapes a transverse process of the first vertebra.

As seen in the carp, the fish usually examined for this purpose, these ossicles of Weber seem to be attached upon the first two vertebral bodies, — the stapes and claustrum on the first, and the malleus and the incus on the second. But, if other *Cyprinidæ* be examined, it will be found that the second vertebral body, apparently simple in the carp, is really compound, and represents the bodies of the second and third vertebræ, in many species separated by an articulating cavity. In this way these vertebræ come under the normal type, and these bones have the following signification, according to this observer: the malleus (on the two sides) represents the branches of the inferior arch of the third vertebra, the superior arch, of two wide pieces, being completed by an intercrural bone; the incus, the branches of the superior arch of the second vertebra, the inferior being represented by two long transverse processes joined to the vertebral body; the stapes, the branches of the superior arch of the first vertebra, the inferior represented by two more or less long transverse processes joined to the body of the vertebra; the claustrum, an intercrural bone, in two halves, in contact on the median line.

In the *Catostomi*, the branches of the upper arch of the second vertebra, or the incus, are very rudimentary, being a simple bony nodule encased in the middle of the tendon which extends from the anterior extremity of the malleus to the summit of the stapes. This isolated position of a rudiment of a vertebral arch, outside of the vertebral column, shows how the principle of connections may lead an observer astray, unless he takes into account the laws of morphology.

ORGANIC FERMENTS; OR, MOLECULAR GRANULATIONS.

M. De Monchy, "Comptes Rendus," February, 1868, finds these very minute movable corpuscles in all concentrated solutions of commercial bicarbonate of soda before filtration, and considers them as organic ferments, as vegetable cells, since they act chemically like ferments in the transformation of cane-sugar and fecula. In the experiments which he gives, the corpuscles are the only active agents, as neither bicarbonate of soda, or carbonate of lime, pure, have any action as a ferment. He admits with M. Béchamp ("Annual of Scientific Discovery," for 1868, p. 269), that fermentations by the organic ferments of chalk, etc., are physiological acts of nutrition; the formation of an acid can be the result only of a secretion effected by the movable corpuscles, thus of necessity organized. These corpuscles lose their activity as ferments at a temperature of 100° C., as also by contact with a solution of potash, one-tenth, in which they are insoluble; he hence concludes that they are vegetable cells, which have already undergone some degree of development; they can come only from the air, in which the germs were in suspension, as it cannot be maintained that organic matter could resist the high temperature employed in these experiments. Their presence in the commercial articles explains the appearance of vegetable productions in media where their presence may seem inexplicable; their action, as ferments, varies according to the media in which they are found; in certain cases they may be producers of alcohol.

M. Béchamp has also shown that these *microzymæ* exist also in all the tissues of organic beings, and in a great number of the cells of these tissues. M. Chaveau has also found them in vaccine and small-pox virus, and in similar products, and it is probable that they play a part, the extent of which physiologists are only beginning to understand, in various healthy and morbid processes.

M. Bernard has shown that one of the functions of the liver is to produce and store up glucogenous matter, to be gradually transformed into glucose. This glucogenous matter is fecula in a peculiar condition of solubility, like that called soluble fecula, by M. Béchamp. The last-named author, "Comptes Rendus," March, 1868, treats the questions of the seat of this function in the liver, and of the way in which fecula becomes glucose in this organ.

A zymase or soluble ferment is always the product of a cell or group of living cells; spontaneously, no albuminoid or other matter becomes a zymase, or acquires its properties; it requires the presence of organized material. In the mouth, the "organisms of Leeuwenhoek," or molecular granulations, form sialozymase (salivary diastase) with the products of the parotid and other saliva. These granulations (genus *Microzyma*) are the cause of the fermentation in old wines, in solutions of cane-sugar and starchy pastes with chalk, exist in the tissues of organic beings, and are constant elements of the hepatic cells. From experiments with the latter, he concludes: 1. That these granulations of the liver are imputrescible, insoluble in acetic acid and potash solutions, and endowed with a mobility which persists even in viscid liquid. 2. They render fluid starch paste with rapidity, and produce soluble fecula. 3. By the zymase, which they produce with the albuminoid matters of the liver cells, they cause the formation of glucose.

In the sap of vegetables, according to M. De Monchy, "Comptes Rendus," March, 1868, are large numbers of granules having an oscillating motion, called by botanists "movable globules." The same granules have been noticed in the pollen-bearing utricles, in the liquids of insects, especially in the eggs and larvæ of lepidoptera, and in the posterior part of the body in spiders, also in the pigment layer of the choroid coat of the eye. His experiments there detailed, show that these oscillating granules, from all the above sources, are organisms acting powerfully, like ferments, on the matters with which they are naturally in contact. They act on cane-sugar, starch, and gelatine as ferments, transforming them more or less quickly and completely into glucose. The function of these granules is to assist in the ripening of fruits, and in both the animal and vegetable kingdom to elaborate certain matters for the nourishment of germs and the incessant regeneration of organs. Leydig says: "We may state absolutely that what we call 'elements of formation' are preceded by a series of creations." M. Monchy regards these oscillating granules as the active agents in this series of creations, effectually aiding in the formation and regeneration of the tissues.

The results of the experiments of these authors are important, and furnish new and much desired materials for the study of cellular physiology.

RATTLESNAKE POISON.

From experiments on pigeons, Dr. Weir Mitchell has arrived at the following conclusions: The venom of the rattlesnake is perfectly harmless when swallowed, as it cannot pass through the mucous surfaces, and undergoes a change during digestion which allows it to enter the blood as a harmless substance, or to escape from the canal in an equally innocent form. Twenty-four hours after it has been swallowed, the contents of the bowel contain no poison. The rectum does not absorb the poison, and it causes no injury when placed in contact with the conjunctiva. It passes through the membranes of the brain, and more swiftly through the peritoneum and pericardium; when it passes through the peritoneum, it so affects the walls of the capillaries as to allow of their rupture and of the consequent escape of blood. The same phenomena appear on the bare surface of muscles thus poisoned, which, together with the defect of the coagulability of the poisoned blood, account for the excessive bleeding about the fang wounds. The blood globules are unaltered. The animal is not susceptible of injury by the venom of its own species.

The sulphites or hyposulphites of soda or lime have no antidotal power. Carbolic acid sometimes delays the fatal result, and usually lessens local bleeding, from no influence of the acid on the venom, but from a direct effect upon the local circulation of the poisoned part; it has no value as a true antidote, and when given internally does not affect the ordinary fatal issue.—*N. Y. Medical Journal.*

MINUTE PARTICLES IN THE AIR OF CITIES.

Mr. J. B. Dancer found the following objects in the air of Manchester, England. Spores appeared in immense numbers, 250,000 to every drop of the water containing the air washing, varying from one ten-thousandth to one fifty-thousandth of an inch in diameter; their peculiar molecular motion was observable for a short time. The mycelium of these minute fungi was similar to that of rust or mildew, such as is found on straw and decaying vegetation. In 36 hours the fungi had greatly increased, and on the third day a number of ciliated zoöspores were seen moving freely among the spores.

The next in quantity was vegetable tissue, the greater portion under high powers, exhibiting what is called the pitted structure; many particles were evidently partially burnt wood used in lighting fires. Along with these were fragments resembling hay and straw, and hay seeds, and some very thin and transparent portions of weather-worn vegetation; there were also some hairs of leaves of plants, and fibres like filaments of cotton, and some fragments of wool.

These floating particles in the air will differ in character according to the season of the year, the direction of the wind, and locality, and are much less in quantity after rain. In the above experiments, it is estimated that 37½ millions of these spores, exclusive of other substances, were collected from 2,495 litres of air, — a quantity which would be respired in about 10 hours by a man of ordinary size, when actively employed. There was a marked absence of particles of carbon among the collected matter. — *Chemical News, April*, 1868.

THE POISON GENERATED IN PUTREFACTION.

Drs. Bergmann and Schmiedeberg have communicated to the "Centralblatt" (German) an account of the isolation of a crystalline substance, which they believe is the proper poison generated in putrefactive fermentation. This poison, the terror of the dissecting-room, has hitherto been known only by its effects. The London "Lancet" gives the following details of the preparation of this substance which these chemists have succeeded in isolating. It is obtained by diffusion through parchment paper, precipitation with corrosive sublimate from an alkaline solution, removal of the mercury by silver, of silver by sulphuretted hydrogen, evaporation, and purification of the residue. Large, well-defined, acicular needles are thus obtained, which are deliquescent in the air, and, exposed to heat, melt and carbonize. They possess a powerfully poisonous action. A solution containing scarcely more than one-hundredth of a gramme was injected into the veins of two dogs. Vomiting was immediately induced, and after a short time diarrhœa, which in the course of an hour became bloody. After nine hours the animals were killed, and, on examination, their stomachs and large intestines were found ecchymosed, and the small intestines congested. — *Scientific American.*

SIAMESE TWINS.

There never has been a question among medical men, either in this country or in Europe, in regard to the feasibility of the separation of these two individuals; that they are two beings having distinct segregated and perfect organizations, one from the other, as any other two individuals; that there is no physical, moral, or mental unity between them, the only connection being a short cartilaginous and integumental band common to the two, the severance of which would, in all probability, be entirely harmless; that no "sensations, nervous impressions, physical, morbid, mental, or nervo-mental condition" ever exhibited a "physical unity in their dual corporeal existence;" that they have no unity of conceptions, impulses, thoughts, etc.; that it never was the professional opinion that the death of one of the brothers would be instantly followed by that of the other, or that their separation was surrounded by fearful difficulties, and that the link now binding them together is not a means of perfect physical union by which sensations or impressions are conveyed from one to the other. There is, in fact, nothing more common between these Siamese than what would have been acquired by any other twins indissolubly united by a hempen or metallic cord, and subjected, as they have been, to precisely similar circumstances from their birth. Indeed, the band uniting them is almost insensible, so much so that, on shipboard they were pulled about by a rope tied to it. No pulsating vessel has ever been detected in it, though, undoubtedly, it is just here and nowhere else, in the centre of this cord, made up of gristle and skin, and for about an inch on either side, that there are vessels and nerves communicating from one to the other. Here, but nowhere else, a touch on the space indicated is felt by both. Precisely here, and here alone in the band uniting them, there is sensation and nothing else whatever common to both. If they are inclined to sleep, eat, etc., and perform the functions of life with great similarity, and agree always in their tastes and habits, we must recollect that their surroundings, positions, etc., have all been precisely alike. People forget, too, that one of them is irritable, the other very mild; one of them is the larger, stronger, and the more intelligent, and he controls the other. His slightest movement is followed by the weaker one from necessity, and not, as is generally supposed, from unity of will or harmonious action. They play games, one against the other, and have quarrelled just like other good brethren, and more than once.

The decision given by the profession in Europe and America, thirty-eight years ago, when this case was first put on exhibition, was that the ligament of union was cartilaginous, probably a prolongation of the ensiform cartilage from the sternum, and the chief, if not the only, objection to its division has been that the peritoneum might be involved in the operation. It was, moreover, not one demanded by surgery, for the twins had lived and might yet live for years.

The London "Lancet" of 1830 even declared that it was more rare than curious. By the ecraseur or knife any student who has attended a course of lectures may perform this operation with success, and which, moreover, should be attempted even by any one in case of death, taking care to divide the parts nearer the one deceased. — *Louisville Med. Journal.*

THE ARTIFICIAL PRODUCTION OF MONSTROSITIES.

M. Dareste, in "Comptes Rendus," January and August, 1868, gives some interesting experiments bearing on teratology, of which we present the following abstract. Attempting, in the first place, to disturb the evolution of the embryo by varnishing the egg, he ascertained that the results obtained depended on another cause; and he turned his attention to artificial incubation, applying the heat to a single point. If, instead of applying the heat directly to the point of the egg, where the cicatricula is always placed at the commencement of development, we heat a point distant from this, the evolution is always disturbed, and an anomaly caused at first in the form of the blastoderm and then in the vascular area. Under these conditions the development of the cicatricula occurs much more in the region between the point of the egg and the point of contact with the source of heat than in the opposite region. Hence, the blastoderm and then the vascular area take on an elliptical form, and the embryo is developed in one of the foci of the ellipse; while in the normal condition the embryo occupies the centre of a perfectly circular blastoderm and vascular area. This abnormal development can be directed to any side according to the application of the heat. These results are evident disturbances of evolution, and not, as M. Cl. Bernard thinks, simple pathological changes.

The embryos which appear in these deformed blastoderms are very often monstrous, and among them may be recognized, in process of formation, almost all the types of simple monstrosity described by I. Geoffroy St. Hilaire, and sometimes also forms unknown to him, as that characterized by the existence of a double heart.

In a previous communication to the Academy he had shown that celosomy, exencephaly, and ectiomely, so often asssociated, result from the arrested development of the amnios; that anencephaly is produced by a dropsy consequent on an alteration of the blood; that the inversion of the viscera is explained by the predominance of one of the two hearts which he had discovered exist normally at a certain epoch of embryonic life. He also shows that symely results from an arrest of development of the caudal hood of the amnios, and cyclopy from arrested development of the cephalic hood of this organ. All these anomalies are essentially characterized by disturbances of evolution, and in none, anencephaly excepted, is there any pathological change to modify the development. He has ascertained that incubation of the eggs at a temperature higher than 40 degrees often produces dwarfed development.

He accepts Cruveilhier's explanation of symely, or the inversion and fusion of the posterior limbs, by rotation and lateral pressure in the early period of intra-uterine life; but adds that the cause of this pressure is an arrest of development of the posterior or caudal extremity of the amnios, it remaining applied against the posterior part of the body instead of being separated from it by the amniotic liquid, and consequently inverting and pressing together the external surfaces of the bud-like posterior limbs, — forming a veritable graft by approximation. What determines this want of parallelism between the embryo and the amnios, and the arrest of development of its posterior portion, future researches must determine.

In this way the development may be augmented in any direction, and the conditions which produce an inversion of the viscera established at the will of the experimenter. He has shown that the incurvation of the cardiac fold to the left of the embryo, the cause of visceral inversion, may be produced simply by so placing the eggs that their long axis shall be oblique to the axis of the heating tubes, and that the pointed should be higher than the obtuse end. To render the inversion certain, there must be also a certain depression of the surrounding temperature, at the points not artificially heated; the inversion did not occur unless the surrounding air was below 22° C.

DARWIN'S THEORY OF PANGENESIS.

While laying great stress on the conditions of existence as the great cause of the modification of species, and as one of the main causes of change in the organs of reproduction, and also on "natural selection" as a modifier of the egg, the seed, the young, as well as the adult, Darwin finds in what he calls his provisional hypothesis of "pangenesis" the solution of the problem and the immediate means by which the change is effected. In his own words, this hypothesis "implies that the whole organization in the sense of every atom or unit reproduces itself. Hence ovules and pollen-grains — the fertilized seed or egg, as well as buds — include and consist of a multitude of germs thrown off from each separate atom of the organism." It is, in the words of a writer in the "Quarterly Journal of Science" for July, 1868, the application of the atomic theory to living forms, and is in perfect conformity with all the teachings of correlation between vital and physical forces." — "The author believes that all changes in the various organisms which result from the contact of the spermatozoön and ovum, as well as those which are derived from gemmation or budding, have their origin in the nature of the cells which constitute the elements or materials in operation. The cells or units which constitute all living bodies, from the simplest to the most complex, are themselves organized, and consist of lesser cells or atoms having various natures, and, according to the author, they give off those constituent atoms as 'gemmules,' and the nature of those atoms or gemmules fixes the future character of the organism into which they enter. In this manner he seeks to account for the first variation in living types; for the transmission of inherited peculiarities from a grandfather, say, through a daughter to a grandchild; for hybridism."

Darwin says, at the conclusion of his chapter on pangenesis: "Finally, the power of propagation possessed by each separate cell, using the term in its largest sense, determines the reproduction, the variability, the development, and renovation of each living organism. Each living creature must be looked at as a microcosm, — a little universe formed of a host of self-propagating organisms, inconceivably minute, and as numerous as the stars in heaven."

For a further development of the theory the reader is referred to Darwin's work on "The Variation of Animals and Plants under Domestication," and to the review above quoted.

ORGANIC PROGRESSION OF ANIMALS OF THE SAME FAMILY.

M. Ed. Lartet, in "Comptes Rendus" for June, 1868, draws attention to the gradual modification in course of time of various organs, especially among the ruminants, with the results of increase of functional energy in special directions, and a real progress in the animal existence of modern times.

In the oldest *cervidæ* of the tertiary epoch, the enamelled crown of the molar teeth above the neck is much lower, and less prominent beyond the alveolar ridge, than in the quaternary and actual deer of this family; so that the tortuous folds of enamel, which form the triturating surface of these teeth, are so shallow that the bottom can always be seen in the former, but never in the latter. This is a useful and certain diagnostic mark for the paleontologist, and is applicable also to other herbivora, pachyderms, rodents, and omnivora.

In the genus *cervus*, the molars cease to grow after the crown is fully developed, and, as this crown is worn away by daily use, the functional duration of these teeth depends on their greater or less elevation above the alveolus; hence it may be legitimately concluded that the ancient tertiary *cervidæ*, whose molars had crowns much less elevated than the later and living species, had a shorter period of life, as the longevity of an animal depends essentially on the functional duration of the organs necessary for nutrition.

It is also a result of his observations that, the older the animal in tertiary time, the smaller becomes the brain in comparison with the size of the head and the dimensions of the body. The inferior character of the brain of *anoplotherium* was long ago observed by Cuvier; in fact, the head of this animal, of the size of an average ass, was six times as long as the impression of its cerebral hemispheres, and its brain was smaller than that of the existing roebuck. As we approach the present epoch, the difference between fossil and recent brains becomes less marked, as does the elevation of the crown of the molar teeth. In the brains of deer and antelopes of the middle miocene of Sansan many convolutions are seen, but the cerebellum is little covered by the hemispheres, and the olfactory lobes are largely developed; in the upper miocene of Pikermi the brain of *hipparion* is less rich in convolutions than in the existing horse. This fact is more marked in animals of the same genus; in the *viverra antiqua* of the lower miocene of Allier as compared with the living *V. genetta*, the former, with a cranium a third longer and a fourth wider than in the latter, had no larger brain, and one at the same time with thinner frontal folds, a less development toward the face, and a large size of the olfactory lobes. Paleontology proves the truth of the remark of Gratiolet, that a great development of the olfactory lobes is a mark of an inferior type.

It is a common observation that the largest mammals are the longest lived; it would be more true to say that normal longevity apparently increases in direct ratio with the absolute volume of the brain. The elephant, which lives 150 years, has a larger brain than any other land mammal; next to the elephant would come man, who, by the absolute size of his brain and by his longevity, is superior to other terrestrial mammals, many of which are of much larger dimensions than the human race.

From facts like these, it appears that, in certain divisions of the mammalia, there has been, since their first appearance on the globe, a gradual increase of vital energy and intelligence; in other words, the duration of life and the development of the intellectual faculties were less in early tertiary epochs than at the present time. The organic differences above alluded to, which diminish in geological succession as we approach the present era, have not arisen from any transformation of generic types, but solely from the effect of the tendency of animated nature toward a perfection whose cause is ever acting and whose limits are unbounded.

ON THE PEDIGREE OF MANKIND.

According to Dr. Haeckel, the line in which man's development from the lower animals took place commenced with amphioxus, and proceeded through the lampreys and the extinct allies of the sharks to the lepidosirens, thence through proteus and its congeners to the tritons and salamanders, and thus to the monotremata (ornithorhynchus). It then passes through the marsupials, the lemurs, the Old-World monkeys (semnopithecus, etc.), and the anthropoid apes (orang, gorilla, etc.).

All the existing varieties of man he regards as having come from one stock, which he considers to be now extinct. He also believes that the various races have the same value in natural history as species, and he describes them as such. They are the following: —

I. *Hominos ulotrichi:* men with woolly hair and long heads.

1. *Homo primigenius.* Ape-like men, now extinct.
2. *H. papua.* Papuan species.
3. *H. hottentottus.* South African species.
4. *H. afer.* Central African species.

II. *Homines lissotrichi:* men with smooth hair; heads long, short, and of medium proportions.

5. *Homo alfurus.* New Holland species.
6. *H. polynesius.* Malayan species.
7. *H. arcticus.* Polar species.
8. *H. mongolicus.* Yellow species.
9. *H. americanus.* Red species.
10. *H. caucasicus.* White species.

Admitting that it is sometimes difficult to draw the line between these groups, he observes that the same difficulty exists in treating of species of other groups of the animal world. — *Quart. Journ. of Science, October*, 1868.

VARIATIONS OF THE FINS OF FISHES.

Form.—A sharp-pointed fin, especially if sickle-shaped with posterior edge concave, indicates a very rapid swimmer; as seen in the pectorals and ventrals of many scomberoids and in all the fins of some selachians. This corresponds to what occurs in birds of rapid flight, as in the sharp-pointed wings of the falcon, swallow, frigate-bird, etc. A deeply-forked tail denotes a good swimmer, especially if the caudal is supported by a pedicle, as in the mackerel family. In like manner birds of high flight have a very forked tail. On the contrary, the fins of fishes of moderate swiftness, other things being equal, have rounded outlines; so the obtuse wings and tail characterize the birds of moderate flight.

Size and Number.—Every one is familiar with the fact that large fins are especially observed in rapid swimmers; for example, the tail of the mackerel, the pectorals in the tunny and flying-fish, etc. The same is true of the number of fins; as in the selachians and cod family, whose dorsals and anals are numerous. In the latter the number of these appendages compensates for the rounded and obtuse shape of the fins. It seems to be a general law that the vertical extent, or the length of the rays, of the dorsal and anal fins is in proportion to the distance of the line of insertion above or below the antero-posterior median line; for instance, in the squammipennes, many scomberoids, and sparoids with arched back. That which is true of the entire fin is often applicable to a relatively small portion of it, as in *pomotis*, *myripristis*, etc., where portions of the dorsal and anal fins are developed in height in relation to the fleshy prominence on which they are implanted. Sometimes, however, the dorsal is very high without a corresponding elevation of the region of implantation above the median axis, as when the great extent of the dorsal is designed to make up for the absence of the ventrals (*Xiphias*), or their small development or reduction to simple rays (*Istiophorus*, *Tetrapturus*, *Pteraclis*, etc). In the last the anal is elevated as well as the dorsal. These are examples of organic balancing, showing that rapidity of swimming is a product of many factors, whose principal variations are in their form, size, and number. A very great antero-posterior extent, in number of rays, of the dorsal and anal fins, becoming even continuous with the tail, is seen in many flat fishes (flounder family) and in very elongated ones (eel family, etc.).

Situation.—Ichthyologists have made use of this character in their classification of fishes, as Linnæus, Lacépéde, Cuvier, Dumeril, etc. The ventrals are either jugular or thoracic, in fishes with large heads (*Trigla*, *Cottus*, etc.); in those which, without having the head very large, have the anterior part of the body thick (percoids, sciænoids, etc.); and in almost all fishes which have the centre of gravity within the anterior two-fifths of the body. On the contrary, abdominal fishes have neither a large head nor thick shoulders, but a fusiform or even elongated body (cyprinoids, herrings, etc.). Hence we may establish the law, that, in fishes whose centre of gravity is far in front, the ventrals seem to be carried forward the better to sustain them. If, with large head and anterior ventrals, the pectorals are inserted far back, the position of the latter is counterbalanced by their length. In a few cases, jugular and thoracic fishes have an elongated body; but generally their odd fins are either very numerous or extended, throwing the ventrals forward and making up in point of velocity for their obtuseness of form. The dorsal may extend forward even to the head; the anal is never anterior to the ventrals; the anterior border of the dorsal apparatus is almost always in front of that of the anal, sometimes on the same line, and rarely posterior to it; it is very rare to find the whole dorsal behind the anal (*anableps*). It is very common in jugular and thoracic fishes to find the posterior border of the dorsal and anal on the same line; while, in most of the abdominal fishes, the anal is wholly behind the dorsal.

Absence. — The ventrals are the most frequently deficient, as in the eel family; in other families, the absence of the ventrals is fully compensated by the length and suppleness of the body or the great development of other fins. The occurrence of ventrals with absence of the pectorals, on one or both sides, is very rare (*pleuronectes*). The simultaneous absence of the pectorals and ventrals occurs in *ophichthys*. The odd fins (dorsal and anal) are, therefore the last to disappear. — GOURIET, *Comptes Rendus*, *June*, 1868.

HOMOLOGIES OF THE TEETH OF THE MAMMALIA.

Mr. Flower stated, in a paper before the British Association in 1868, that he had discovered that some of the so-called monophyodont mammals, as the armadillos, had a complete set of milk teeth preceding those with which they are provided when adult; and that in marsupials only one tooth, the so-called fourth premolar, has a successor, while in dogs only one, or at most two, of the premolars have predecessors. In seals the first set of teeth are extremely minute, mere points, and this led to the belief that they were evanescent. He concludes that the so-called milk, or first set of teeth is by no means to be regarded as the typical series to which the second set are added, as Owen maintains; but, on the contrary, that the milk teeth are something added to the normal dentition in the higher mammals, and more especially in those groups which require teeth when young. It is a question whether the evanescent condition of the milk-series of teeth in the seals indicates an approach to the condition of the cetacea, which have but one set, or are monophyodont.

SIREDON, A LARVAL FORM OF AMBLYSTOMA.

Dumeril in 1867, from changes observed at the "Garden of Plants," in Paris, maintained that the Mexican axolotl is a larval salamander, a conclusion strengthened by similar changes noticed in the *Siredon* from the Rocky Mountains, by Prof. Marsh.

The first phase observed in the transformation was the appearance of dark spots on the sides of the tail, and, soon after, the membrane along the back, and especially that below the tail, began to disappear by absorption. Next the external branchiæ began to be absorbed, and the animal came more frequently to the surface of the water for air. As the change went on, the spots gradually extended over the rest of the body; the external branchiæ, as well as the branchial arches, became absorbed, and the openings on the neck closed by the adhesion of the opercular flap. The body diminished in size; the head became more rounded above, and more oval in outline; the eyes became more convex and prominent, the opening of the mouth larger, and the tongue considerably increased in size. Important changes also took place in the teeth and in other parts of the structure, and the animal finally escaped from the water a true *Amblystoma*, not to be distinguished from *A. mavortium* (Baird). Subsequently, several other siredons went through the same metamorphosis, during which it was shown that the rapidity of the change was greatly affected by variations in light and temperature, the specimens most favorably situated in these respects having undergone apparently their entire transformation in about three weeks. Whether the species ever changes in its native lake, about 7,000 feet above the sea, is uncertain, but it probably breeds in the siredon state, like the axolotls from Mexico. This interesting metamorphosis leads to the suspicion that other so-called perennibranchiates may prove to be the undeveloped young of well-known species. — *Proceedings Boston Society Natural History, Sept.*, 1868.

The menobranchus of Lake Superior, kept for two years under the most favorable conditions as to light, temperature, and food, did not undergo any of the above changes; nor is there in the north any salamandroid of sufficient size to be regarded as the possible adult condition of the menobranchus. — *Editor.*

DISCOLORATION OF THE SEA.

Arctic voyagers have long been familiar with the "black water" of Davis's Straits, Baffin's Bay, and other northern seas, in which the color is dark olive-green or even black. This color has been generally attributed to the presence of great multitudes of minute animals, as medusæ, entomostracan crustaceans, and pteropods. It was noticed, however, by Mr. Robert Brown that, though these animals often sunk, the water still retained its dark color. He afterward discovered the cause to be great numbers of diatoms, chiefly of one moniliform species, of undetermined name. The medusæ and other animals feed upon these plants and are themselves the food of the whales which frequent these waters. The same diatoms are the cause of the brown "rotten ice" of the polar regions.

The yellowish-brown scum, called by sailors "sea-dust," seen in the Indian Ocean and China Seas, is caused by a minute alga, referable to *Trichodesmium*, a genus of *Oscillatoriæ*. The plant consists of short filaments, composed of a single line of cells, combined into a cylindrical unbranched fibre; many are aggregated into little bundles, having the appearance of a sheaf or a wedge, according as they are in close contact either at the middle or at one end.

The red discoloration seen in the Red Sea, Persian Gulf, and in the north Pacific, is caused by one or more closely allied species of *Trichodesmium*.

ANCESTRY OF INSECTS AND CRUSTACEANS.

Dr. A. Dohrn, of Jena, has lately described a new fossil insect, which he calls *Eugereon Bœckingi*, which has characters intermediate between those of the hemiptera and neuroptera, and must, he thinks, be genetically related to the two orders, — not that it was the common ancestor of these two groups, for the neuroptera are found alongside of it, but that at a period not much earlier an insect form existed completely intermediate between the neuroptera and hemiptera, from which these two orders were differentiated and from which *Eugereon* also was descended, not having become so much modified.

According to Prof. Haeckel, insects, spiders, centipedes, and crustacea must have had a common ancestor. The ancestral form of the crustacea is known, appearing in their development as the *Zoëæ*. The ancient adult *Zoëæ* or *Zoepoda*, as he calls them, flourished early in the Silurian period according to him, and it was probably about the Devonian epoch that certain zoepods were naturally selected for a terrestrial life, developed tracheæ, and became *Protracheata*, or progenitors of all the great tracheiferous group of the articulate-limbed animals; while those which remained in the water are the ancestors of the branchiferous forms called crabs, lobsters, and shrimps. Whether any *Protracheatæ* exist still is, says Haeckel, doubtful; perhaps the *Solifugæ*, a strange group of aberrant spiders, and also those insects which have no wings (not through disease as in many cases, but by their progenitors never developing them), represent amongst to-day's fauna the protracheata of the past. — *Quart. Jour. of Sci., Oct.*, 1868.

A VIVIPAROUS ECHINODERM.

Dr. Ed. Grube describes an echinoderm from the Chinese Seas under the name of *Anochanus*, which produces young echini like itself, having spines, feet, and even pedicellariæ. These young, though having a general resemblance to the parent, are not quite the same in detail, and must undergo modification with growth. This discovery is of remarkable interest, for it adds one more to the many diverse methods of reproduction known among echinoderms, and completes the parallel which they present to the worms. We now know, in both groups, of animals laying eggs which produce embryos developing directly into the adult form; of others which present strange larval conditions, which either become completely altered so as to form the adults, or bud off from their interiors a small mass of living tissue which becomes the adult, leaving the larva to perish. We know, in both groups, of hermaphrodites and of diœcious species, and now we have added a viviparous form of echinoderm, such as was previously observed in some nemertian worms. We have yet to discover among the echinoderms the various modifications of a sexual reproduction, by pseudova, fission, or true parthenogenesis; the first two of which methods (especially fission) are so well known among worms. — *Quart. Journ. of Science, Oct.*, 1868.

ELASMOSAURUS PLATYURUS: A NEW FOSSIL MARINE REPTILE.

In the Proceedings of the Academy of Sciences, of Philadelphia, 1868, Prof. Cope has described a new large enaliosaurian reptile, discovered in Kansas, by Dr. T. H. Turner. The remains consisted of over 100 vertebræ, the greater part of the pelvic and scapular arches, many portions of ribs, and part of a muzzle with teeth. Though related to the *Plesiosaurus* and its allies, it differed in important features; such as the absence of diapophyses on the caudal vertebræ, and the presence of inferiorly directed plate-like parapophyses which took the place of the usual chevron bones in the same position; also in the presence of chevron-like bones on the cervical vertebræ, and in some details of the pelvic and scapular arches. It differed from *Cimoliosaurus* and *Brimosaurus* (Leidy) in the absence of diapophyses on the lumbar vertebræ; those of the dorsals originated from the centre, and not from the neural arch. It differed from *Plesiosaurus* in the enormous length of the tail, and the relatively shorter neck. The total length of the vertebral column sent was 31 feet, 10 inches, as follows: caudals, 18 feet 10 inches; dorsals, 9⅝ feet; cervicals, 3½ feet; adding for missing cervicals and cranium, 2½ feet, we have a total of about 34½ feet, and probably 38 feet. The caudals had very compressed centres, and elevated neural and hæmal laminæ, and were unusually elongated; neural arches everywhere co-ossified to the column. The name is derived from the caudal laminæ, and the great plate bones of the sternal and pelvic regions.

It was a marine saurian, progressing rather by the tail than by its paddles. The teeth and muzzle showed it to be an ally of plesiosaurus; the former were cylindrical, implanted in very deep sockets, and with a very small pulp cavity; the exposed surface closely and sharply striate to the narrowly acuminate tip. The beds were argillaceous, with much gypsum, the latter coating the bones; the age was cretaceous, perhaps the upper middle.

[The elongated form of this marine saurian comes nearer to the described modern sea-serpent than any other; it may have disappeared, actually or apparently in the tertiary, to reappear at the present time in a modified form, intermediate between the enaliosaurians and the elongated cetaceans.] — *Editor.*

HAIR OF DIFFERENT RACES OF MEN.

M. Pruner-Bey has shown that the hair is not always black in the negress. Beside a red color, which is very exceptional, he has met with hair of an ashy tint in some cases. Among 200 specimens of hair from natives of India, only one occurred of a straw color, and even this might have been of a foreign origin. The hair of every race south of the Himalayas is jet-black; but in proportion as we ascend into more elevated regions, a brown color occurs more and more frequently. The differential characters of the hair of various races are found chiefly in the forms presented by transverse sections, which determine not only the form, but the size of the hair, — a character which he considers of the greatest importance. The Arian races show a regular oval outline in the transverse section of the hair, while the Semitic have a more or less angular outline. — *Quart. Journal of Science, October*, 1868.

THE NOMAD RACES OF EUROPEAN RUSSIA.

Mr. H. H. Howorth in a paper presented at the 1868 meeting of the British Association, concluded that the various races known in history as Huns, Avares, Khazary, Hungarians, and Bulgarians are in the main but branches and tribes of the same race. They all come from the same country; their languages and manners were the same. Planted in Europe as early as the fourth century, they were constantly reinforced by fresh arrivals, and continued to exercise great influence in Southern and Central Europe, until their power was broken by the stronger arm of Charlemagne. Ethnologically he considered all these tribes to have been Ugrian or Fin, their leaders and aristocracy at one time German, at another Turk, but their main body, as we still find it in Hungary, speaking the Finnic tongue. He could find little support for the notion that the earlier invaders, the Huns and Avares, were Mongols, and that they were completely stamped out by the later Hungarians. Byzantine chroniclers inform us that after the fall of the Caliphate, its dependent races broke through surrounding barriers, and overflowed their neighbors. It was thus we find the Ugrians gradually driven out of their lands, while the latter became occupied by Turks, the Bashkirs succeeding the Ostiahs. The frontier robbers of Thrace gradually changed with this immigration, and became more or less Turk. Petcheney, Coman, and Nogay succeeded one another, until Little Tartary became a Turkish area, while the Hungarians and Circassians became isolated from one another, and became mixed and corrupted in language and blood. The history was one of the gradual supersession of Ugrian by Turk influence.

NATURAL HYBRIDS.

Dr. Fritz Müller has recently directed Mr. Darwin's attention to the barnacles occurring on the coast of South America, and among others describes a natural hybrid between *Balanus armatus* and *B. assimilis*, which he accounts for by the isolation of the respective parents. If, he says, we regard the species of a genus as descendants of a common primitive form, and, at the same time, in accordance with the well-known experience of gardeners, regard their various peculiarities as so much better fixed, or so much less variable, the earlier they were acquired, the longer they have been inherited unchanged, it becomes intelligible that, above all, the characters proper to the primitive form persist; and consequently, in the crossing of two species, these are more readily transferred to the hybrid than later acquired peculiarities of the parents. He thus thinks to explain many peculiarities of hybrids, and perhaps in many cases to trace from the form of the hybrids to the primitive form of the genus; the latter, of course, only with the greatest care, for the mere fact that the hybrids produced by males of one species with females of another do not agree with those produced by males of the second species with females of the first, furnishes a proof that other circumstances aid in determining the form of the hybrids. — *Quarterly Journal of Science, October*, 1868.

THE ARABIAN HORSE A SPECIFIC TYPE.

M. Sanson, "Comptes Rendus," March, 30, 1868, in studying the specimens in the museum of Paris, noticed several skeletons of horses labelled "Arabian" which had only 5 lumbar vertebræ, instead of 6, the normal number in the horses of Western Europe. Examining also the collections of Germany, and from 14 authentic specimens, he has arrived at the following conclusions: 1. There exist in the Eastern countries two specific types of race of the genus *Equus*, hitherto confounded under the name of the Arabian or Oriental horse. 2. Both are brachycephalous, but in one the forehead is flat, the nasal bones rectilinear, and the lumbar vertebræ 6; in the other the forehead is convex, the nasal bones slightly curvilinear, and the lumbar vertebræ only 5; these vertebræ differ, not only in their number, but in the form of their transverse processes, and their disposition in the series. 3. These two types seem to have distinct geographical origins, as they are evidently the issue of different stocks; the type with 6 lumbar vertebræ would undoubtedly belong to the Asiatic continent; the type with 5 lumbar vertebræ to the African continent, as the other African types of the genus, as the ass and the zebras, acknowledged to be distinct species, have the same number. 4. The reality of the specific type of this horse with 5 lumbar vertebræ would explain many anomalies of the spine in the crosses with this type, the evident result of a conflict of physiological heredity.

THE KABYLES.

M. Duhousset ("Comptes Rendus," March, 1868) gives the physical characters of the Kabyle tribes of the northern slopes of Mt. Djurjura and of the region of the rivers Sahel, Sebaou, and Isser. He considers the Berber or Kabyle race as the most ancient occupant of the north of Africa, if not indigenous there. An Arabian tradition derives them from Egypt. They migrated even to the desert, carrying their agriculture with them; they bravely resisted the Romans, retreating to the almost inaccessible mountains. The population is more compact than in France, and every available foot of ground is cultivated.

From his observation, the Kabyle has an oval countenance, widest above, the face appearing short on account of the width at the temples; the cranium is generally unsymmetrical. The average height is 1,690 millemetres, and comparatively few surpass this.

LIFE IN THE OCEAN DEPTHS.

Prof. Edward Forbes and other distinguished naturalists have maintained that the pressure at the lower depths of the ocean was too great, that there was not sufficient light, and that the water contained too little air to allow of animal existence there.

At the last meeting of the National Academy of Sciences, M. Pourtalés read a paper on the dredgings of the Gulf Stream.

This was listened to with the greatest interest, for it upsets all sorts of theories, and will suggest work in many new directions. It has long been supposed that 100 fathoms was the greatest depth at which animal and vegetable life could exist, but when Henry Mitchell and Pourtalés were appointed to the coast work between Florida and Cuba, and pursued it partly in connection with explorations for the submarine telegraph, a new state of things appeared. The charts show near the shore a plateau of silicious sand, spotted with banks of green sand, and then outside of this a deposit of shelly and calcareous matter like the base of a coral reef, far below 100 fathoms. Corallines were found at the depth of 700 fathoms. The fauna of Cuba and Florida coasts were found to differ. A single dredging of 500 fathoms brought up a dozen forms of life, and among them shells of the most delicate structure, and at the depth of 400 fathoms a crinoid of a wholly new species, that being an extinct creature of which all the museums in the world furnish not more than nine specimens of the only living species.

It is claimed that by these discoveries we become possessed for the first time of a deep-sea fauna, containing several supposed extinct types, and that we find in the Atlantic also types supposed to be peculiar to the South Seas.

A full account of these interesting discoveries will be found in the "American Journal of Science," for Nov. 1868, p. 410.

NATIVE RACES OF ABYSSINIA.

Dr. H. Blanc, one of the Abyssinian captives, read a paper upon this subject at the 1868 meeting of the British Association.

Detailed characteristics of the following great divisions of the inhabitants were given, premising that the Abyssinians differ from all other native African races, and present much analogy to many European nations the offspring of divers invaders, and that there never was, in all probability, a pure original Abyssinian race: — the Amharas, a name applied to the majority of the people, all Christians; the Tigre people, dwelling in the north, and much resembling the Amharas; the people of Lasto, who combine the best points in the two former; the Shoas, each of those people being Islams. The Falashas are the most important of the separate tribes, and are the supposed descendants of the Jews, said to have accompanied the Queen of Sheba on her return from her visit to Solomon, and to have settled in the country under her son Menilek, the alleged offspring of Solomon. The Kainawnts, a peculiar people, have much in common with the Falashas, and profess a religion which is a mixture of Judaism and Paganism, though under compulsion, exercised by Theodore, they for a time professed to be Christians. The Agaws, another separate tribe, are of Galla origin, but whose manners are such as to have impressed themselves favorably in Dr. Blanc's remembrance. The Agaws wear the mahtab, the mark of Christianity, but are looked upon with some prejudice by the Amhara Christians. The Zalas are a separate caste, industrious, and, therefore, looked on with contempt by the lazy and vainglorious Amhara, but still, by the help of a stick, enabled to hold his own against several Amharas armed with spear and shield. The Waitos, another small tribe, are noted for their predilection for the unclean hippopotamus, and consequently, they are placed under a ban, though actually always obliging and civil. The Figens are a border tribe, cruel, and famed for their powers of incantation. The Wallo Gallas, originally from equatorial Africa, were, however, before Theodore's rise, the most powerful people in Abyssinia. They invaded the country in the sixteenth century, not only subdued and occupied the fairest provinces, their present country, but often carried their victorious arms to Gondar and Tigre, and imposed their rule on many Christian emperors. They are a brave, handsome race, and now that their great enemy is no more they bid fair, should they, burying in oblivion all internal rivalries and petty jealousies, once more unite, to overrun Abyssinia and impose on the debauched and sensual Christians of that country the false creed of the Koran. Such, said Dr. Blanc, are the several tribes and classes that constitute the Abyssinian race. Taken as a whole, with the exception of the oppressed and hard-working peasants, there is nothing in them to praise or extol.

TYPES OF THE HUMAN RACES.

At the 1868 meeting of the British Association, Prof. Huxley delivered a lecture, from which the following are extracts: —

"Supposing all the various forms of mankind were gathered together in one place, and supposing you had to pick out all the great groups, I think you would reduce them to four. In the first place there is that form which I call 'Australoid,' because I believe the best type of this form is to be found in Australia at the present day. What I mean by Australoid is this, a man of dark complexion ranging through various shades of chocolate, with black eyes, smooth, soft, wavy hair, neither crisp, nor lank, nor straight, with an invariably long skull, that is to say, a skull the breadth of which is less than eight-tenths of the length; and as far as stature goes, and other characteristics, there are many differences; but the three points upon which I base this class are, the dark complexion and eyes, the wavy and silken hair, and the long skull. All the forms of mankind which I include under this head have these characteristics. The second type is the 'Negroid.' This term also has a precise, well-defined limitation. I mean by it those men who have dark skins, — varying from darkish-brown to what we call black, — though true black is a great rarity, with invariably, unless under abnormal conditions, black eyes; with dark hair, usually black, and also usually crisp, or what we call woolly. In this type, as in the former, except in one or two exceptional cases, the skull is invariably a long skull, very different in many respects from the Australoid, but at the same time a long skull. The third group is one for which I have no good name; but I will use one, which is a very old and respectable authority. The group consists of men of a complexion varying from a yellowish to an olive tint; with black eyes and black hair, which is usually straight and lanky. Here I must remark that this group differs from the two I have mentioned in the character of the skull; so that here, as in other cases, characters of hair and complexion and skin are more permanent and of more value than those of the skull, which is not at first what we should expect. I should term this the 'Mongoloid' type. The fourth type, of which I have to speak as one of the great primary forms, is that which is extremely common amongst ourselves, especially in the eastern and southern counties of England; and also in Germany and the Sclavonic countries. It is what is known as the 'Blonde' type; but sometime ago I proposed the name of 'Xanthochroid.' These people vary in stature, and are characterized by fair, delicate skins, through which the blood shows, imparting that color which we admire so much; yellow hair and blue eyes; and they are usually of tall stature. In this group, as in the other, there is an extreme variation in the type of skull; that is to say, you may have every variety, from the long skull of the Scandinavian to the broad skull of Central Germany."

WHY THE LEAVES FALL.

According to Von Mohl, "Shortly before the fall of the leaf there begins to be formed a very delicate layer of cells, the growth of which is from above downward, so that, beginning from the axillary side of the leaf and gradually extending downward and outward, nearly at right angles to the long diameter of the cells of the leaf-stalk, at any rate at right angles to the plane of the leaf, it effects a gradual separation between the stem and the leaf as effectually as a knife would do. These changes are not wholly due to a change of seasons from wet to dry, or from hot to cold, for it not unfrequently happens that if a tree be stripped of its leaves in summer, it forms during the autumn new ones, which remain on the tree during the greater part of the winter, or until long after the usual period." — *Pop. Science Review.*

AIR-VESICLES OF THE UTRICULARIÆ.

S. B. Schnetzler, in the "Annals of Natural History," publishes an account of these curious appendages to the leaves. The genus *Utricularia* consists of aquatic plants found in the stagnant waters of ditches, marshes, etc.; the leaves are submerged and furnished with the remarkable utricles. De Candolle states that in the young plant these vesicles are filled with mucilage heavier than water, which, like ballast, hold the plant down at the bottom. Toward the period of flowering, the leaves secrete a gas which makes its way into the utricles, and drives out the mucilage by raising an operculum or lid with which the utricles are furnished. The plant, thus provided with a multitude of air-bladders, rises slowly and floats at the surface. After flowering in the air, the mucilage is again secreted, and the plant sinks to the bottom to ripen its seeds. After careful investigation of the morphology and history of these organs, he concludes that they play the part both of organs of respiration and of a hydrostatic apparatus. They do not appear at a given moment and for a particular purpose, but as a natural consequence of the anatomical structure of the plant and the action of the surrounding medium.

ON THE MUFFA OF THE SULPHUR SPRINGS OF VALDIERI.

A paper was read on this subject by Mr. Moggridge, at the 1868 meeting of the British Association.

The Baths of Valdieri are situated in a valley on the northern side of the Maritime Alps, and have long been celebrated, not only for the excellence of their mineral waters, but also for the "Muffa," — a substance occurring in one of those waters, which, while of great medicinal value, is interesting when viewed under the microscope, for the vegetable, animal, and mineral productions which it contains. These baths are 4,426 feet above the level of the sea.

Found in those sulphur springs, which have a temperature of about 50° C., the muffa first appears as tender, minute filaments, soft and floating, of a greenish-white color, surrounded by a mucilaginous milky-white substance imbued with a sulphurous deposit. Of little consistency in its early state, it soon becomes more substantial, changing in color to violet, then light yellow, and finally to a pale green. When mature it resembles a gelatinous lard, carpeting the rock down which the water flows.

The vegetable above referred to was considered by Allioni to be *Ulva labyrinthiformis* (Linnæus). In 1837 Fontan detected a distinct organization, describing it as composed of white filaments from one four-hundredth to one two-hundredth of a millimetre in diameter; tubular, cylindrical, simple, devoid of septa, containing small semi-opaque globules, collocated when young, and separated toward the the end of the tubes in mature individuals. To this plant he gave the name *Sulphuraria*, it not having been found in any except sulphur springs.

Delponte, of the Botanic Garden at Turin, after a careful microscopic examination, places it in the genus *Leptothrix* (Kützing), near to *L. compacta* and *L. lamellosa*, naming it after the place of its nativity, *Valderia*.

A parasitic alga accompanies the above, growing upon it, and an *Oscillatoria* sometimes covers the upper surface, where the water has not more than 35° of temperature. A *Conferva* also occurs.

The microscope reveals curious spontaneous movements in the muffa; these are the work of numerous minute animals, which live and multiply at a temperature of 40°. Prof. Defilippi considers them to be coleopterous insects, of the genera *Cryptophagus* and *Comurus*, with others which he could not determine.

The residuum after burning dried muffa was 28.055 per cent. Of this, 10.924 were mineral substances belonging to the vegetable organization, — that is, true cinders; and 17.134 sand mixed with the vegetable, from which it had been found difficult to separate it. One hundred parts of pure cinder contained: Oxide of potassium, 15.271; oxide of sodium, 11,637; oxide of calcium, 7.938; oxide of magnesia, 1.915; oxide of alumina, 9.833; oxide of iron and manganese, 24.162; chlorine, 2.445; sulphuric acid, 9.232; phosphoric acid, 4.481; silicious acid, 13.115.

SPECIES AMONG DIATOMS.

Mr. A. M. Edwards announced to the Lyceum of Natural History of New York, in April, 1868, two discoveries he had made in vegetable physiology, which he considered of importance in their bearing upon the subject of the origin of species, and desired to place them on record so as to make them public at as early a date as possible. In examining, by means of the microscope, a gathering of fresh-water plants from a pond in New Jersey, made in last November, he had found two forms of minute organisms belonging to the family *Diatomaceæ*, commonly called "Infusoria," and placed by all writers in separate species of the genus *Gomphonema,* attached together by the same common stalk in such a way as show them to be but states of one species. Also, when examining in the same way, during the present month, some plants taken from the waters of New York harbor, he had found a form of *Schizonema* and a form of *Homœocladia*, both hitherto considered distinct genera of *Diatomaceæ*, which grow within membranous tubes, in one and the same tube, thus connecting the two genera in a novel manner. He said he was not yet prepared to account for these remarkable occurrences, as the life-history of these organisms was as yet but imperfectly understood.

BIOLOGICAL SUMMARY.

Mental and Manual Labor. — Prof. Houghton, of Trinity College, Dublin, has published some curious chemical computations respecting the relative amounts of physical exhaustion produced by mental and manual labor. According to these chemical estimates, two hours of severe mental study abstract from the human system as much vital strength as is taken from it by an entire day of mere hand-work. This fact, which seems to rest upon strictly scientific laws, shows that the men who do brain-work should be careful, first, not to overtask themselves by continuous exertion; and, secondly, that they should not omit to take physical exertion on a portion of each day, sufficient to restore the equilibrium between the nervous and the muscular system. — *Medical and Surgical Reporter.*

Eustachian Tube in Swallowing. — Prof. Cleland has answered the question, Is the Eustachian tube opened or shut in swallowing? He pointed out that this tube was not, as generally supposed, shut, in ordinary circumstances, and opened in swallowing, but opened in ordinary circumstances and spasmodically shut in the act of swallowing. The proof of this position was based partly on anatomical consideration, and partly on observations made on a patient in whom the Eustachian tube was visible on one side through an ulcerated opening, and whom he had taught to swallow with his mouth open.

Physiology of Pain. — Prof. Rolleston has said it was a common mistake to suppose that pain was an exaltation and excitement of function, for it might also be occasioned by a lowering of functional activity, brought about mainly by starvation or shock. Starvation was produced by a cutting off of the supply to the tissues from the blood-vessels which, by an excessive action of the vaso-motor nerves, contracted so forcibly as to cause the current to cease. The pain from shock was produced by a sudden impact without the intervention of blood-vessels, though not without the intervention of the tubes containing nerve matter.

Seat of the Faculty of Articulate Language. — According to Prof. Paul Broca, the seat of this faculty is the third frontal convolution of the brain (chiefly the left side), which, he said, acted upon the external organs through the medium of the *corpus striatum.* He referred to the diagnostic symptoms of the various forms of defective speech, and proposed a new terminology for their expression, namely, *alogia*, the loss of speech from defective intelligence; *amnesia*, from defective memory of words; *aphemia*, from a defect in the special faculty of language; and *alalia*, from defective articulation.

Action of the Pancreas on Fat and Starch. — The influence exerted by the pancreas upon fats appears to operate by breaking up the aggregation of the crystals of the fat and altering its hydration. It alters the molecular condition of the fat, mingling it with water in such a way that even ether cannot separate the fat from the water. A permanent emulsion is thus formed, ready to mix with a larger quantity of water whenever it may be added.

The pancreas, therefore, in acting upon fat, does not decompose it into fatty acid and glycerine, the absence of the glycerine from the watery stratum, and the presence of the glycerine in the pancreatized fat of the ethereal stratum, having been demonstrated.

It is well known that, in addition to the influence of the pancreas upon fat, it has the power of converting starch into glycose by simple mixture. This property remains, to a certain extent, after the pancreas has exhausted its property of acting upon fat. The quantity of pancreas which before mixture with fat will convert about eight parts of starch into glycose, after saturation with fat will still convert about two parts of starch into glycose.

The Action of Veratria. — Praag has arrived at the following conclusions from his experiments: —

1. Poisoning by veratria diminishes the intensity of the respiration and of the circulation.
2. The muscles lose their tension.
3. The sensibility of the peripheral nerves is diminished.
4. Small doses produce nausea, vomiting, and diarrhœa.
5. The secretion of urine is slightly, that of saliva markedly, increased.

Kölliker deduced from his observations: —

1. That veratria excites the medulla oblongata, and the spinal marrow, and causes tetanus that does not last long.
2. The brain is not affected, at all events before the spinal marrow.
3. It has no influence on the trunks of the motor nerves. The apparent paralysis depends on paralysis of the muscles.
4. The striped muscular fibre very soon becomes paralyzed and motionless.
5. The heart soon becomes motionless; this apparently depends on a direct influence exerted upon the muscular fibre.
6. The topical application of dilute solutions affects the spinal marrow and the medulla oblongata, but not the nerves.

Glucosuria and Albuminuria. — M. Collas expresses the opinion that diabetic disease depends upon an incapacity of the system to convert sugar into an insoluble modification. This incapacity he attributes to a deficiency of phosphate. His proof he rests on the following observations: —

That during gestation, there is unusual difficulty in healing fractures, owing to the appropriation of every particle of earthy phosphate to the fœtus to form its bone, and at the same time there is a great tendency to glucosuria.

To prove that phosphates have this power, he makes the following experiment: A solution of ordinary diphosphate of soda is made in water containing carbonic acid, and is mixed with cane sugar. In a fortnight this solution will be found to be thick and viscous. He therefore recommends the administration of phosphates and phosphoric acid.

In albuminuria, a most valuable constituent of the system is wasted through the urine. If M. Collas's reasoning is true with respect to the waste of sugar, by parity of argument, it seems probable that the loss of albumen may arise from the absence of fixing principles, and this would immediately suggest the administration of remedies capable of coagulating albumen, such as mineral acids, alkaline nitrates, etc. In fact the number is so extensive that the only difficulty would seem to be in the selection.

Local Anæsthesia. — The "Medical Gazette" contains the following report of a case in which ether was thus applied: —

"The subject of the experiment had 16 teeth extracted with scarcely any pain, and what little discomfort there was, he referred rather to the gum than to the dental nerves. Richardson's spray instrument was used, and the jet directed upon the external orifice of the ear, and a little in front of it for between 3 and 4 minutes. One side was anæsthetized first, and a number of teeth and stumps on that side extracted, and the same process repeated afterward on the opposite side. The central incisor of the side first operated on caused some pain, partly, perhaps, from subsidence of the anæsthetic action (that being the last tooth removed on that side), partly, possibly, from some inosculation of the terminal branches of the superior maxillary nerve of the opposite, undeadened side.

"Many physiologists hold that the anæsthesia produced by the spray instrument is due, not to any specific effect of the agent employed, but simply to a 'freezing process,' the result of rapid evaporation. In this case, however, even the integument (though greatly reduced in temperature) was not frozen, and, had it been, it would have been impossible for the mere action of cold to penetrate to the ganglion of Casser. The subcutaneous cellular tissue, fat (the worst possible conductor) muscular and fibrous layers, must surely protect the ganglion from very intense refrigeration, and, moreover, the insensibility of the dental nerves continued for some minutes after the skin had recovered its warmth at the spot where the spray had been applied."

Minute Structure of the Liver.— Hering, Eberth, and others, have given up Dr. Beale's view, as also that which attributes to the bile-ducts the formation of distinct capillaries within the lobules, having a membrana propria like the blood-capillaries, and in contact only externally with the liver-cells. Prof. Turner supports the new view; namely, that the bile passes to the periphery of the lobule in channels which lie between and have their walls formed by the liver-cells, and which communicate with the interlobular branches of the hepatic duct.

Oxygenized Blood and Decapitation.— According to the experiments of Dr. Claude Bernard, if oxygenized blood be injected into the arteries of the neck immediately after decapitation, warmth and sensibility return, the eyes get animated, and display such perception, that an object shaken before them will cause winking and movements of the eyeballs as if to avoid injury.

Pyœmia.— Dr. Richardson has separated the poison of pyæmia; it may be, he says, evaporated to the form of a syrup or extract. It forms, when dried, a substance closely resembling the snake poison. If pulverized, and introduced into the wound of a healthy animal, it produces precisely the same symptoms as those of the patient from which the poison was taken.

Hæmatoidin.— According to Holm, hæmatoidin differs from bilirubin not only in form and color, but in essential chemical properties. The latter has the properties of a weak acid and combines with bases, the former is an indifferent body; the latter is insoluble in ether, the former easily soluble; the latter is removed from alkaline solutions by chloroform, the former not. According to Staedeler, the coloring matter of the yolk of the egg is either hæmatoidin itself, or a body very similar to it.

Santonine.— According to Prof. Franceschi, santonine, the vegetable base of *Artemisia santonica*, in itself white, when taken internally, causes objects to appear tinged with yellow. He attributes this to the santonine imparting a yellow tint to the humors of the eye, having undergone a chemical change of color from contact with the serum of the blood.

Watering Streets and Sidewalks. — The practice of deluging uncleaned streets and sidewalks, not merely sprinkling them, is deleterious to the public health, as the rapid evaporation of the moisture carries with it into the atmosphere a large amount of poisonous organic matter calculated to breed disease. Street-filth is far less deleterious when dry than when moist during the extreme heat of summer. Sprinkling furnishes one of the two conditions that are absolutely necessary before decomposition can take place, namely, moisture.

Animal Quinoidine. — This curious substance was discovered by Dr. Bence Jones. It causes the phenomena known as fluorescence of tissues. We learn from the "Gazette Hebdomadaire" that Dr. Chalvet has proved before the Société de Biologie, that this is not produced in the tissues, as previous observers supposed, but is found in most articles of food, especially wine and vegetables. It is introduced into the organs with these ingesta, and mixes with the fluids of the body, like iron, but is never originated there. His researches tend to prove its identity with quinine.

Curious Effect of Thallium. — This substance has the property of entering the circulation, and producing the most offensive odor to the perspiration of the parties taking it. Dr. Bunsen was compelled to absent himself from society for four weeks on this account. This one property will kill it for all practical use in medicine. Its action is similar to zinc and iron on the economy.

acting as a tonic, and producing, in large doses, severe headache.

Picric Acid. — Picric acid is an efficacious remedy in intermittent fevers. Persons affected with such types of fever, upon whom quinine has lost all its beneficial effects by continuous usage of it, — and this is the case with some of our soldiers who return from India, — derive, physicians say, wonderful benefit from the use of picric acid and picrates, as Dr. Aspland has proved to be the case at the military hospital at Dukinfield. The knowledge of this fact may be useful in districts in which poor populations exist, for it affords them a cheap febrifuge; and, moreover, picric acid is not dangerous, as arsenical preparations are, nor does it derange the stomach like quinine.

Wounds by the Chassepot Rifle. — Experiments have recently been made at the camp of Lyons on the bodies of dead horses, with the view of ascertaining the precise character of the wounds produced by conical bullets discharged from the Chassepot muskets. It is said that the aperture made by the projectile at the moment it penetrates the flesh is commonly no larger than an ordinary pea, but that the rotary movement of the ball revolving on its axis gradually enlarges its circles until it makes a hole into which a person could thrust the fist.

Death by Fire-Damp. — Dr. B. W. Richardson, F.R.S., in investigating the physiological action of the methyl compounds, has particularly observed the action of the hydride of methyl, which occurs naturally in the form of fire-damp in mines, and as marsh gas on land. Seeking first to ascertain what percentage would prove fatal in the air, he found that even pigeons could live in an air charged with 35 per cent. of the gas, for half an hour. When death finally ensued, it came as a sleep, so gentle that it was determined with difficulty when either circulation or respiration ceased. From these observations he concluded that the victims of a mine explosion die an easy but prolonged death, and while the knowledge of the first of these truths should inspire thankfulness, the latter should encourage the rescuing party not to abandon their exertions even for days after the accident has occurred.

Means of Recognizing Death with Certainty. — Dr. E. Martenot, of Lyons, France, has devised a method of deciding the question in cases of doubtful death. It consists in applying the flame of a candle to the flesh of the finger or toe of the patient for a few seconds, until a blister is raised. This invariably takes place. If the blister is filled with serum, life still remains; if the blister is filled with vapor, death has taken place. A dry blister signifies death; a moist blister, life. — *L'Union Medicale.*

Antidote for External Poisoning by Cyanide of Potassium. — This substance is extensively used in electroplating and other arts, where its external poisoning effects produce many painful and troublesome ulcers on the hands of the workmen. The foreman of the gilding department of the American Watch Works writes to the Boston "Journal of Chemistry" that experience has taught him the most effectual remedy that can be employed in such cases, which is the proto-sulphate of iron in fine powder, rubbed up with raw linseed oil.

The Calabar Bean. — One of the Paris journals asserts that this has been found to be an antidote to strychnia. The latter destroys by spasmodic contraction; the former when taken alone paralyzes, and consequently neutralizes the action of strychnia if given after that poison. The most interesting effect of the Calabar bean is that of contracting the pupil of the eye, whereby distant objects are apparently magnified and seen nearer, and it is now considerably used for increasing the power of accommodating the eye to distances.

Sea-Weeds as Food. — Sea-weeds, according to Dr. Letheby, an English physician, furnish an abundance of nutritious food, which by a little management may be made palatable. He asserts that when in moderately dry condition sea-weeds contain from 18 to 26 per cent. of water; and that the nitrogenous constituents amount to from 9½ to 15 per cent., while the starchy matter and sugar average about 66 per cent., and that these results place sea-weeds among the most nutritious of vegetable substances; in fact, being richer in nitrogenous matter than oatmeal or Indian corn.

Preservation of Anatomical Specimens. — The process of M. Von Vetter: "Add to 7 parts of glycerine at 22° 1 part of raw brown sugar and half a part of nitre, till a slight deposit is formed at the bottom of the vessel. The portion required to be preserved is then plunged, dried or not dried, and is left in the mixture for a time proportional to its dimensions; a hand, for example, should remain 8 days in the liquid; when it is taken out it is as stiff as a piece of wood, but if it be suspended in a dry and warm place the muscles and articulations recover their suppleness."

Petrification of the Human Body. — W. P. Bain, M.D., writes as follows to the "Lancet," on the subject of Dr. Marini's preparations of the human body: —

"Having handled some of his preparations in Florence last autumn, I am able to say that he is the inventor of a mode of turning the human body or any part of it into stone, in any attitude that may be desired. I inclose the photograph of a senator of the Italian Parliament taken four months after his decease, in which he is represented seated in his chair, with his clothes on, just as when alive, his eyes retaining in an astonishing degree the vivacity of life. I also inclose the photograph of a table, the slab of which is formed of pieces of the human body, — brain, muscles, etc., — all turned into stone, and which, when struck by me, sounded as a marble table. I also inspected a lady's foot, likewise petrified, and which had every appearance of marble, until upon close inspection the texture of the skin was apparent. Dr. Marini showed me, too, some specimens of the human body, which were in a moist and perfect condition, preserved for years. He assured me also that the week before he had dined off a duck which had been killed months previously. The foot of a mummy was in his apartment at the time of my visit, in which the color assumed that of life, and the toes were perfectly flexible.

"I am perfectly certain that these inventions are genuine, and of high value."

Natural Aniline. — Mons. Ziegler, of Muhlhouse, has subjected to a careful examination the red coloring matter which is secreted by a mollusk (*Aplysia depilans*), generally known as the sea-hare, which animal is not rarely found on certain coasts and is especially abundant on the coast of Portugal after heavy storms. The coloring matter has a peculiar odor and serves the animal as a defence against its enemies by rendering the water turbid and at the same time disagreeably odoriferous. A chemical examination disclosed the fact that the coloring matter is aniline with a slight admixture of other organic substances, and that it can be easily obtained in a state of purity; but as the pound would cost about 60 francs, this new source of aniline is practically without any value. The most interesting part of the article is the suggestion of Mons. Ziegler that the sea-hare and not the murex, as now generally believed, is the animal from which the Phœnicians obtained their famous purple, and thus it is rendered probable that the priceless purple of Tyre, the only dye thought fit for the imperial vestments of Ancient Rome, is identical with the cheap coal-tar aniline of modern manufacture.

Drooping Ears of Animals. — Darwin, in his treatise on animals and plants under domestication, says: —

"Our domesticated quadrupeds are all descended, so far as is known, from species having erect ears; yet few kinds can be named, of which at least one race has not drooping ears. Cats in China, horses in parts of Russia, sheep in Italy and elsewhere, the guinea pig in Germany, goats and cattle in India, rabbits, pigs, and dogs in all civilized countries, have dependent ears. With wild animals, which constantly use their ears like funnels to catch every passing sound, and especially to ascertain the direction whence it comes, there is not, as Mr. Blythe has remarked, any species with drooping ears except the elephant. Hence the incapacity to erect the ears is certainly in some manner the result of domestication; and this incapacity has been attributed by various authors to disuse, for animals protected by man are not compelled habitually to use their ears. Col. Hamilton Smith states that in ancient effigies of the dog, 'with the exception of one Egyptian instance, no sculpture of the early Grecian era produces representations of hounds with completely drooping ears; those with them half pendulous are missing in the most ancient, and this character increases, by degrees, in the works of the Roman period.' Godron has also remarked that 'the pigs of the ancient Egyptians had not their ears enlarged and pendent.' But it is remarkable that the drooping of the ears, though probably the effect of disuse, is not accompanied by any decrease in size. On the contrary, when we remember that animals so different as fancy rabbits, certain Indian breeds of the goat, our petted spaniels, bloodhounds, and other dogs, have enormously elongated ears, it would appear as if disuse actually caused an increase in length. With rabbits, the drooping of the much elongated ears has effected even the structure of the skull."

The Norfolk Bustard —A paper, by Mr. H. Stevenson, on "The Extinction of the great Bustard in Norfolk and Suffolk," was read at the 1868 meeting of the British Association. After referring to some very early allusions to the existence of the bustard in the country, and to the gradual diminution and extinction of the species in the different English counties, the author said that Norfolk was the last county to reckon the bustard amongst its resident species.

All accounts agreed in stating that the last remaining birds were hens. One great cause of the extinction of the bird was the introduction of improved agricultural implements, which destroyed the eggs. The precise time of extinction could not be determined with accuracy; the last known specimens were seen about the year 1838, but it had been stated that some of the birds had lingered on till 1843 or 1845.

Having served its purpose, in its day, in the great scheme of nature, the great bustard has passed forever out of our local fauna.

Venom of Toads.— Experiments made by MM. Gratiolet, Cloez, and Vulpian show that the matter exuding from the parotid region of the toad becomes poisonous when introduced into the tissues. A tortoise of the species *Testudo Mauritanica*, lamed in the hind foot, was completely paralyzed at the end of 15 days; and the paralysis lasted during several months. Some savages in South America use the acid fluid of the cutaneous glands of the toad instead of the curara. The venom exists in somewhat large quantity on the toad's back. Treated with ether it dissolves, leaving a residuum; the evaporated solution exhibits oleaginous granules. The residuum contains a toxic power sufficiently strong, even after complete desiccation, to kill a small bird.

Importance of Wild Animals.— Mr. Tristan contended, at the last meeting of the British Association, that birds of prey were the sanitary police of nature, and that if they had existed in their original strength they would have stamped out the grouse disease, just as the orders in council stamped out the cattle-plague. The hawk, by preference, made sickly birds its quarry. In Norfolk there was no moor game, and therefore no grouse disease. But he would ask the game-preservers of the county whether they really believed that their stock of pheasants and partridges was materially increased by the destruction of everything which they were pleased to call vermin. He believed that the abundance of game had but little to do with the scarcity of birds of prey, and could declare that in some foreign countries the existence of numerous birds of prey was a pledge of the plentifulness of game. Owls were undoubtedly the game-preserver's best friend. His most serious foe was the rat, and the owl consumed more rats and mice than any other description of food. So with regard to polecats, stoats, and weasels.

Dr. Grierson also mentioned an instance in which the destruction of weasels had led to an enormous increase of field-mice, which had destroyed the bark of a large number of young trees, and occasioned their death.

Eyes of Vertebrates.— At the 1868 meeting of the British Association, Mr. Crisp read a paper on the relative weight, form, and color of the eye in vertebrate animals, illustrated by the casts and drawings of more than 1,000 eyes of different species. The eyes of 600 different species of mammals, birds, reptiles, and fishes, filled with plaster-of-Paris and colored after nature, were exhibited in evidence of this plan first mentioned by the author at Bath in 1864. The following were some of his conclusions: That birds among terrestrial animals have the largest eyes proportionately, but fishes have relatively the largest eyes of all animals; that among quadrupeds, the giraffe, horse, eland, elk, and bison have the largest eyes; that, with the exception of fishes, brown, in all divisions, is the prevailing color; and that whales, among mammals, have relatively very small eyes.

Nationality in Voices.— Sir Duncan Gibb, the vice-president of the Anthropological Society of London, recently prepared a paper on the character of the voice in the nations of Asia and Africa contrasted with that in the nations of Europe. Since then the subject has attracted no little attention abroad. He has arrived at the following deductions from his observations: The Chinese and Japanese possess voices of low power, feeble compass, whining in tone and "possessing a metallic twang." That of the Tartars, Thibetians, and Mongols partakes slightly of the same twang. In India and Burmah the voice is not powerful but shrill, soft, and feminine, that of the inhabitants of the hills being more robust, possessing more of the metallic twang and less of the whine than that of the inhabitants of the plains. The larynx of the negro is intermediate in size between that of the Chinese and Tartars. The negro wants vocal power, possessing the elements of a roaring, bellowing voice. "The European nations possess strong, powerful, sonorous, clear voices. Variations as to character and tone might and did exist, but as a rule they all agreed in powerful compass, range, clearness, and loudness of sound." He thinks the Germans possess the most powerful voices in Europe, but in their strength they must yield to the Tartars.

The Esquimau Race.— According to Prof. Rolleston, it is difficult to distinguish the male Esquimau from the female Esquimau by their skulls, they are so much alike. The skulls indicate that the Greenlanders were a carnivorous people; there are no sutures in the skulls such as we find in higher races. In the Esquimaux they are nearly obliterated, just as they are obliterated in the Carnivora. It has been surmised that the Norsemen were the progenitors of the Esquimau race, but if there is anything in craniology they were not; nor does the shape of the skulls indicate that there is any ethnological connection between the Esquimau and the Red Indian. All the skulls are like one another, which is to be accounted for by the uniformity of their habits and conditions.

Sterility among Skates.— In a letter published in the "Proceedings of the Essex Institute" for 1867, Salem, Mass., Prof. Agassiz states that he has recently ascertained the existence of sterile males and females among the skates, the appearance of which is so different from the normal specimens, that they have been frequently described as distinct species. The chief differences exist in the claspers of the males. The internal sexual organs retain their embryonic condition through life, even in the largest specimens, which may equal the size of the largest fertile individuals. The characteristic spines of the males, upon the upper surface of the pectoral fins, are either wanting or greatly reduced in number in the sterile males.

Sexes of Spiders.—In the extensive group of *Epeiridæ*, Mr. Pickard Cambridge has never seen an example of the male, and none can be found in the great European museums. They are so very small that they are overlooked by collectors, and resemble horny and spiny ticks. In the large *Nephila*, the males are ridiculously small in comparison with the females. This fact illustrates Mr. Darwin's principle of natural selection, as the smaller the male the greater his chance of escaping the ferocity of the female, by hiding, like a parasite, on various parts of her body; the point of required safety attained, the males would no longer diminish in size.

Amphioxus. — M. P. Bert, in "Comptes Rendus," corrects some of the errors made by Quatrefages on this lowest form of vertebrates. He denies the existence of the lateral canal opening at the side of the mouth, and describes the position of the abdominal pore and its relation to the body cavity. Like all other fish, amphioxus has the generative glands early developed, and has been seen spontaneously to discharge the spermatic fluid, showing this is not an immature form. He also speaks of the termination of the nerves in corpuscular bodies, as well as a retiform or endless disposition of the finer nerve twigs. It seems probable that the corpuscular bodies in connection with nerve-ending and muscle fibre may be connected with that form of sensation called the muscular sense, just as other corpuscular bodies (tactile, etc.) are connected with the more obvious perception of heat, cold, etc. The *plaques motrices* must be regarded merely as corpuscles of muscular sense. — *Quart. Journal of Science.*

Pterodactyle. — According to Mr. Seely the pterodactyle stood at the head of the class of reptiles, and was more highly organized than any other reptile, living or extinct. The characters of the brain were clearly ornithic, and their alleged hollow bone cavities are important facts; but as no pterosaurian had any sternal rib, their respiration must have differed from that of birds.

Ichthyosaurus. — Many have regarded the ichthyosaurus as of an inferior rank, on account of the very great number of bones in the paddle, which represents the hand; but many of the marginal bones, according to Mr. Huxley, have been confounded with the true digits.

Production of the Sexes of Bees. — M. Landois asserts, as the result of experiments made by himself, that the sex of the bee depends on the quality of the nourishment received by the larva in the cell in which the egg was deposited by the queen. He states that he has seen eggs deposited in the cells of worker bees give origin to males after having been by him transposed into the cells of males, and *vice versa.* Experiments by MM. Bessels, Sanson, and

Bastian show that eggs thus transposed from male cells to those of workers, and *vice versa*, are invariably expelled by the bees; that the sex is actually preformed in the egg when deposited; and that the manner in which the larva is nourished and the dimensions of the cells have nothing to do with the production of males or workers.— *Comptes Rendus, July*, 1868.

New Arctic Conifer. —In the "Journal of Botany," Mr. A. Murray describes the most northerly tree on the north-west coast of America. It was found forming forests on the banks of the rivers Noatak and Buckland, on the American side of Behring's Straits, nearly 7 degrees farther north than the limits of the woods on the eastern side of the American continent. Originally described by Dr. Seeman as a variety of *Abies alba*, Mr. Murray, from certain differences in the bract of the scale, regards it as a new species, and names it *A. arctica*. The desolate country where this tree is found is thus described by Dr. Seeman: "There is nothing to relieve the monotony of the steppes. A few stunted coniferous and willow trees afford little variety, and even these, on passing the boundary of the frigid zone, are either transformed into dwarf bushes or disappear altogether. About Norton Sound groves of white spruce trees and *Salix speciosa* are frequent; northwards they become less abundant, till in lat. 66° 44′ N., on the banks of the Noatak, *Pinus alba* disappears."

Fertilization of Plants. — According to Darwin, all plants with conspicuously colored flowers, or powerful odors, or honeyed secretions, are fertilized by insects; all with inconspicuous flowers, and especially such as have pendulous anthers, or incoherent pollen, are fertilized by the wind. Whence he infers that, before honey-feeding insects existed, the vegetation of our globe could not have been ornamented with bright-colored flowers, but consisted of such plants as pines, oaks, grasses, nettles, etc.

Tubular Vessels of Plants. — Physiologists are not agreed as to the functions of these vessels, which permeate vegetable tissue from the tip of the roots to the petals and pistils. Some affirm that they contain air, others fluids, others gases, etc. Herbert Spencer has shown that these vessels are not only charged at certain seasons of the year with fluid, but that they are intimately connected with the formation of wood; and from experiments with colored fluids capable of entering the tissues without impairing vitality, not only in cuttings of plants, but in individuals in which the roots were uninjured, that the sap not only ascends by the vascular tissue, but that the same tissue acts in its turn as absorbents, returning and distributing the sap which has been modified in the leaves. That this tissue acts some important part is clear from the constancy with which it is produced at a very early stage in adventitious buds, establishing a connection between the tissue of the old and new parts.

ASTRONOMY AND METEOROLOGY.

TOTAL ECLIPSE OF THE SUN, AUG. 17, 1868.

ACCORDING to Dr. Edmund Weise, the shadow touches the earth near Gondar, in Abyssinia, crosses the Straits of Bab-el-Mandeb, including Perim, Mohka, and Aden, leaves Arabia by Cape Râs-Furtak, and enters the Indian peninsula between Goa and Rajahpoor. The maximum duration of totality occurs in the Gulf of Siam, when it reaches on the central line no less than 6′ 50″, the altitude of the sun being 87½°. On its further progress the shadow runs through Borneo, Celebes, Bouru, Amboyna, Ceram, and the Arrou Archipelago; covers completely the southern part of New Guinea, and then moves toward the New Hebrides, where the totality begins at sunset.

This eclipse is very important to astronomers from the fact that the totality lasts almost as long as possible under any circumstances. At the commencement the moon will just have passed a perigee of uncommon proximity, and reaches, during the eclipse, the ascending node of her orbit. Thus the eclipsed sun rises nearly to the zenith of those countries where the eclipse takes place at noon; and therefore the augmentation of the moon's diameter (due to her altitude) is a maximum, and the rate at which the shadow sweeps over the surface of the earth is a minimum. The result of the coincidence of all these favorable circumstances will be an eclipse without rival in the records of past eclipses. There are to be found only two which may be compared in size with that of August 17, 1868, and none in which the totality lasts so long. The first is the eclipse of Thales, May 28, 585, B. C., said to have been the first predicted, and to have concluded a fierce engagement between the Medes and Lydians. The second was on June 17, 1435, in Scotland, and the time of its occurrence was long remembered by the people of that country, as "the black hour." — *Proc. of Royal Astron. Soc.*

The intense brilliancy of the light of the sun prevents astronomers from seeing any of the subordinate phenomena which are taking place on its surface, so that little else than the spots on the sun are ordinarily open to telescopic observation. Nay, the moon and planets cannot be seen through a telescope when they are anywhere in the neighborhood of the sun. Consequently, when the dark body of the moon comes between the earth and the sun, so as to totally obscure the latter, the atmosphere of the sun is displayed for observation. Red prominences or flames having been seen in the sun's atmosphere during total eclipses, Mr. Warren De La Rue, a few years ago, fitted up some apparatus, among the Spanish mountains, to photograph the red appearances, and he was very successful. The photographs proved beyond doubt that the red prominences belonged to the sun, and are in no way due to the interposition of the moon,— a point on which there had been previously some doubt.

This fact having been established the questions arose, "What are these prominences? Are they solid, or are they gaseous?" Further observations with spectroscopes in addition to telescopes and photographic apparatus, would alone be likely to furnish replies to the questions, and years had to pass away before another total eclipse of the sun would allow the instruments to be brought to bear upon the phenomena. The foregoing facts explain the intense interest with which astronomers and philosophers looked forward to the precious 5 minutes of August last, during which the sun was totally obscured. Many expeditions, fitted out by governments, were in India, watching the eclipse. Among the expeditions in India was one under the superintendence of Major Tennant, which was engaged in photographic work; another under Lieut. Herschel, engaged principally in making observations with the spectroscope; a third under the charge of Mr. Pogson, astronomer to the Government of Madras; and a fourth, the French expedition, under the management of Dr. Janssen, of Paris. All these observers took up positions in the eastern part of India, principally in the neighborhood of Guntoor and Masulipatam. Mr. Pogson intended to observe either at Masulipatam or Narsipore; he also stationed one assistant at Gunnapoor, and another near to Beejapore, towards the Bombay side.

Major Tennant and his party of sappers, took out with them, to photograph the eclipse, a great telescope, which was constructed by Mr. John Browning. This telescope has a mirror of silvered glass, 9¼ inches in diameter, and 5 feet 9 inches in focus, throwing a picture of the sun a little more than three-quarters of an inch in diameter, from the circumference of which the red flames and other phenomena would radiate. Consequently, the plates of glass to receive the picture were about 4 inches square. The image of the sun was not thrown directly upon the photographic plates by the mirror, but a small plane mirror was interposed to throw out the image at the side of the tube, as in the Newtonian telescope.

The spectroscopic observations in India were very successful, and all the observers agreed that the protuberances are gaseous in their nature.

The last fact has an importance of its own. The cause of the heat of the sun has long been a puzzle to philosophers. The heat is not produced by common combustion, for a rough approximation to the real quantity of heat given off continuously by the sun has been ascertained by experiment and calculation. It is also known that if the sun were a globe of coal continuously supplied with oxygen, it would all be burnt out in about 5,000 years. There is also evidence that the sun is not a hot body now cooling.

Planetary dust and small stones abound within the limits of the solar system, and they are constantly entering the atmosphere of our earth as meteors, the heat and light being caused by the enormous friction of the stones against the air. Toward the centre of attraction of the system — that is to say, the sun — these bodies must be much more numerous, and if we were only certain that a great mass of stones and rocks were constantly striking the surface of the sun, it can be mathematically proved that this cause is sufficient to produce these effects of intense light and heat which we see. The intense light of the sun, and the smallness of the hypothetical stones, make telescopic observation of no use in solving this problem, though on one occasion, as two observers were looking at a sun-spot, they saw a brilliant body pass across it, and at the same instant the magnetographic needles at Kew Observatory were violently deflected. The zodiacal light appears to consist of an infinity of small solid bodies revolving round the sun, because the light is brighter at one time than at another, just at that angle where it should grow brighter if its light came from the sun by reflection. When the planet Venus is at the self-same angle between the sun and the earth, it is also brighter, for the very same reason. Now, the fact just ascertained in India supports the above views, towards which philosophers are at present inclined to lean, because it would be difficult to suppose that enormous solid protuberances could be present where such violent action is going on, and where all chemical substances are probably in a state of gas and fusion.

HANSEN'S THEORY OF THE PHYSICAL CONSTITUTION OF THE MOON.

Prof. S. Newcomb read a paper on this subject at the 1868 meeting of the American Association, designed to show that astronomer's celebrated theory, that the centre of gravity and the centre of figure of the moon do not coincide, to be erroneous.

According to Hansen the moon is lap-sided, her centre of gravity being some 35 miles more distant from us than her centre of figure. Consequently, though there was no atmosphere on this side of the moon, there might be on the other side, and speculators eagerly seized upon the theory to show that plants and animals might occupy that invisible region. He argued that the whole result flowed from an oversight in Hansen's reasoning, and that the whole doctrine was totally devoid of logical foundation. There is not the slightest reason for supposing that the moon, in this respect, differs from the other heavenly bodies in being perfectly symmetrical with respect to her centre of gravity.

The circumstance from which it is concluded is, that the perturbations of the moon, derived from measurement, are slightly greater than those deduced from the theory of gravitation. The moon revolves on her axis with a uniform motion, so that if she revolved around the earth uniformly she would always present accurately the same face to us. But owing to the inequality of her motion different points of her surface are presented to us at different times, which is, in fact, the phenomenon of libration.

Let us suppose that the centre of gravity and figure were both visible to us, then it is plain that when the moon is ahead of her mean place her centre of figure will appear ahead of her centre of gravity, and *vice versa*. The irregularities of the apparent angular motions of the two centres will be inversely as their distance from the earth.

The centre of gravity of the moon is supposed to move around the earth in accordance with the theory of gravitation. But it is the motion of the centre of figure which is given by observations. Hence, in this case supposed, the inequalities derived from observation will all be too great in a constant ratio.

COLOR OF SUN-SPOTS.

Mr. S. Broughton, on observing with high powers a group of fine sun-spots, one of large size, tried the effect of removing the dark glass, and keeping the eye much beyond the focus of the heating rays and at such a distance that the spot almost filled the apparent field of the eye-piece. The spot at once appeared of a dark blood-red. Thinking this might be from the strong contrast of color, he projected the image of the spot on a disc of plaster of Paris attached to the telescope. Under a common pocket magnifier, the image was seen to be of a dark blood-red, although the observatory was not darkened, and the disc was merely protected from the direct rays by an intervening opaque substance. Should these observations be confirmed, it will confirm the opinion that the spots are not black, but appear so by contrast, as it would seem, from the intervention of the colored glass.

Interesting information concerning solar physics may be found in "Comptes Rendus" for July, 1868, by M. Faye.

COMETS OF 1868.

Brorsen's Comet. — This comet is of the small number whose periodicity is well established. It was first discovered the 26th of February, 1846, by M. Brorsen, in Denmark, and remained visible for about 8 weeks. Soon after it was found that the observations made upon it would be best satisfied by the assumption that it revolved in an ellipse around the sun in about 5½ years; and in this view the return of the comet September 26, 1851, was predicted. At that date, however, the portion of the heavens in which it was supposed to be moving was unfavorably situated for observation, and accordingly it was not detected. The next return, by theory, would take place in the spring of 1857, to which time the astronomical world looked forward with great interest. The comet was in fact rediscovered by Bruhns, at Berlin, on the night of March 18, 1857, and a little later it was seen and assiduously observed by many other astronomers. It followed very closely the track which had been lain down for it, thus proving its identity with the object seen 11 years previously. It was accordingly removed from the ordinary class of parabolic comets, and assigned an elliptic orbit with a period of 2031.55 days. Another return occurred in September, 1862, but owing to unfavorable circumstances, similar to those that had operated in 1851, it eluded detection. But early this year, faithful to prediction, it has again appeared, passed its perihelion, and is now rapidly receding from the sun.

Father Secchi, of the College Observatory at Rome, who has given much attention to spectroscopic research, has examined the spectrum of this comet, and the results of his investigation are given in a late number of the "Comptes Rendus" (May 11). From the faintness of the object, the whole light of the comet being not greater than that of a star of the seventh magnitude, which is invisible to the naked eye, the observations were attended with considerable difficulty.

We shall translate the most interesting portion of Secchi's communication: —

"The spectrum of the comet is discontinous; it consists first of a feeble light filling the field of view, is superposed by three bands so vivid as to appear more dilated than the rest of the field. The brightest of these bands is the middle one, which is in the green, and corresponds to the region between the magnesium (*b*) and the hydrogen (F), but much nearer the former; the breadth of this band is very small, not greater than one-fifth of the distance between the two rays. At moments when the atmosphere is particularly favorable it is reduced to a bright line of the same apparent breadth as the nucleus of the comet. Another bright band, but of much less intensity, is in the green-yellow, between and equidistant from the sodium (D) and the magnesium (*b*). Another band, in the red, may sometimes be distinguished, but its position can be fixed only with the greatest difficulty. The third luminous zone, nearly intermediate between the two preceding, is near the blue end, about a third of the distance between F and G from F. This band is bright enough to admit of good measurement, and to produce by scintillation the linear appearance.

"These observations lead us at once to results of considerable interest. It seems first a justifiable inference that this comet shines not merely by reflected solar light; the only solar light is perhaps that diffused in the field of view. The comet is, then, self-luminous, and its light is very like in color that of the nebulæ, but very different in position from that of the nebulous rays, of which one coincides with *f*; the other ray of the comet is also in a different position and at the opposite end, much nearer the magnesium than the nebulous ray. It is thus proved that the displacement is not caused by motion, but by the nature of cometary matter. Moreover, these bands being brighter than those of a star of equal brilliancy, we are led to conclude that the comet emits light of its own. The measures are not sufficiently precise to afford means of rigorous comparison with other known spectra, and besides we now know that such comparison would be illusory, since the visibility of gaseous spectra depends upon many circumstances which it is impossible for us to determine.

"Secondly, this spectrum is very similar to what has been noticed in other comets, both by other astronomers and myself. A generalization of these results by induction would furnish an argument for the extra-planetary origin of these bodies."

The observations of Secchi were made by comparing the spectrum of the comet with that of the planet Venus, the character of which is well known. In the course of their prosecution he met with evidences of atmospheric action which he thinks cannot be attributed to the earth's atmosphere, since he detected them at elevations above the horizon where its influence would have been insensible. The opinion that Venus is surrounded by an atmosphere analogous to that enveloping our own globe has long been held, from other considerations, to possess a good degree of probability; and of this opinion Secchi's observations, should they be established by future experience, will afford very satisfactory confirmation.—*Boston Transcript.*

This recently rediscovered comet must not be confounded with another going by the same name, which has a much more extended orbit. It belongs to the family of short period, with Biela's, De Vico's, and others, which have the aphelia of their orbits pretty close to the orbit of Jupiter. It seems probable that the introduction of these comets within the solar system, at any rate to their present position in it, is due to the action of Jupiter. D'Arrest has shown that Brorsen's comet before 1842 had been moving in an orbit of a very different figure from that of its present one, having passed in that year very near to Jupiter, and been compelled by his attractive influence to take a different path. Seen in 1846, missed at the perihelion passage of 1851, again seen in 1857, and again missed in 1862, it was rediscovered in April, 1868; it will travel across the southernmost parts of the constellations Ursa Major and Bootes, invisible to the naked eye.

This comet has been subjected to spectroscopic analysis by Mr. Huggins, with very interesting results. Two former comets, examined by him, exhibited in the light of their nuclei spectra closely resembling those of the gaseous nebulæ, their comæ apparently shining by reflected light. The spectrum of the present comet, however, consists of three bright bands, somewhat resembling those seen by Donati in the spectrum of the comet bearing his name; the length of the bands shows that they are not due to the stellar nucleus of the comet alone, but are produced by the light of the brighter portions of the coma. In one of the bands were occasionally seen two bright lines, shorter than the band, and probably due to the nucleus alone; they were not visible when the middle of the comet was not upon the slit, whereas the nebulous band on which they were projected continued visible as long as any part of the comet, except its extreme margin, was upon the slit; there was also a very faint continuous spectrum. The brightest band was found to lie nearly in the same position as the brightest line of the nebulæ, which is coincident with the double line in the spectrum of nitrogen.

This comet, then, resembles the others above named in this respect, that the nucleus and part of the coma shine by their own light, with the difference that nearly the whole of the coma of Brorsen's comet is self-luminous. — *Comptes Rendus.*

The conclusion of Secchi, from spectrum analysis, that most of the cometary light belongs to these bodies, and is not the reflected light of the sun, from the absence in the spectrum of this comet of the lines of Fraunhofer, and the presence of luminous bands, is doubted by M. Prazmowski. He maintains that the results of spectroscopic observations are greatly modified by the width of the slit of the spectroscope; if the object is feebly illuminated, even a colored band of paper, the slit must be of a certain width to render the spectrum visible. If the angular opening surpasses the angle which the widest Fraunhofer lines subtend, not the least trace of these will be seen, and yet we know in the experiment that the light is the reflected light of the sun; the lines of Fraunhofer exist in the spectrum, but we do not see them. He thinks, therefore, that the light of Brorsen's and Donati's comets has a solar origin. — *Comptes Rendus, June* 1, 1868.

Spectrum of Comet II., 1868. — Mr. Huggins, in a paper communicated to the Royal Society in July, 1868, describes the appearance of this comet on June 22d, as consisting of a nearly circular coma, becoming suddenly brighter toward the centre, where there was a nearly round spot of light; a tail was traced for nearly a degree. Under the spectroscope, with two prisms of 60°, the light was resolved into three broad, bright bands, — the brightest commencing at about *b* and extending nearly to F, — and then beginning at a distance beyond F, rather greater than half the interval between *b* and F, — the third about midway between D and E. In the two more refrangible of these bands the light was brightest at the less refrangible end, and gradually diminished toward the other limit of the bands; the least refrangible of the three bands did not exhibit a similar gradation of brightness; they could not be resolved into lines, nor was any light seen beyond them toward the violet and the red. He found this spectrum to agree exactly with a form of the spectrum of carbon which he had observed in 1864, when an induction spark is taken in a current of olefiant gas. This resemblance of spectra suggests the identity of the substances by which the light was emitted in both cases. Some comets have approached sufficiently near the sun to acquire a temperature high enough to vaporize carbon; as to others, we do not know the conditions under which even a gas permanent at the temperature of the earth could maintain sufficient heat to emit light. He gives reasons why cometary light cannot be considered as of a phosphorescent character. The spectrum shows that the color of this comet was bluish-green. If carbon be the substance of some comets, if incandescent in the solid state, or reflecting in a condition of minute division the light of the sun, this substance would afford a light which, in comparison with that emitted by the luminous vapor of carbon, would appear yellowish or approaching to red. These results are interesting as bearing on the apparent identity of the orbits of the periodical meteors with those of some comets. — *Chemical News.*

FACTS IN SPECTRUM ANALYSIS.

Spectra of the Stars. — The proper motion of the stars, or their apparent change of place, is in reality only the *transverse* portion of their true motion; the other part, or the motion of the star directly to or from the eye, produces no effects perceptible to the telescope. It would require thousands of years before any motion of this sort could produce an appreciable change in a star's apparent brilliancy. By means of spectroscopic analysis Mr. Huggins has led the way in a process of research which promises to afford us information respecting this part of the stellar motions. The law on which the inquiry proceeds may be thus illustrated: If a powerful swimmer urge his way rapidly against a series of advancing waves, it is evident that they will pass him more rapidly — in other words, they will seem narrower — than if he were at rest; on the contrary, if he urged his way in the same direction as the waves, they would appear broader than they really are. As the light of the stars reaches us in a succession of minute waves, it is clear that if we are approaching a star or receding from it, whether through the earth's motion or that of the star, the light-waves will appear modified in length, — in other words, the light's refrangibility will be altered. Thus the lines in the star's spectrum will be altered in position, and will no longer coincide with the corresponding lines in the spectra of terrestrial substances. Mr. Huggins' delicate researches have shown, first, that the nebulæ are not approaching the earth nor receding from it at a rate which is appreciable by his instruments; second, that the bright star Sirius — the only fixed star which he has had time to examine satisfactorily — is approaching the solar system at the rate of nearly 29½ miles per second. — *Quart. Jour. of Science, July*, 1868.

Spectra of the Nebulæ. — Mr. Huggins finds that when the intensity of the spectrum of nitrogen is diminished by removing the induction spark in nitrogen to a sufficient distance, the whole spectrum disappears except the double line, which agrees in position with the bright line in the nebulæ. "It is obvious," he says, "that if the spectrum of hydrogen were greatly reduced in intensity, the strong line in the blue, which corresponds to one of the lines of the nebular spectrum, would remain visible after the line in the red, and the lines more refrangible than F, had become too feeble to affect the eye." There seems reason for supposing that the light of the gaseous nebulæ is emitted by nitrogen and hydrogen.

Spectra of the Umbræ and Penumbræ of Solar Spots. — According to Messrs. Lockyer and Huggins, most of the dark lines of the solar spectrum are wider in the spectrum of the umbræ. The lines F and C, due to hydrogen, are not stronger; none of the lines of the normal solar spectrum were wanting in the spectrum of the umbra.

Spectrum of the Nebula in Argo. — From the examination by the spectroscope by the expedition under Lieut. John Herschel to the southern hemisphere, we are informed that the great nebula in Argo exhibits a spectrum of bright lines, so that, like its splendid northern rival, the great Orion nebula, this object is gaseous.

Great Nebula in Orion. — According to Father Secchi's observations, this nebula is much better seen in moonlight than on dark nights. This surprising statement he makes as the consequence of that optical principle, that the difference of two lights is more easily appreciated when they are weak than when both are strong. He finds that the spectrum of hydrogen, as Mr. Huggins anticipated, may be made, by sufficiently diminishing the light, to present the middle line only, which is that visible in the nebula.

Stellar Spectra. — Father Secchi, in a recent communication to the French Academy, draws attention to a fourth type of stellar spectra, which had hitherto escaped him from the small size of the stars, and the imperfection of instruments. The essential character of this type is the appearance of three luminous bands, separated by obscure intervals. The brightest band is in the green, generally well-defined and greatly dilated. Another band, much feebler, presents itself in the blue, often visible with difficulty; the third band is found in the yellow, and widens toward the red, only it is subdivided into many others. All these have the characteristic that their light goes on increasing from the side of the violet, where they stop suddenly. On the contrary, toward the red they present a gradual diminution of color to perfect black. There is, therefore, a complete opposition between this type and the third; for in the latter the columns are not only double in an equal space, but they show the maximum of light on the side of the red, and the minimum toward the violet. The two spectra, consequently, are not a modification of a single type, but are evidently due to completely different substances. What are the substances which produce these phenomena cannot be exactly defined, but they present a remarkable analogy to the reversed spectrum of carbon.

In general, red stars have zoned spectra; the smaller have often a continuous one; this continuity may be only apparent, and the stars may belong to the red type without zones, as in Arcturus among the larger stars. The rays of hydrogen coincide precisely with the four black rays of α Lyræ; even the most refrangible ray of the violet is found in its place in the spectrum of hydrogen; another secondary line of hydrogen appears in the spectrum of this star, and there can be no doubt that this substance forms its absorbent atmosphere, and that the star has no appreciable proper motion. The coincidence of the rays of hydrogen with those of the light of the sun, reflected by the moon, is as precise as for α Lyræ.

Spectrum of Arcturus. — According to M. Secchi, the spectrum of Arcturus presents the same fine metallic rays as α Orion, and α Scorpion (Antares). The appearances which render, at first sight, these spectra so different, depend on wide bands of absorption, which are absent in Arcturus, well marked in α Orion, and still more developed in Antares. These obscure and ill-defined bands are independent of the metallic lines, and may be compared to those produced by the gaseous terrestrial atmosphere in the solar spectrum near the horizon, and they may have a similar origin. The two systems, therefore, the one formed by five metallic rays or lines, and the other by black gaseous bands, are independent of each other.

Spectrum of the Aurora Borealis. — According to M. Otto Struve, it consists of one line, so that the light is monochromatic. The line falls near the margin of the yellow and green, about the position 1,259, on Kirchhoff's map.

WATER ON THE PLANETS AND STARS.

Janssen thinks he has noticed the presence of the spectrum of the vapor of water in several of the stars, among them, Antares. The spectrum of this star presents very plainly the lines and bands of the vapor of water, the lines being black, very broad, and with the characteristic position. He has taken into account the error proceeding from the moisture of the air; he has made trials on the heights of Mt. Etna, where the air is very dry, and at Palermo and Marseilles. He has also observed evidence of the presence of the vapor of water in the atmosphere of Mars and Saturn.

This latter result is particularly interesting. It may be remembered that the planet Mars shows bright areas at its poles, alternately increasing and decreasing, appearing precisely in the same manner as our own earth would look at a great distance; having, during the winter season, its northern polar region covered with snow and ice much farther toward the equator than during our summer season. Hence it has long been concluded that the planet Mars is covered with water, just like our earth. From other observations it has long been known that Mars, Jupiter, and Saturn are surrounded by gaseous atmospheres. By the above observations of Janssen, the presence of water on Mars is now finally proved; as the seasons change on the planet, its polar regions are more or less enveloped in ice, just as here on the earth, and at all times the watery vapor in the atmosphere of Mars is seen in the spectrum of the planet, as we notice the vapor of our atmosphere in the spectrum of the setting sun.

Janssen concludes his report with the following remarks: "To the close analogies which already unite the planets of our system, a new and important character has just been added. All these planets form, accordingly, but one family; they revolve around the same central body giving them heat and light. They have each a year, seasons, an atmosphere, and on many of the planets clouds have been observed in these atmospheres. Finally, water, which plays so important a part in all organized beings, is also an element common to the planets. These are powerful reasons to think that life is no exclusive privilege of our little earth, the younger sister in the great planetary family."

NEW PLANETS IN 1868.

Among the planets of 1867, No. 93 has received from Prof. Watson, its discoverer, the name of Minerva, and No. 94 the name of Aurora. No. 95, discovered by Dr. Luther, at Bilk, Nov. 23, 1867, has been called by him Arethusa.

Planet 96 was discovered by M. Coggia at Marseilles, Feb. 17th, 1868; as large as a star of 11th magnitude; meantime at Marseilles 15h. 29m. 30s.; right ascension 9h. 33m. 59.16s.; polar distance 76° 8′ 50.1″.

Planet 97, Clotho, was discovered by M. Tempel, at Marseilles, Feb. 17, 1868.

Planet 98 was discovered by Prof. Peters, at Clinton, N. Y., April 18th; of 12th magnitude.

Planet 99 was discovered by M. Borelli, at Marseilles, May 28th; 13th magnitude; right ascension, 13h. 24m. 7.92s.; polar distance 99° 5′ 49.11″.

Planet 100, called Hecate, was discovered by Prof. Watson, at Ann Arbor, Michigan, July 11th. Seen by Prof. Peters, at Clinton, N. Y., July 15th, and by M. Coggia, at Marseilles, July 17; 12th magnitude; at 11h. 47m. 4.1s., mean Paris time, on the 18th, as observed by Wolf, the right ascension was 21h. 7m. 4.71s.; declination 106° 22′ 45.3″.

Planet 101, Helena, was discovered by Prof. Watson, at Ann Arbor, Aug. 15th, at 12h. 7m. 38s.; right ascension 23h. 53m. 39.61s.; declination —0° 48′ 39.2″; 10th magnitude.

Planet 102, was discovered by Prof. Peters, at Clinton, N. Y., Aug. 23; in constellation Pisces, and at 3 A. M. on the 24th, had 18° 38′ of right ascension and 12° 54′ declination, moving slowly to the east; 11th magnitude; he proposes to call it Miriam.

Planet 103 was discovered by Prof. Watson, at Ann Arbor, Sept. 7th; of the 10th magnitude. Planet 104 was discovered Sept. 13th; of the 12th magnitude; planet 105, Sept. 16th, of the same brightness; and planet 106, Oct. 10th, of the 10th magnitude; the last three by Prof. Watson, at Ann Arbor.

METEORIC SHOWER OF 1868.

The shower of Aug. 10, not well observed in this country, was quite brilliant in Europe. From a paper read by Mr. G. Forbes to the British Association, in 1868, it appears that the hourly average on the evening of the 10th was 20, which, when compared with the average of 25 last year, shows that the shower has not yet ceased decreasing since the maximum in 1863. As nearly as can be determined the radiant point is R. A. 2h. 16m. N. P. D. 31°. The point discovered last year is R. A. 2h. 43m. N. P. D. 29°. 30″. On the night common to the 11th and 12th of August, the meteors were far more erratic.

The color of the meteors was almost uniformly white, but on the evening of the 10th, at 6 minutes past 11, an erratic one passing through Cassiopea was green and red, scintillating like Sirius, and equal to a third magnitude star. In the case of a meteor leaving a train, the nucleus was generally noticed to pass beyond the end of the train.

The most curious appearances in the late shower were, — 1st, the description of curves; 2d, the passing of the nucleus beyond the end of the train (this is perhaps an optical delusion); 3d, the undiminished brilliancy of the nucleus before its sudden extinction; 4th, the fact that the intensity of the shower still continues to decrease each year; and, 5th, the apparent change in the position of the radiant point on successive nights. This however, is possibly an error, arising from an insufficient number of observations; but it was suspected by Dr. Twining, in America, many years ago. In fact, he found the radiant point on ten successive nights in the great August shower of 1863, and so far from agreeing, these points, on being joined in order, formed a regular curve.

November Shower. — On Nov. 14th, the time of the maximum frequency of the meteors was about 5 hours, when they fell at the rate of about 2,500 per hour. The radiant point was quite well defined during the latter end of the shower, and was found by estimation to be about 149° in right ascension, and 22 minutes 30 seconds in declination. The trains were unusually brilliant, presenting the various shades of green, orange, blue, and red, and remained visible for an unusual length of time. Frequently as many as 5 could be seen at once, presenting an appearance, when nearly dissipated, of light cirrus clouds. The shower commenced several hours before it was expected, as it was predicted last year that it would be seen in 1868 in the Pacific Ocean only.

For a full account of this shower, as seen in the Northern, Middle, and Western States, and in Canada, the reader is referred to the "American Journal of Science" for Jan. 1869.

ATLANTIC STORMS REACHING THE MEDITERRANEAN.

M. Matteucci, "Comptes Rendus," May, 1868, from observations made for two years on the propagation of tempests from the Atlantic Ocean to the coast of Italy, gives his results in a tabular form, from which it appears that out of 118 tempests on the west coast of Great Britain, with a fall in the barometer of 15 to 20 millimetres, and sometimes in winter of 28 to 33 millimetres, only 49 reached the Italian shores. In October, November, and December this propagation was much more extensive than in the other months; out of 29 all but 6 were severely felt in the Mediterranean. In April, May, June, July, August, and September, of 50 only 12 reached Italy; in January, February, and March, out of 39, 14 extended to the Mediterranean.

TRANSPARENCY OF THE AIR.

The inhabitants of valleys know that one of the surest signs of rain is the clearness of outline and blue color of the distant mountains; it indicates great dampness in the air. But how does it happen that this dampness aids the transmission of light, while it hinders that of radiating heat, as Tyndall has shown? According to Col. Jackson, the watery vapor dissolves the impurities which are mingled with the air, and thus renders it very transparent. Entering into these ideas, and recalling the large proportion of atmospheric dust of all kinds which later works have made known to exist, De la Rive has concluded that not only does the atmospheric dust become transparent on absorbing the watery vapor, but that the water absorbed renders the dust heavier and makes it fall to the ground. He also admits that if the presence of watery vapor renders the air transparent when it contains dust or organic particles, its presence is no longer necessary for this end in the absence of dust. This explains why, in winter, mountains appear so clearly at a distance, even when the air is very dry; why the air is so clear over plains of snow, and why it is always the same on the peak of Teneriffe in consequence of the east wind. In the warm season, and in the months when organic life has the greatest activity, the air is most charged with this kind of dry vapor, which in calm weather diminishes in so wonderful a manner the visibility of distant objects. Of the various kinds of dust, only those which are soluble in water, as common salt, according to Bunsen, are always in the air, even in regions remote from the coast; these are the kinds of dust which contribute to the fertilization of the soil; the chemist Barral has even found phosphates.

According to Marshal Vaillant, atmospheric refraction has very much to do with these phenomena. In the hot seasons the air is warmed by contact with the soil, expands and changes its density and refracting power, — effects which do not happen when the air is cold. These considerations have induced De la Rive to include the transparency of the atmosphere in the list of meteorological elements, to be regularly observed in order to establish the precise relations which exist between this particular element and all others, such as the pressure, temperature, moisture, hour of the day, and epoch of the year; a kind of observation of interest not only to science, properly so-called, but also perhaps to medicine. With the aid of Mr. Thury, De la Rive has had constructed a photometer designed to measure the variations in the transparency of the air at different seasons. — *Amer. Journ. of Science, Jan.*, 1868.

SUMMARY OF FACTS IN ASTRONOMY AND METEOROLOGY.

Color of the Sky. — As seen from a balloon by M. Flammarion, the sky above the height of 3,000 metres appears dark and impenetrable; it is deep grayish-blue near the zenith, azure blue in the zone of 40° to 50°, pale blue, and growing whiter toward the horizon. The darkness of the upper sky is generally in proportion to the decrease of moisture. When the air was very clear, there seemed a delicate transparent blue veil beneath the balloon, between it and the deeper coloration of the surface of the earth.

Influence of the Moon on the Condensation of Watery Vapor. — M. Flammarion states, as a result of his balloon experiments, that often near midnight, when he was below light clouds, he has seen them gradually melt away under the light of the moon, and entirely disappear, as takes place on a larger scale by day under the action of the sunlight. Whether this is a mere coincidence, or a direct effect of the moon's influence, he does not undertake to determine. — *Comptes Rendus, July,* 1868.

Segmentation of Solar Spots. — An interesting fact in solar physics is the segmentation of a large solar spot, described by M. Flammarion, as occurring between May 9, 1868, when it appeared on the east border of the sun, and May 22, when it disappeared in consequence of rotation. — *Comptes Rendus, July* 13, 1868.

Rotation Period of the Planet Mars. — According to the new determination of Mr. Proctor, the sidereal day of Mars is a period of 24 h. 37 m. 23.73 s., instead of 24 h. 37 m. 27.745 s., as at first obtained. His observations extend over a period of 200 years.

Lunar Crater Linnæus. — The opinion seems to prevail that there has been no change in the crater; but that, owing to the peculiar character of the moon's surface in this neighborhood, very slight variations in the illumination serve to produce marked variations in the appearance of the crater.

Light of the Moon, and Daybreak. — As seen from a balloon by M. Flammarion, the light of the moon (just passed the meridian) and of the dawn of day, at 2 h. 45 m. A. M., 1¼ hours before sunrise, are equal; after that the light of day increased, while that of the moon relatively diminished. He also recognized that the whiteness of moonlight is only in comparison with our artificial lights; it becomes reddish in presence of the light of dawn, as gas-light does before moonlight. Even when the light of dawn is less than that of the moon, it penetrates natural objects, while that of the moon glances over them. Even in the clearest sky, the regions near the earth, as seen from above, are always veiled in vapor. The twinkling of the stars is more feeble in the heights of the atmosphere than at the surface of the earth.

Lunar Vegetation. — A German astronomer, Prof. Schwabe, has been closely examining certain dark lines which by the aid of the telescope may be seen extending across the slopes of the highest mountains in the moon. These streaks have been explained variously, some believing them to be the beds of dried-up streams, others, the channels left by torrents of lava. Prof. Schwabe claims to have discovered in these lines a greenish color which appears at certain seasons, lasts a few months, and disappears. He regards them as belts of vegetation.

Warmth of the Snow Blanket. — Much controversy existed as to the warmth imparted to the earth by a covering of snow, until M.

Boussingault, during the winter of 1841–2, found that a thermometer plunged in snow to the depth of a decimeter (about 4 inches) sometimes marked 9° of heat greater than at the surface.

Meteoric Theory. — Sir John Herschel has recently advanced the theory, not wholly new, but never before supported by well-known facts, that meteoric showers are simply the light caused by the collision of the earth's atmosphere with the tenuous substance of a comet. Prof. Adams, who shared with Leverrier the credit of discovering the planet Neptune, accepts this theory. Those who have read Prof. Tyndall's work on heat may find in this theory an additional reason to accept the learned writer's hypothesis as to the origin of the sun's light and heat.

Color of the Clouds. — The varied colors which the clouds assume at various times, especially at sunrise and sunset, are explained on the principle that the clear, transparent vapor of water absorbs more of the red rays of light than of any other, while the lower strata of the atmosphere offer more resistance to the passage of the blue rays. At sunrise and sunset the light of the sun has to pass though about 200 miles of atmosphere within a mile of the surface of the earth in order to illuminate a cloud a mile from the ground. In passing through this great thickness the blue rays are absorbed to a far greater extent than the red, and much of the yellow is also removed. Hence clouds thus illuminated are red. When the sun is higher above the horizon, the yellow light passes more readily, and the clouds become orange, then yellow, and finally white. Clouds in different parts of the sky, or at different elevations, often show these various colors at the same time.

Determining the Colors of the Stars. — To the astronomer this is a subject of much interest, and different observers vary greatly in their opinions, in this respect, as to particular stars. For the sake of a more definite and reliable means of determination, a simple contrivance has been recently invented, consisting of a series of vials filled with solutions of known tints, and attached to a revolving drum. A platinum wire is rendered incandescent by means of a galvanic battery, and as the vials are brought before the light their colors can be distinctly seen at night, and by successive comparisons with that of the star the exact shade is found.

GEOGRAPHY AND ANTIQUITIES.

INTERCONTINENTAL SEAS.

M. ROCHAT, "Comptes Rendus," March 30, 1868, draws attention to one of the most important and interesting analogies between the Old and New World, in the fact that the continents in both are deeply indented by a large interior sea, the Old World by the Indian Ocean and the New by the Gulf of Mexico. Each of these seas is placed in the very centre of the continent, in the direction of its length and in its hottest part; the Indian Ocean is traversed in the middle by the equator, the Gulf of Mexico by the Tropic of Cancer. Each is large in proportion to the extent of the continent which it bounds, the Asiatic being at least twice as vast as the American; each has the form of a semicircle or a pyramid with truncated apex, the base turned toward the ocean; both toward the apex have two great peninsulas, one Honduras and Yucatan, the other India and Chin-India; these two peninsulas separate three gulfs, namely, Mosquito, Honduras, and Campeachy; and Oman, Bengal, and China. Both contain numerous large and small islands, and have been the theatre of grand volcanic phenomena; and both are traversed by regular winds, on one side the monsoons, on the other the trade winds. The differences which certainly exist relate only to minor details.

These seas not only render possible communication between these countries and the ocean, but moderate the tropical heat which otherwise would be intolerable in the centre of the continents, and are the source of the necessary rains and fertilizing rivers, which render the East Indies and the Mississippi Valley the most productive regions of the earth.

GEOGRAPHY OF ALASKA.

According to Mr. W. H. Dall, in a paper read before the Boston Society of Natural History, in most of the maps of North America the Rocky Mountain range is represented as extending in a straight line to the Northern Ocean. This is an error. About latitude 64°, the mountains tend to the westward and meet the coast range in a confused, high, rolling country, where the distinctive characters of both ranges are lost. They soon merge, however, in one lofty volcanic range, extending first westward and then southward, and forming the backbone of the peninsula of Alaska. To the northward, between the Mackenzie and Porcupine Rivers, the country is filled with low, rolling hills, but along the northern coast, west of the Mackenzie River, a separate, lofty, snow-capped range rises and extends nearly to the mouth of the Colville River. This range has long been known as the Romanzoff Mountains. For the southern volcanic range Mr. Dall suggested the name of the Alaskan Mountains. On account of this deflection of the main chain of the Rocky Mountains, the fauna of the west coast of North America is bounded on the north by the Alaskan Mountains, while the great valley of the Yukon, or the central portion of Alaska, possesses a northern and eastern fauna.

The country, except on the extreme sea-coast, is heavily timbered with spruce, poplar, birch, willow, alder, and larch. The most northern pines on the Yukon are found at Fort Selkirk, 2,000 miles from the sea.

The inhabitants are of two races. Of those the Esquimaux, or coast tribes, are tall, well-formed, athletic and intelligent men, entirely different from the commonly received idea of Esquimaux. Undoubtedly they are of the same stock as the Greenland tribes, their languages being quite similar. The North American Indians are found everywhere in the interior, and are proved by their dialects to be of the original American stock. They are totally distinct from the Esquimaux, have no intercourse with them except by trade, and are their inferiors in many respects.

North of the Alaskan Mountains Mr. Dall has carefully searched the country for traces of glacial action. Thus far he has not observed a single boulder, nor a case of transportation of material or morainal deposit; there is no sign of striation or polishing of the rocks, which are of the most flinty character. South of the Alaskan range, in the fiords and inlets for which the coast is remarkable, there are many local glaciers. The mountains of the territory are low, and, if we except the volcanic peaks of the Alaskan Mountains, and a few in the Romanzoff range, probably not volcanic, the height will not exceed 2,000 or 3,000 feet.

THE GEOGRAPHY OF ABYSSINIA.

At the 1868 meeting of the British Association Mr. Clements Markham, attached as geographer to the recent Abyssinian expedition, read a paper, "On the Physical Geography of the Portion of Abyssinia traversed by the English Expeditionary Force." The following are extracts from his paper: —

"That region is far from being the least interesting in Abyssinia. A series of mountains and plateaux, extending north and south for upwards of 300 miles, form the watershed between the Nile and the Red Sea, and contain the sources of Egypt's fertility. They are divided, with reference to their western streams, into three distinctly defined regions: —

"I. The region drained by the Mareb,
II. " " " Atbara,
III. " " " Albai (or Blue Nile.)

"The Abyssinian highlands, though from their elevation of 7,000 to 10,000 feet above the sea they enjoy a delightful climate, are not so favorably situated with regard to moisture as several other temperate regions within the tropics. On one side is the boundless Sahara Desert, on the other the narrow strip of the Red Sea, with the arid waste of Arabia beyond. Nothing in the way of moisture is to be got from the former, and but a sorry sprinkling along the coast during the winter and spring months, when easterly winds prevail, from the latter. Abyssinia has to look to the equator for most of her moisture, when the sun comes to the north, after having pumped up the necessary water from the Indian Ocean. Then, from June to September, she gets her rainy season; for her mountains are high enough to reach and condense the moisture that is hurrying northward, and to bring it down to deluge and fertilize the plateaux and valleys. But as the wind progresses northward, much of its moisture has already been discharged.

The northern portion of Abyssinia, which is drained by the Mareb, is consequently much drier than the more southerly provinces.

The plateaux stretch from north to south along the main line of the Abyssinian Alps, and form their summit ridge, and they also extend over a vast area to the westward. They are composed of sandstone, overlying a formation of schistose rock 4,000 feet thick, which rests on gneiss. Grand peaks rise from the plateaux, frequently with flat tops and scarped sides. The valleys surrounded by the steep scarped sides of the plateaux are tolerably well watered and yield good crops of grass and corn.

The country between Antalo and Magdala is a mountainous region, entirely composed of volcanic rock, but it is divided into two very distinct parts by the River Takazé. That to the north is an elevated ridge, crossed by several lofty ranges of mountains. That to the south is a plateau of still greater height, cut by ravines of enormous depth. The former contains the sources of the Takazé; the latter is drained by the principal affluents of the Albai or Blue Nile.

The plain of Antalo is bounded on the south by the deep and fertile valley of Musgi, beyond which is the mountain range of Wodgerat, towering up into peaks, such as Alagi, which attain a height of 10,000 feet above the sea. The peculiar feature of this whole region is that, while the backbone of the mountain system runs north and south, it is crossed by ranges of great elevation, running across it in the direction of the drainage, and dividing it into sections, thus forming lateral valleys. Thus the Wodgerat Mountains rise up as a great southern barrier, separating the dreary plains round Antalo from the rich valleys of the volcanic formation.

THE AINOS, OR HAIRY MEN OF YESSO.

Mr. A. S. Bickmore, in the "American Journal of Science" for May, 1868, communicates two papers on the "Hairy Men of Yesso, Saghalien, and the Kurile Islands," read before the Boston Society of Natural History. Yesso is a large island to the north of Niphon. the great island of Japan, and in its southern part is the port of Hakodadi; the Ainos are the Aborigines of these islands. They are stout and strong, hardly taller than the Japanese, — about 5 feet 2 inches, — and not as tall as the average of the people in the north of China. One of their chief peculiarities is the great development of their hair, not only on the head and face, but over the whole body. Their eyebrows and eyelashes are very thick, and, like their beards and hair, always of a jet-black till past middle life, when, as with us, they change to gray, and in extreme old age to white. The hair appears coarse compared with ours or with that of the Japanese; they wear it long, down to the shoulders, and the men as long or longer than the women. Their eyelids are horizontal and open widely, as in the Indo-European races, and are not oblique and open but partially, as in the Mongolian races; their eyes are bright and always black; the cheek-bones are not prominent. The fine development of their chests, their full and heavy beards, give them the appearance of noble and hardy men as compared with their effeminate Japanese rulers. They seem to be endowed with great vitality, and the fact that they so successfully resisted the repeated attacks of a more enlightened race for 1,800 years, sufficiently proves their daring and perseverance. They have many gods, but fire is the principal one, and they pray to it in general terms for everything they need. They obtain their wives by presents to the parents, and make no great rejoicing nor display at their marriages. When a wife dies they burn the house in which she lived, but when a man dies they bury him without any funeral ceremony. They keep no cats, but catch rats in traps; they keep fowls, but no ducks, eating the birds but never their eggs. They have no special burying-grounds, and desire to forget the dead as soon as possible. They do not appear to have any idea of a future life; they have no written history, and only oral traditions.

According to Japanese chronology, the first Japanese emperor effected a permanent settlement on Niphon B. C. 660, on the south-east part of the island, conquering the Aborigines, doubtless the ancestors of the present Ainos.

In the characters above mentioned they call to mind the bearded peasants in Russia, of the Slavonian branch of the Aryan family. He asks "Are they, therefore, an extreme branch of the North Turanian family, or, as is more probable, in the same manner that the Indo-European races migrated from the high plateau of Central Asia through the plateau of Iran to the west, and the Persians and Indians to the south, did another part of that same family pass on to the east until they finally reached the islands now forming the empire of Japan; and do their living representatives now appear before us in the persons of this isolated and ancient people, the Ainos?"

In the second paper he remarks that these Ainos differ from all the Turanians not only in their physical but in their mental characteristics; instead of being reserved and shy, like Mongolians, they are open-hearted and communicative; instead of being of a roving character, they seem to be attached to their own country;

they are also mild and generous in their dispositions. An additional physical character is that, though their nostrils are somewhat thick, the nose is much more prominent than in any branch of the North Turanian family at least. Their language, though somewhat modified by intercourse with the Japanese, is peculiar and independent, having no connection with that of any of the neighboring countries, as far as regards the roots of words. The general rules, however, according to which the parts of speech are declined and conjugated, agree with those of their southern, northern, and western Mongolian neighbors, who write their language syllabically, and not figuratively, using signs for words, like the Chinese. So that "Here we have an Aryan people speaking a non-Aryan language, and that language peculiarly their own; not learned from a people who have subjugated them, or from a people whom they have subjugated, at least within 2,500 years." This people are rapidly passing away, their numbers constantly diminishing from the oppression of the Japanese, the rigors of the climate, and the ravages of the small-pox.

MAMMALIA ASSOCIATED WITH PRE-HISTORIC MAN.

According to Mr. Boyd Dawkins, in a paper read before the British Association in 1868, at the time when man first appeared on the earth, the physical conditions of Europe were altogether different from the present. Britain formed part of the main land of Europe, and her fertile plains, covered with the vegetation peculiar to a moderately severe climate, stretched far away into the Atlantic from the present western coast line. The Thames also, instead of flowing into the German Ocean, joined the Elbe and the Rhine in an estuary opening into the North Sea about the latitude of Berwick. The climate resembled that of Siberia and North America.

The animals of that vast pleistocene continent, under those conditions of life, differed materially from those now living on what are the mere relics of that submerged land. Some of them have entirely disappeared from the earth, such as the sabre-toothed lion, the cave bear, the Irish elk, the mammoth, the woolly rhinoceros. Others have gone to the far north, as the reindeer, the true elk, the glutton, the musk sheep; while others, like the cave lion and hyæna, have retired to the south, and taken refuge in Africa and Asia respectively. He considered the pre-historic epoch as one of uncertain length, to be reckoned perhaps by centuries only, and perhaps by tens of thousands of years. The remains of the animals that had been carefully sought after in Switzerland and Denmark, had been comparatively neglected elsewhere. He characterized the various periods as follows: preglacial period, the rhinoceros *Etruscus;* glacial period, boulder clay; post-glacial, mammoth; pre-historic, goat, short-horn, or *bos longifrons*, sheep; Roman occupation, fallow deer.

Mr. Busk would divide the pre-historic period into two distinct segments, one characterized by the existence of human remains with wild animals, and the other by their existence with domesticated animals. The majority of the domesticated animals have been associated with man from the earliest times.

ANTIQUITY OF MAN.

At the 1868 meeting of the American Association much time was taken up in the discussion of this subject.

Col. Whittlesey commenced the discussion by citing a number of cases of the discovery of the handiworks of ancient man. The following are some of the more remarkable: —

1. The discovery of flint arrows in Missouri beneath the skeleton of the mastodon, in the ancient alluvial formation, buried in a peat bed covered with sand to the depth of 14 feet. He therefore inferred that man was contemporary with the mastodon, and survived the convulsion which destroyed the latter.

2. When the High Rock Spring at Saratoga was cleaned, under the cove there was found, at the depth of 13 or 14 feet, a log that appeared to have been used by persons who had occasion to reach the spring. It had been computed that the time required for the deposit over the log was nearly 5,000 years, and from the foot tracks, it would appear that the people were the common Indians.

He also alluded to the discovery, some years since, on the Florida reefs, of a fossil human jaw with one tooth, which, from the position in which it was found, had been calculated to have been there 10,000 years, and to a number of other cases already made known to the public.

He enumerated several races which had flourished in America before the red man. First, the mound-builders; second, a race in the territory which is now Wisconsin; third, a warlike race in the region south of Lakes Ontario and Erie; and, fourth, a religious people in Mexico. How long ago these races flourished is uncertain, but it was certainly several thousands of years beyond the Christian Era. Pottery, arrow-heads, and other works of man have been found in conjunction with and beneath the bones of the mastodon and megatherium. In regard to the time the Indians have occupied this country the following fact throws some light: Three skeletons were found in a cave beneath a heap of accumulations several feet in depth. The crania were so perfect that there was left no doubt of their being the crania of red men. These bones were computed to have been placed in their sepulchre 2,000 years ago.

Dr. J. W. Foster, of Chicago, followed with another treatise on the same subject. His views agreed with those of Col. Whittlesey in the belief that the place of man in the creation is much earlier than that usually given him, and that the age of the mound-builders should be fixed much further back than the 6,000 years commonly allotted as the age of the human race. He enlarged upon the evidences of civilization among this ancient race, and showed, by exhibiting examples of their work, that they were not only much further advanced in the arts than the red man, but that the form of the features and the outline of the face were very different from those of the more recent race.

Prof. J. D. Whitney read a paper on a fossil human skull found in Calaveras County, California, at the bottom of a shaft 130 feet deep. Above the layer of gravel in which it was found were 4 beds of lava, with 3 of gravel interposed between them. Large portions of the skull were gone, rendering it impossible to identify the race of men to which it belonged with any certainty, but they appeared not to differ much from the present Esquimaux. From the manner in which the skull was fractured, Prof. Whitney concluded that it was swept with many other bones down a shallow but violent stream, where it was exposed to the boulders of the bed. In its passage it was broken, and at last came to rest in a position where water charged with calcareous matter had access to it, on a base of auriferous gravel. From all the circumstances the speaker thought the owner of the skull lived before the glacial epoch, and that man had therefore seen and survived that great convulsion.

It remains to indicate what follows if the discovery be accepted as true. The period of man's existence is extended back for ages beyond what geologists have ever assigned to it before. Since the stream flowed in that ancient water-course by the side of which this skull was found, a deposit of 130 feet of earth, lava, and basalt has been placed above it, and another river has worn another valley to a depth of thousands of feet through the rock which formed the site of the ancient valley. The geologist shrinks from naming the number of thousands of years which forms the lowest period necessary for bringing about such changes. The fact, however, that such changes must have taken place since the water ceased to flow in the ancient stream can no more be denied than the multiplication table.

There was great difference of opinion expressed on the subject of this skull, and a general feeling that the evidence did not warrant the conclusion of the great antiquity of man founded upon it.

PRE-HISTORIC MAN.

At the 1868 meeting of the British Association, Mr E. B. Tylor read a paper on the "Condition of Pre-historic Races as inferred from Observation of Modern Tribes." The object of the paper was to show that there must have been a great similarity of character between those who lived in the four great pre-historic ages and the character of the savages and semi-savages of Africa, Australia, and America of the present day. This was illustrated by references to the arts, manners, customs, and pursuits of modern barbarians and those of the pre-historic ages as shown by the relics that had been found in mounds in various parts of the world. One of the most interesting points of the paper was a description of the funeral rites and superstitions prevailing among both the pre-historic and modern savages. On the whole, the author thought that there was striking evidence that in very ancient times Europe was inhabited by savage tribes, but he did not think they would be right in concluding that those tribes were much below the condition of many savage races that existed at the present day.

He says: "Of the religion of the pre-historic races we have occasionally excellent evidence. The burial of wives and slaves, weapons, implements, garments, ornaments, and food with a deceased chief in a tumulus of unknown date and race, bears, no doubt, the same meaning as the precisely similar practice among historic barbarians of Scythia and among modern savages. It belongs to the opinion of a personal soul or ghost which survives the death of the body, and which indeed demonstrates its continued existence by appearing to living men in visions and dreams. The wives and slaves are killed and buried, or burned with the body of the deceased, that their ghosts may accompany and serve him as in this life. The best rule I can lay down as to the theoretical interpretation of remains of animals and objects found with the dead is this: If the food, etc., are left separate from the corpse, and can be reached from outside, then they are for the haunting ghost of the departed to return and enjoy. If they represent such a retinue of followers and such a provision of horses, clothes, weapons, and supplies of food as would do for an earthly journey, then they are for that spiritual journey to the land of souls, which the savage models on a common journey to a distant region. But the attendants and weapons that serve the dead to travel with, are also partly to be used after his arrival in the next life, and especially anything like a stock of property, as, for instance, the monstrous accumulation of food, furniture, jewelry, and the like, which is sacrificed at a royal funeral in Siam, has no sense except as meaning direct transfer for use in the next world. But I believe we have no doubt that the discovery even of weapons or ornaments in a pre-historic grave is an evidence of the existence in some form or other of that doctrine of souls which is found strong among very low modern races, and extends upward through the whole range of religion."

At the 1868 meeting of the International Congress of Prehistoric Archæology, Sir John Lubbock, the President, delivered an address, from which the following are extracts: —

There were two principal heads into which the subject of their investigation was divided, — one concerning savages in ancient times, and the other relating to savages in modern times; and in their inquiries they endeavored to trace up the development and growth of the human race to the present time.

The earliest traces of man were perhaps those which had been found in the miocene era. These traces might be divided into two heads, those of stone and those of bone.

The implements of the *paleolithic*, or *old stone age*, were never found with pottery, and never had any trace of polish upon them. Putting these facts together — the peculiar form of the implements, their never being polished, their never being found with pottery — they considered that these things corresponded to a peculiar phase of human history to which they might be permitted to give some name or another. Then, if they examined the animals that coexisted at this period, they would find that they embraced nearly all the animals still in Europe, and it would be therefore remarkable indeed if man had not coexisted with them. The existence of man was proved in these early ages by certain flint implements which were found to be associated with certain groups of animals not now existing in this part of the world. Then he would come to the *Neolithic* or *Polished Stone Age*. The evidences connected with this period were derived from Denmark and Switzerland. It was said that some of the great tumuli in which these polished implements were found were made by people in possession of metal, because the hard stone was engraved with figures; but it had been shown that these engravings could be made with flint implements, and not with those of bronze. They differed from those of the first age partly in form, and partly from the fact that they were polished. There were also other indications that they belonged to a people further advanced than the former. They had pottery in use among them, and some spindle whorls had been found. When the fauna also was compared, it was found that the elephant, the rhinoceros, the reindeer, etc., had disappeared. In these facts we had all the necessary materials for separating this age from the paleolithic. But how should we separate this age from the *Metal Age?* We were enabled to do this by the same kind of evidence. The tumuli and the Swiss lake villages of the *Bronze Age* were conclusive proofs on this point. If the knowledge of metal had been gradually and slowly introduced by its discovery on the spot, then copper would have preceded bronze, the latter being a compound of the former with tin. As far, however, as Western Europe was concerned, while we had thousands of bronze implements we had hardly one of copper. Then it might be said that the only difference was, that the inhabitants who dwelt where the metal was found were rich, while those where the stone was found were poor. But when we found such things as awls and fish-hooks made of bronze, we knew that the people who used them were not very rich; and then surely those who were in the stone villages would have possessed themselves of some of the bronze implements of their richer neighbors. There were, moreover, several indications that the people who used the bronze were in a higher state of civilization than those who used the stone. We find the pottery better, and the ornaments better, and more skilfully made, and the animals and plants different.

As soon as iron was introduced it would replace bronze because it was a better cutting substance. There were weapons made partly of bronze and partly of iron, and in the cases in which they were mingled, the handle was made of bronze and the blade of iron. Of course there must have been a period when the use of bronze was gradually giving way to the use of iron.

He thought these facts clearly proved that they had sufficient reason to believe that there were four great pre-historic periods.

Pre-historic Remains in the West.—Within the last 20 years, scientific men have collected a vast amount of evidence tending to prove man's existence for more than 6,000 years. To say nothing of the geological testimony, which is conflicting, Baron Bunsen's researches in Egypt, the discovery of the lake habitations of Switzerland, and the investigation of the mounds of the Mississippi valley, have brought to light many facts which point to a greater antiquity, or at least, to an earlier civilization, than has commonly been attributed to man. In regard to the mounds, Mr. W. De Haas has been writing some interesting accounts to the St. Louis papers.

The mounds which he describes are at American Bottom, Ill., and with those on the adjacent bluffs number about 200. They are in two groups, constituting one grand system, and are, in shape, conical, truncated, ellipsoidal and square, and in height they vary from an elevation scarcely distinguishable to that of 90 feet. They are composed of earth and vegetable mould taken from the adjacent bluffs, and after long investigation Mr. De Haas has not the slightest doubt but that they were built by human labor. Originally they were intended for tombs, but were also used as temples and dwelling-places.

The form of the skulls discovered indicates that at least two races dwelt there. Whether one drove out the other, or subdued and became amalgamated with it, is not yet determined. The types of heads found there are the pyramidal or pyramid-shaped, and the semi-prognathous, or those with projecting jaws. The pottery is of two kinds; one is fine, compact, kiln-burned, and tastefully ornamented with paint, while the other is coarse, sun-dried and rudely ornamented. These ancient potters did not use the wheel, but moulded by the hand, vases, urns, and dishes of various patterns. The implements and ornaments are also of two kinds, some being of polished stone, exquisitely wrought, and others of undressed stone. The agricultural implements are different from those found in the Ohio valley, and are of stone.

ETHNOLOGICAL SUMMARY.

Bone Caves. — M. Delgado has described three caves in the Jurasic limestone of Cesareda, Portugal, and finds therein evidence that man once existed in that district in so rude a condition that he lived in caves, ate human flesh, and possessed chipped flints for his sole weapons. From the fragmentary condition of the human bones, which had been cut and scraped, the long bones having also been split, he concludes that the caves were used as burial-places for a tribe of cannibals.

Similarity of Implements in different Races. — From an essay by Mr. A. C. Anderson, in part 5 of "Reliquiæ Aquitanicæ," it appears that there is a striking resemblance between many of the Dordogne works of art and of the implements now or formerly used by the North American Indians. Without considering this resemblance as implying any affinity between the tribes, we may admit, in the words of the author, "that, under similar circumstances and conditions of things, isolated branches of the human race will arrive, in simple matters of domestic or offensive art, at nearly similar conclusions, each independently of the other."

Ethnology and Philology. — Dr. Davis, in a paper on the Ethnology of India, in the Proceedings of the Asiatic Society of Bengal, attempts to show that philology is not so sure a guide in ethnology as craniology, and he consequently objects to the Aryan hypothesis. He says, "If Europeans and Hindoos be of the same family, why cannot the former migrate to and live in India? How is it that the people of India are celebrated for the smallness of their heads, while the inhabitants of Europe have large heads?" While the Syro-Arabian division of mankind is admitted to be physically identical with the Aryan, they cannot be allied, it is said, "because the languages of the two families utterly sunder them." He also objects to the hypothesis of the unity of the human race, regarding our species as, "in the main, an aggregate of families formed by the hand of the Creator, in every different locality in which it is found, and each constituted for the climate and productions by which it is surrounded."

Stone Age in Switzerland. — A human station of the stone age, in which remains of the reindeer have been found, has been recently discovered in a small elevation, at the foot of Mt. Saleve, near Geneva, making a sixth locality in the terrace alluvium in Switzerland, in which remains of the reindeer have been found, the 5 others being 3 places on Lake Geneva, at Meilen on the borders of Lake Zurich, and at Windisch on the Reuss. The remains were found 42 metres above the present level of the River Arve, whose waters since the glacial period have evidently attained nearly this height. M. Favre, who records the discovery, believes that the mound was inhabited by man when the water of the river was at a higher level than the present, though probably not when it was at its highest. M. Lartet is of opinion that the reindeer period is probably not of the same age, but somewhat more ancient in Southern Europe than in more northern latitudes, the animal having migrated northward.

Flint Implements. — It must be borne in mind, in studying flint implements, that the natural forms of flints may deceive the inexperienced observer into the belief that they have been formed artificially. These natural forms may be produced at the original formation of the flint in the chalk, by fracture, and by weathering; the only evidence of the human origin of such implements which can be admitted is the evidence of design shown in various ways.

Division of Caverns. — In the "Anthropological Review" for April, 1868, caverns are divided into three classes: 1. Those which contain the quaternary fauna, now utterly extinct. 2. Those in which the reindeer assumes a large development. 3. Those which contain only the animals now found in the country, many of which had been no doubt domesticated.

Pre-historic Man. — It is generally admitted that cannibalism was practised in pre-historic times down to the period of polished stone. It is probable that there were two races, one brachycephalic, and the other dolicocephalic, — the former characterized by a lozenge-shaped and the other by an oval-shaped face.

The Ogham Monuments. — These monumental stones, principally confined to the counties of Cork, Waterford, and Clare, in Ireland, are inscribed with the Ogham characters. Some of them were of a sepulchral or a memorial character; others were termini or boundary stones. Mr. R. B. Brash regards them as pre-Christian in time, because the inscriptions allude to pagan rites and ceremonies, and because no allusions can be found to any Christian doctrines. He thinks that the people who raised these monuments came originally from Spain, and the more so as there are striking ethnological affinities between the inhabitants on the coast of Ireland and the Spaniards. There are probably many of these monuments in Ireland yet undiscovered. Col. Fox considers the characters on these monuments as having been derived from the primitive marks known to be made by savages upon their arrow-heads. They bear no resemblance to the Runic alphabet, which belongs to the common stock of languages; the Ogham alphabet was special and peculiar, and different from anything else of the kind known.

Khasias of Bengal. — These are a tribe of semi-savages, an Indo-Chinese race, living in East Bengal, within 300 miles of the British capital of India, who habitually erect dolmens, cysts, cromlechs, etc., almost as gigantic as, and very similar in appearance and construction to, the so-called Druidical remains of Western Europe. They are hardly alluded to in the modern literature of pre-historic monuments. They keep cattle, but drink no milk, and estimate distances traversed by the mouthfuls of pawn chewed en route. The undulating eminences of the country, 4,000 to 6,000 feet above the level of the sea, are dotted with groups of huge unpolished squared pillars and tabular slabs, supported on three or four rude piers. In one spot Dr. Hooker found a nearly complete circle of menhirs, the tallest of which was 30 feet out of the ground, 6 feet broad, and 2¾ feet thick; and in front of each was a dolmen or cromlech of proportionately gigantic pieces of rock. It is said that some are put up every year. The method of removing the blocks is by cutting grooves, along which fires are lit, and into which, when heated, cold water is run, which causes the rock to fissure along the groove; the lever and the rope are the only mechanical aids used in transporting and erecting the blocks. The objects of their erection are various, — sepulchral, memorial, etc.

Stone Age in Japan. — Mr. A. W. Franks stated, at the meeting of the British Association in 1868, that flint and stone implements are found in various parts of Japan, chiefly in the northern part of the great island of Niphon. They are much sought after by the Japanese, who value them highly as relics of their mythical or spirit period. They consist of barbed arrow-heads, with or without tangs, spindle-formed spear-heads, knives or scrapers, and axes or celts; the forms are similar to those of Europe and America. The material of the arrow-heads is generally flint or jasper, and occasionally obsidian; the axes appear to be of basalt and jadite. The belief in the supernatural origin of these weapons in Japan shows that they are pre-historic, and older than the existing civilized age. Stone implements occur in China, but less often apparently than in Japan. Though not absolutely proved, it is extremely probable that there has been a stone age in every part of the world.

A Scottish "Cran-Nog." — During 12 years past great archæological interest has been centred in Scotland from the fact that in various parts of the country lake-dwellings have been discovered, which, though differing in size and structure from the Swiss and Italian lake-dwellings, are evidently sufficiently similar in idea to form another link between the ancient populations inhabiting these widely separated lands.

The first cran-nog was found upon draining a fresh-water loch in Arisaig. It appeared to have been placed in deep water, as the soft and wet mud around it is not fathomable by a long pole; the nearest point of land is about 250 yards distant. It is formed of the trunks of trees, some of which are of very large size; one that was measured is 28 feet long and 5 feet in circumference, at 2 feet from the base; another is 39 feet long, and 5 feet 8 inches at the base. The structure consists of several tiers or layers of these trees; 2 layers have been partially washed away by returning tides; 4 layers were exposed to view in examining the building, and a probe of 8 feet long detected timbers at that further depth. Each layer in succession lies across the one below it, forming a strong, firm structure of rectangular shape; the sides are 43 feet by 41 feet. On the floor were several flag-stones in three or four places, which evidently had been the fire-places of the inhabitants. At a distance of about 2 feet 6 inches from the building was a rampart, formed of upright posts, inclined inwards and sharpened at the top, across which are placed large trees that were fastened at the corners by a hollow scooped out of the wood.

Stone Circles of Scotland. — Mr. John Stuart said, at the 1868 meeting of the British Association: "The numerous excavations in stone circles and other groups of stone pillars already made show an all but universal occurrence of sepulchral deposits, and I think we are entitled to infer that stone circles were monuments of the dead. They may have had additional purposes, but, if so, we are entirely ignorant of them. The greater size and importance of some stone circles afford no ground for presuming that they were different in character from the smaller circles, any more than we can infer that a small cairn or barrow had a different purpose from a large one."

Stonehenge. — Sir. J. Lubbock stated, at the 1868 meeting of the British Association, that he thought Stonehenge was a place that was held sacred, though perhaps not a place of worship. He thought the Druids had nothing whatever to do with the erection of those stones. The name of Stonehenge was derived from the presence of these stones already gathered together in the spot, and the word merely meant "the place of stones," and he therefore believed those who gave the name knew nothing of the origin of the relics. Those who made the place would have given it some more definite name, and he believed we knew nothing of the people from whom it had its origin. Within 3 or 4 miles of Stonehenge there were 300 or 400 tumuli. There was no reason why there should be this extraordinary number of tumuli there, were it not that they clustered around this spot as a sacred place. In these tumuli there were found no ancient weapons of iron; 2 or 3 had been found there, but they had evidently been placed there subsequently. More than 50 of these tumuli contained, however, weapons or ornaments of bronze, and he therefore believed that Stonehenge was a monument erected during the Bronze Age.

Rock Sculptures. — A paper, by Mr. H. M. Westropp, on "Rock Sculptures in various Parts of the World," was read at the 1868 meeting of the British Association. It embraced a description of the various carvings on rocks in different parts of the world, which the author showed had everywhere a remarkable analogy or likeness. Sir James Simpson had said that man, even in the earliest and rudest ages, was a sculpturing and painting animal, and exhibited his love of imitation when his artistic instinct was evolved. The conjectures of the origin and age of the carvings have been various and numerous. Professor Nilsson attributed those found in Scandinavia to the Phœnicians, and he considered the circles as symbols of the sun and other heavenly bodies, which the author considered an untenable hypothesis, as no such remains were found among the Phœnicians themselves. Similar circles were found in America and other countries where no Phœnician influence could have reached. The author thought we might come to a just conclusion concerning their origin, if we remembered that man, in his rude, early, and primitive age, bore a great analogy in his thoughts and actions to a child. The savage and the primitive man had the same fondness for imitation, the same love of laborious idleness, as the child. A child would pass hours in whittling and paring a stick, building a diminutive house or wall, and tracing forms on the turf. The savage would wear away years in carving his war-club and polishing his stone adze. From these considerations, the author was led to attribute these carvings and sculptures to the laborious idleness of a pastoral people. Passing the long and weary day in tending their flocks and herds, they amused themselves by cutting those various figures of the sun, moon, or any animals or objects in their neighborhood, on the rocks near them. Sir James Simpson had shown that most of the Scandinavian carvings belonged to the stone age, which was synchronous with the pastoral phase of civilization. Some of the ruder descriptions might belong to an earlier age, or the hunting phase.

Antiquities of the Pacific Islands. — Various idol statues and monuments occur in the several islands of the different groups. Some of the monuments bear evidences of great antiquity, and of skill and perseverance on the part of the forgotten races who formed them. Many of the relics are of such enormous magnitude, and of such an elaborate character, that if they were the work of the ancestors of the present inhabitants, the people have greatly deteriorated. Amongst the natives, all traditions of the origin of the monuments are lost.

No Bronze Age in Africa. — Col. Lane Fox quotes several authorities to show that Africa was an iron-producing country, and is of opinion that the iron age followed immediately after the stone age instead of passing through a bronze age.

News from Dr. Livingstone. — Sir Roderick Murchison announces the receipt of letters from the explorer Livingstone, written in October and December, 1867, and dated at Marungu and Cazembe, places lying south and south-westerly of Lake Tanganyika. When these letters were written, Livingstone had been living for three months with friendly Arabs, waiting for the close of a native war before proceeding on his way to Ujiji, and he told an Arab messenger that after exploring Lake Tanganyika he intended to return to Zanzibar. This is the first announcement from himself that he intends to quit Africa by that route.

Fate of Sir John Franklin. — By the recent arrival from the polar regions, of Dr. Goold, of Dublin, interesting intelligence is afforded respecting the search now prosecuted by Captain Hall for traces or remains of the "Erebus" and "Terror," and their crews. In August, 1867, Captain Hall was at Repulse Bay, preparing an expedition to King William's Land, where, from information obtained from the Esquimaux, it seems that important records and some relics of the Franklin expedition are still preserved. The point to be reached was 450 miles north of Repulse Bay, and in a country the inhabitants of which were known to be hostile to Europeans and to the Esquimaux living at Repulse Bay. It was the opinion of the latter, who are known as King Albert's followers, that Franklin's men had been killed by King William's men. According to native information, the last six survivors of the party built a rude vault of stones, and deposited in it some documents and such articles as they had no use for, or would be an incumbrance to them in their journey southward. It is Capt. Hall's object to reach this depository.

It will doubtless cause a thrill of mingled surprise and sorrow to learn that, after all that has been done to discover the Franklin expedition, two of its members survived to as recent a period as 1864. These were Captain Crozier and a steward of one of the lost vessels, who died near Southampton Island while endeavoring to make their way to that place, in the belief that they would there find a whaler which would carry them home. Capt. Hall is confident of the identity of Captain Crozier with one of the men described to have perished, and has in his possession several articles that belonged to him.

The German Arctic Expedition. — European papers announce the unexpected return of the "Germania," and the failure in one aspect of the expedition. While unsuccessful in their attempts to penetrate to an open polar sea, or to make the coast of Greenland, on account of the solid masses of ice which they found in their way; they reached, however, the highest degree of northern latitude ever attained by any ship; namely, 81° 5′, their longitude being at the time 16° east. They sighted the coast of Greenland several times, but were never able to reach it. The expedition has made important corrections in previous charts, and has secured other important results.

Swedish Polar Expedition.— By telegram from Stockholm, October 1, 1868, it seems that this expedition had by the last of August reached 81° 10′. From Spitzbergen, Greenland could not be reached on account of immense ice-fields. Several soundings showed 2,100 fathoms.

Ancient Buddhist Remains.— Mr. Fergusson, at the 1868 meeting of the British Association, read a paper in which he stated that he believed that tree and serpent worship had prevailed in the world from the earliest times. The history of the tree and serpent in the book of Genesis, he believed, was a remnant of that old worship, and he thought the curse of the serpent was a curse upon that old impure religion. He showed most elaborately that this form of worship found its way among the Greeks, thence among the Romans, thence to Scandinavia and every part of Europe. Tree and serpent worship prevailed in Africa to a large extent, and there were evidences of its existence in America. It was the very oldest form of primitive superstition. The gods of the oldest race were always the tree and the serpent. The architectural remains in the various parts of the world testified to this fact. He expressed strongly his feelings that architecture was a very valuable ethnographic aid to the student; that it was a more reasonable and more tangible test of race than language. When language was very clear and distinct it was very positive and certain, but there were many cases in which language failed, and then architecture came into play. There was not in the whole world a single building which was not developed out of some building that preceded it, and which did not express the history and feeling of the people who erected it more clearly than any book ever written.

OBITUARY

OF MEN EMINENT IN SCIENCE. 1868.

Arnott, Prof. George A. W., Scotch Botanist, June 17, æt. 69.

Berryer, Antoine P., French Advocate, Nov. 28, æt. 78.

Blakely, Capt., English Inventor of Ordnance, May 3.

Boucher de Perthes, M., French Archæo-Geologist, Aug. 3, æt. 80.

Brewster, Sir David, Scotch Physicist, Feb. 10, æt. 87.

Brougham, Henry, Lord, English Philosopher, May 9, æt. 89.

Clark, Thomas, Scotch Chemist, Nov. 27, 1867.

Claeudt, M., French Photographer, Feb.

Coke, Thomas, English Astronomical Instrument Maker, Nov.

Coulvier-Gravier, M., French Astronomer, Feb., æt. 68.

Crawfurd, John, English Ethnologist and Geographer, May 11, æt. 85.

Dana, Samuel L., M.D., American Chemist, March 11.

De la Roquette, M., French Geographer, October.

Forbes, Prof. James D., Scotch Physicist, December.

Foucault, Leon., French Physicist, March, æt. 48.

Herapath, William, English Chemist, Feb. 13, æt. 72.

Hughes, Robert Ball, Anglo-American Sculptor, March 5, æt. 62.

Jesse, Edward, English Naturalist, April, æt. 88.

Mann, Horace, American Botanist, Nov. 11, æt. 24.

Matteucci, Prof. Carlo, Italian Physicist, June 26.

Morton, Wm. T. G., M.D., Discoverer of Practical Anæsthesia by Sulphuric Ether, July 15, æt. 49.

Nicholson, Samuel, American Inventor, Jan. 6, æt. 76.

Noyes, Prof. George R., D.D., American Biblical Scholar, June 3, æt 70.

Page, Charles G., American Physicist and Electrician, May 5, æt. 56.

Plucker, Prof. Julius, German Physicist, May 22, æt. 67.

Poeppig, Edward, German Botanist, Sept. 4, æt. 70.

Pouillet, Claude S. M., French Physicist, June 14, æt. 77.

Rosing, Anton, Swedish Chemist, March 29, 1867, æt. 40.

Rossini, Gioachino, Italian Musical Composer, Nov. 14, æt. 76.

Schoenbein, Christian F., Swiss Chemist and Physicist, Sept. 4, æt. 69.

Schultz, Dr. C. H., Bavarian Botanist, Dec. 17, 1867, æt. 62.

Serres, E. R. A., French Physiologist, Jan. 22.

Van der Hoeven, Jan., Dutch Zoologist, March 11, æt. 67.

Ward, Nathaniel B., English Botanist, June 4, æt. 77.

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