From a Photograph — *Engd by L. S. Punderson*

Jeffries Wyman

Engd for the Annual of Scientific Discovery 1857.

ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1857.

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

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

TOGETHER WITH

A LIST OF RECENT SCIENTIFIC PUBLICATIONS; A CLASSIFIED LIST OF PATENTS; OBITUARIES OF EMINENT SCIENTIFIC MEN; NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1856, ETC.

EDITED BY

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BOSTON:

GOULD AND LINCOLN,

59 WASHINGTON STREET.

NEW YORK: G. P. PUTNAM & CO.; SHELDON, BLAKEMAN & CO.

LONDON: TRÜBNER & CO.

1857.

R. CRAIGHEAD, Printer and Stereotyper,
Caxton Building,
81, 83, and 85 Centre st., N. Y.

NOTES BY THE EDITOR

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1856.

The Tenth Meeting of the American Association for the Promotion of Science was held at Albany, commencing August 20th, Prof. Hall in the chair. The meeting was by far the largest which has thus far been held, and the citizens of Albany, both in their public and private capacity, received the members with a most generous hospitality. The session continued until the 28th, when it adjourned to meet on the 12th of August, 1857, at Montreal, in compliance with an invitation from the City Council and Natural History Society of that city. The officers appointed for the ensuing year are Prof. J. W. Bailey of West Point, President; Prof. A. Caswell of Providence, Vice-President; Prof. John Le Conte of South Carolina, General Secretary; and Prof. J. Lovering of Cambridge, was continued as Permanent Secretary.

The whole number of Papers contributed was one hundred and sixteen: 65 in the section of Mathematics, Physics, and Chemistry; 44 in the section of Natural History; and 7 in Ethnology.

In addition to the usual sessions of the Association there were two exercises of extraordinary character, and indeed of extraordinary interest for the country. On the 27th, the inauguration of the State Geological Hall took place. Addresses were made by Profs. Agassiz, Hitchcock, Dewey, Henry, and others. A merited tribute was paid to the memory of the late Dr. T. Romeyn Beck of Albany, and resolutions of respect to his memory were passed by silently rising.

On the following day (Thursday) there was the inauguration of the Dudley Observatory, when the Hon. Edward Everett delivered to an audience of five thousand, an oration of great power, admirably adapted to the occasion.

The following resolutions were passed by the Association:—

Raising the salary of the Permanent Secretary from $300 to $500.

That a Committee be appointed to memorialize the Legislature of Ohio to cause a complete geological survey of that state to be made.

That foreign learned societies be invited to attend the meetings of the Association.

Some steps were also taken for obtaining the protection of the National Government, as well as of the State government of California, for the gigantic specimens of trees, *Washingtonia gigantea*, which exist in the above named state. It is feared that, unless some measures are taken, these most wonderful specimens of vegetable growth will be soon sacrificed by the cupidity of private individuals.

Notwithstanding the unusually large attendance, and the number of Papers presented, the meeting of the American Association for 1856 was not eminently successful, so far as the progress of science and the promotion of good feeling among the members was concerned. Of the great majority of the papers presented, comparatively few contained any really new contributions to science. Many, when examined critically, will be found to contain little else than a repetition of facts and theories which have been before published in the proceedings of the Association and of other societies. It may be very pleasant and agreeable for some individuals to discourse popular science by the hour to popular audiences; to indulge in fulsome adulations of one another; for one to designate the other as a second Kepler, and for another to rise in his place and "thank God that such men as Profs. X., Y., and Z. existed." These occurrences may be well enough in a mutual admiration society, but do not properly belong to the proceedings of an American Association assembled for the discussion of abstract science.

The subject of the alterations of the Constitution, postponed from a previous meeting, was brought up and discussed, with much feeling and division of sentiment. The disagreement which existed in relation to these matters, was augmented by the non-familiarity on the part of the Chair with parliamentary laws and usages.

The constitutional question was, however, settled at this meeting, and it is to be hoped that no further difficulty will originate from this source.

There is much of truth in the following comments on the transactions of the Albany Meeting, as expressed by one of the leading New York Journals. "The undue prominence given by the Association to papers of no practical utility whatever characterized the meeting. The great mass of the papers presented were ponderable in quantity, but imponderable in quality. No papers were read on new discoveries in chemistry relating to its applications to the arts; none on any of the great manufacturing interests of our country, which require so much real science to conduct and carry on; none on civil or mechanical engineering; none on practical mining; none on shipbuilding; none on any of the useful arts whatever."

The twenty-sixth Annual Meeting of the British Association was held at Cheltenham in August, 1856, Dr. Daubeny in the Chair. The attendance was not large, but the papers presented were more practical and valuable than usual. The meeting for 1857 was appointed to be held at Dublin, Dr. Lloyd, of Trinity College, Dublin, being the President elect.

The following were among the resolutions adopted by the Association, which we publish as indicative of the proposed fields of scientific research to be occupied:

That Prof. Buckman and Prof. Voelcker be requested to continue their researches into the effects of external agents on the growth of plants.

That a Deputation be named to wait upon her Majesty's Secretary for Foreign Affairs, to urge the desirableness of sending out an Annual Expedition to the Niger, at the period of the rising of the waters of that river (which has been proved to be the most healthy season), as proposed by Dr. Baikie, supported by the Royal Geographical Society, and advocated by persons deeply interested in establishing a regular commercial intercourse with the inhabitants of that portion of Africa.

That a memorial be presented to the Admiralty, praying for the complete publication, in a minute form, of the results of the trials of Her Majesty's steamships.

That Mr. Rennie be requested to prosecute his experiments on the velocity of the screw propeller.

That the Earl of Harrowby, and other gentlemen, be requested to continue their efforts for amending the patent system of England, so that the funds arising may be available to the reward of meritorious inventors.

That Mr. Henderson, and others, be requested to consider the best mode of improving the system of measurement for tonnage of ships, and the estimation of the power of steam engines.

Mr. Fairbairn was requested to complete his report on boiler explosions; Mr. Thompson, his report on the measurement of water by weir boards; and these two gentlemen to concur in experiments on the friction of disks in water, and on centrifrugal pumps.

A donation of $100 was voted to Madame Ida Pfeiffer to aid her proposed exploration of Madagascar.

In the Geological section an exciting debate occurred between Prof.

H. D. Rogers, of Boston, Mass., and Sir R. I. Murchison, the latter claiming and upholding the priority of certain English geological nomenclature, a point that was manfully and stoutly opposed by Prof. R.

The Institute of France held its Annual Meeting on the 14th of August, at Paris, under the presidency of M. Berenger, President of the Academy of Moral and Political Sciences. What is called the Institute, consists of five great Academies of France—Française, Fine Arts, Sciences, Inscriptions et Belles Lettres, and Moral and Political Sciences—which during the year meet apart, and pursue their respective walks with little or no communication with another. The annual meeting of these learned bodies united is generally an affair of great interest, and this year it was not less so than usual. M. Berenger, as President, delivered a long harangue, in which he touched on a multiplicity of subjects, literary, scientific, economic, governmental, &c. Amongst other things, he stated that the different academies are in possession of a capital producing £6,000 sterling a year, for distribution in prizes, without counting £1,200 which the government gives them to disburse in the same way. He said that the Academy of Sciences, in the course of last year, received not fewer than 165 manuscript treatises on scientific problems proposed by it for public competition; the Académie Française a far greater number on literary subjects which it proposed; and the Academy of Moral and Political Sciences thirty-four, most of them of great length, for a Manual of Political Economy, which it demanded. The great prize of £1,200, offered by the Emperor for the new work or discovery best calculated to do honor to the country, was awarded to M. Fizeau, for his important and interesting experiments on the rapidity with which light travels.

The German Association for the Promotion of Science held their Annual Meeting at Vienna, September 15th, Prof. Haidinger, Director-General of the Geological Survey of Austria, acting as the general presiding officer. The attendance was quite large.

At the opening of the Congress the following sections were formed: Mineralogy, Geology and Palæontology, Botany and Vegetable Physiology, Zoology and Comparative Anatomy, Natural Philosophy, Chemistry, Geography and Meteorology, Mathematics and Astronomy, Anatomy and Physiology, Medicine, Surgery.

In the course of the meeting several sections subdivided themselves into sub-sections—*ex. gr.* for Entomology, Vegetable Geography, Periodical Phenomena in Organic Life, &c.; others occasionally combined, according to the nature of the communications and discussions.

The Anniversary Meeting of the Ray Society was held during the meeting of the British Association at Cheltenham. It appears from the Report of the Council that they have now published their two great serial works, Agassiz & Strickland's Zoological and Geological Bibliography, and Alder & Hancock's beautiful work on the Naked Marine Mollusca. The report announced that the next work to be published is one by Prof. Allman, of Edinburgh, on the Fresh Water Polyps of Great Britain. Several other works were also announced on various departments of British Natural History. Amongst them are Prof. Williamson's British Foraminifera, Mr. Bowerbank's British Sponges, and Mr. Blackwall's British Spiders.

The American Pharmaceutical Association held their third Annual Meeting in Baltimore in September. During the three days in which the Association was in session, much interesting matter was discussed, in regard to the professions of the pharmaceutist and druggist, and their relations to the physician and public in general. Committees were appointed to report at the meeting to be held next year in Philadelphia, upon home adulterations, a standard for weights and measures, statistics of pharmacy, scientific papers, and regulations in regard to the sale of poisons.

During the past summer the Dudley Observatory, at Albany, has been formally inaugurated, and now takes its place as one of the best endowed and furnished observatories in this country or Europe. The Dudley Observatory originated in the munificence of Mrs. Dudley, of Albany, lady of the late Charles E. Dudley, of that city, formerly member of Congress. Her donations to its foundation and support have been as follows:—for its building, $12,000; instruments, $14,500; endowment, $50,000; total, $76,500. In addition to the above, Mr. Thomas W. Olcott, of Albany, has given $10,000; Hon. Erastus Corning a superb astronomical clock and other instruments, while liberal subscriptions have been also made by Mr. De Witt, J. H. Rathbone, and others. Mr. Rathbone, also, in addition to the liberal sums previously tendered by him, has recently given the amount requisite for the purchase of the celebrated calculating engine of Mr. George Scheutz, of Stockholm, which was on exhibition at the Palace of Industry at Paris in 1855. In addition to the above, twelve gentlemen of Albany have pledged themselves to defray the future expenses of publishing Gould's *Astronomical Journal.*

The Dudley Observatory is to be placed under the charge of Dr. B. A. Gould, the well-known editor of the *Astronomical Journal.*

From the annual report of the Astronomer Royal of Great Britain, we learn that the Greenwich Observatory still maintains its pre-eminence for meridional and lunar observations, and the magnetical and meteorological observations are kept up with praiseworthy diligence. The galvanic method of recording transits succeeds to perfection; and the distribution of the time signals to different parts of the kingdom is continued, and promises to develope itself into an important branch of commercial astronomy. Two noteworthy facts are mentioned in the report: one is, that the hill on which the observatory stands is in a state of tremor, whereby the trough of mercury in which stars are observed by reflection, is so much agitated as to make observation impossible. To overcome the difficulty, a well ten feet deep was dug, and filled with "incoherent rubbish," on which the trough was placed, resting on stages suspended by strips of caoutchouc, "leaving the image practically," as Mr. Airy says, "almost perfect." The other is, that fluctuations were found to occur in the zero of the altazimuth circle, and simultaneously with a sudden and marked change of atmospheric temperature—a phenomenon which the Astronomer Royal cannot account for, "except by supposing that in sudden atmospheric changes the gravel rock of Greenwich Hill does suddenly change its position."

During the past year the trigonometrical survey of Great Britain, commenced in 1784, has been completed. The object which the government had chiefly in view in 1784 was the determination of the difference of longitude between the observatories of Greenwich and Paris. The geodetical problems have been satisfactorily solved, but the survey has assumed a wider scope as it advanced, and its important results, both in scientific and national points of view, are familiarly known.

In India, under the auspices of the British Government, a trigonometrical survey has been undertaken, and above fifty sheets of an Indian Atlas, based on the survey, have been already published.

In a discussion which took place at the Albany Meeting of the American Association, relative to the utility and comparatively small expenditure of the coast survey, Prof. Alexander stated that he had taken pains to compute the cost, square mile by square mile, of that work, and had found that its cost did not exceed that of the crude surveys of the public lands.

At the last Meeting of the American Association, Mr. W. P. Blake called attention to the very gross inaccuracies existing in a map recently published by M. Marcou, of France, of the geology of the region between the Mississippi and the Pacific. Mr. Blake enumerated several of the prominent errors, among them the representation of the rocks of San Francisco as granitic and metamorphic, they being tertiary, and making Fremont's Peak into a volcano, when in his official report it was clearly and fully stated to be granitic. Proofs were brought forward to show that the formation called Jurassic, &c., by M. Marcou was not so, but was cretacious. There was no evidence by fossils to show that the triassic formations were found under the cretacious; they might be, but no fossils had been obtained, and the age could not yet be affirmed. M. Marcou had, however, made four great divisions of the strata, corresponding with those abroad, but this was entirely arbitrary, and a generalization beyond all these facts which had been obtained. Mr. Blake protested against the reception of the western portion of the map as a fair exhibition of the knowledge which had already been published, and stated that his criticisms were not upon local details of the map, but upon erroneous representations extending for hundreds of miles. Moreover, M. Marcou had not availed himself of the printed documents and reports upon American Geology in his possession, but his representations were in many cases directly opposite to those made by the explorers of regions where he had never been. The view taken by Mr. Blake was also sustained by all the geologists present.

The second annual report of the Geological Survey of North Carolina, by Prof. E. Emmons, has been presented to the Legislature of that state and published. The results of the survey, thus far, have been most interesting, and throw much light upon the age of the red sandstone rocks, extending from the Valley of the Connecticut to North Carolina. Some of the fossils described by Dr. Emmons most resemble those obtained from the Permian strata of Europe. Many new and undescribed species have, in addition, been brought to light, which, at present, it is difficult to classify. The final result when developed and worked out, as it will be by Dr. Emmons, will form one of the most valuable contributions ever made to American Science.

During the past year the first volume of the Proceedings of the Philosophical Society of Victoria, published at Melbourne, Australia, has been received in this country. It is difficult to realize that a scientific and learned society should be in full and vigorous action in a land which so recently was considered a *terra incognita*, and which, at the present time even, is so far removed from European or American influences.

The following suggestion, which is especially worthy the attention of all friends of American scientific progress, was made at the last Meeting of the American Association by President Hitchcock:—So large a portion of our country has now been examined, more or less thoroughly, by the several State Governments, that it does seem to me the time has come when the National Government should order a survey—geological, zoological, and botanical—of the whole country, on such a liberal and thorough plan as the surveys in Great Britain are now conducted; in the latter country it being understood that at least thirty years will be occupied in the work.

Mr. Stainton, the well known Entomologist, of England, proposes to issue an "Entomologist Weekly Intelligencer," of eight octavo pages. as a medium among entomologists for the prompt registration and dissemination of their discoveries. Each observer, says the editor, has but to write to him, and in ten days his discovery will be in print, and in the hands of every entomologist in the kingdom. Mr. Stainton's penny journal, which marks a step in entomological science highly characteristic of the times, is deserving of the warmest encouragement.

One of the most valuable of recent publications is Schubarth's Repertorium, or a "Subject Matter Index of Patents, with Published Inventions of all Nations, from 1823 to 1853, inclusive." Mr. Schubarth is one of the Prussian Commissioners of Patents, and the work in question is the result of thirty years' labor.

Schubarth's Repertorium has been ordered to be printed in Prussia at the public expense, by the Minister of Commerce. It embraces a period of *thirty-one years*, from 1823 to 1853, inclusive. It is intended to publish a Supplementary Index in 1859.

It is an advantageous circumstance that this Index, although written in the German language, is printed in English type, by which it is made intelligible to any European who may wish to consult it; but in order to render the Repertorium perfectly available to the general public of England and America, an English translation and a new alphabetical arrangement of its 644 general heads has recently been made. This Mr. Bennet Woodcroft, Superintendent of English Patents, has done, adding at the same time, in parallel columns, to each of Mr. Schubarth's heads, the corresponding references to the subject matter Indexes of British Patents.

Schubarth's Repertorium, in conjunction with Mr. B. Woodcroft's Indexes of British Patents, affords to intending patentees, or their agents, a facility of reference and consultation which leaves little doubt that the great desideratum of placing the entire mass of the industrial information of the world within the reach of every mechanic will ultimately be attained. At least, two very important preliminary steps towards this end have been taken simultaneously, yet independently, by the two gentlemen already named.

The Geographical Society at Paris, in its first Annual Meeting for 1856, awarded its prize, for the most important discovery during the last year, to Dr. Heinrich Barth. The next prize, of a golden medal, was adjudged to Mr. E. George Squier, of the United States, for his Central American Researches.

The Founders' Gold Medal of the Royal Geographical Society, England, has been awarded to Dr. Kane for his discoveries in the Polar Regions.

The International Association for the Uniformity of Weights, Measures, and Money, which recently assembled at Paris, is slowly but surely effecting its objects, and achieving results which will hereafter be of the utmost importance to reciprocal trade and the more enlarged interchange of commerce. The Permanent International Committee now comprises influential and intelligent members from Portugal, Mexico, England, the United States, Austria, and France. Sweden, Belgium, and other countries are also working in the common cause. The press of every nation has been requested to consider—first, the question of unity in the denomination of moneys; secondly, unity of standard; and, thirdly, unity of weights and measures of all kinds, whether economical or scientific.

No two countries have the same weights and measures, though the same name to designate them may be used in many countries. Take the mile measure, for instance. In England and the United States, a mile means 1,760 yards; in the Netherlands it is 1,093 yards; while in Germany it is 10,120 yards, or nearly six English miles; in France it is 3,025 yards. The Scotch mile is 1,984, and the Irish 2,038 yards; the Spanish is 2,472 yards, and the Swedish mile 11,700 yards. These are computed in English yards; but the yard itself, of three feet in length, has divers significations in different places. The English yard is 36 inches; the French, 39·13 inches; the Geneva yard, 57·60; the Austrian, 37·35; the Spanish yard, 33·04; the Prussian, 36·57; the Russian, 39·51. For measures of capacity, the dissimilarity is wider and more perplexing.

There is no necessity, however, for introducing the French metrical system into Great Britain and the United States, as with much less trouble and confusion a decimal system can be introduced on the established units. Thus the pound and the foot may be decimally divided without introducing the kilogramme or the metre, or, what would be the very sure form of the operation, a "usuel" pound and foot, being respectively half a kilogramme and one-third of a metre, and thereby defeating the benefits of a decimal system of calculation. It is not a little remarkable that with a decimal currency system—acknowledged to be practically the best in operation—the people and the government of the United States have been content so long to continue the use of the antiquated scale of weights and measures with which trade has been embarrassed in England and its dependencies—the pound as the unit of weight, with its heterogeneous multiples and divisions, of ounce, pennyweight, and grain, of stone, quarter, hundredweight, and ton; moreover, occasionally duplicates of these, as the pound troy, and the pound avoirdupoise—the stone of 14, and the stone of 8 pounds, &c. Nor has the lineal unit better recommendation. Its division into feet and inches, and its multiples, those of pole, furlong, and mile, are of an antiquity that renders them always cumbrous and incongruous, and, in the main, practically unsuited to the age.

There appears to be no reason why a decimal system should not afford equal advantages if applied, as it no doubt will be ultimately, to the scale of weights and measures. The adoption of such a system, however simple it may appear in the abstract, would nevertheless entail little less than an entire revolution in all the transactions of commerce, and, like all other innovations upon established usage, would have its opponents and its victims, as well as its interested advocates, and should, therefore, be approached with great caution.

The second Annual Report of the Geological Survey of New Jersey, by Prof. Kitchell, the first and second Annual Report of the Geological Survey of Missouri, by Prof. Swallow, and a Geological Reconnoissance of Tennessee, by Prof. Safford, have all been published during the past season.

The Board of Trustees of the University of Mississippi have authorized the erection of a first class Astronomical Observatory at Oxford, Mississippi, and have contracted for a transit circle similar to that introduced by Prof. Airy at Greenwich. If the enlightened policy, thus inaugurated by the Board of Trustees, be fully carried out, Mississippi, through her University, will soon place herself in a very honorable relation to the progress of intellectual improvement in the world.

The sum of fifteen thousand pounds has been voted by the British Parliament for the exploration of Northern Australia, under the direction of the Royal Geographical Society, and an expedition, under the charge of Mr. Gregory, left New South Wales for the interior during the past year. The objects of the expedition are, briefly to trace the Victoria river to its source, and to determine the character of the north-western interior, and afterwards to endeavor to find out a more direct tract than the circuitous route traversed by Leichardt, from the head of the Gulf of Carpentaria to the settlements on the eastern coast, comprised under the general name of Moreton Bay. The time required to do this is estimated at not less than three years.

M. Petermann, in a recent publication on the Explorations of Central Africa, says, the country lying south of five degrees is one wide, flat plain, over which isolated mountains or groups of mountains are scattered, but that, north of that latitude, a chain of mountains, about seventy-five geographical miles in length, runs from east to west. Tracts of mountains, many rising into the regions of eternal snow, extend from these across the equator.

The mystery of the Nile is about to be attacked on every side. Capt. Burton is preparing a new expedition; the East India Company having granted him two years' leave with full pay, and the English Government having allowed £1,000 towards the expenses. The Pasha of Egypt has also ordered a new expedition to be organized to ascend the Nile, under M. de Lauture, an experienced African traveller. The expedition will be accompanied by twelve Europeans. This expedition is undertaken entirely at the cost of the Viceroy of Egypt, and the members will receive, in addition to their rations, the sum of £10 to £14 per month during the time employed on it, which is computed at two years. Count de Lauture and Capt. Burton will advance in friendly rivalry from opposite quarters towards the sources of the Nile, and perhaps meet on a common ground to solve the most attractive of geographical problems.

A successful attempt has been made during the past year to ascend Mount Ararat (a feat but once before successfully accomplished), by a party of English officers and tourists. The height of this mountain is 17,323 feet above the sea-level, and 14,300 feet above the plain adjoining. Major Stuart, of the British army, one of the party, says:—

"The whole surface of Mount Ararat bears evidence of having been subject to violent volcanic action, being seamed and scored with deep ravines. The rocky ridges that protrude from the snow are either basalt or tufa; and near the summit we found some bits of pumice on a spot which still emits a strong sulphurous smell. The summit itself is nearly level, of a triangular shape, the base being about 200 yards in length, the perpendicular about 300. The highest point is at the apex of the triangle, which points nearly due west; separated from it by a hollow is another point of nearly equal altitude, and the base of the triangle is an elevated ridge, forming a third eminence. These three points stand out in distinct relief on a clear day. The snow on the top is almost as dry as powder, and in walking over it we did not sink more than half-way to the knee. The impression left on my mind is, that the summit is an extinct crater filled with snow. We experienced no difficulty of respiration, except being sooner blown by exertion than we should have been at a lower level. The cold was intense."

During the past season Prof. Piazzi Smyth, Astronomer Royal of Scotland, through assistance generously offered by Robert Stephenson, the well known engineer, visited the Peak of Teneriffe, for the purpose of astronomical observation.

The immediate object of this expedition was to determine how far astronomical observation may be improved by the elevation of telescopes into the higher regions of the atmosphere. Prof. S. carried with him the great equatorial telescope of the Edinburgh Observatory, and a full supply of all other minor instruments of the very best character. The party having reached their destination in safety, two stations were successively occupied: one 8,870 feet above the sea-level, the other 10,900 feet.

At both these stations, the nights were almost constantly clear, and the purity of the atmosphere was abundantly proved by the brightness and definition of the stars examined. In proof of the advantage of the elevation, Prof. Smyth states that the limit of vision of the smaller telescope was extended from the stars of the tenth to those of the fourteenth degree of magnitude; and as to fineness of definition, while at Edinburgh he had never seen good images of stars in that instrument, at the lower station it exhibited such clear and perfect stellar disks as he had never before seen in any telescope at or near the level of the sea.

The astronomical conclusions as to the purity of the atmosphere were confirmed by other observations, some of them attended with unforeseen and untoward accidents. A radiation thermometer was broken in a few minutes by the intense power of the sun, for which its maker, in foggy England, had made no provision. Two other thermometers that had been prepared according to Arago's ideas, and the greater strength of the sun in France, though marking 180°, were insufficient to register the extraordinary intensity of the solar rays; for, by 10 A.M., the top of the scale was reached, and the upper bulb began to fill to an unknown extent. More successful was the observation of the radiation of the moon by means of the Admiralty delicate thermo-multiplier lent by Mr. Gassiot.

"The position of the moon was by no means favorable, being on the night of the full, 19° south of the Equator; but the air was perfectly calm, and the rare atmosphere so favorable to radiation, that a very sensible amount of heat was found both on this and the following night. The absolute amount was small, being about one-third of that radiated by a candle at a distance of fifteen feet; but the perfect capacity of the instrument to measure still smaller quantities, and the confirmatory result of groups of several hundred observations, leave no doubt of the fact of our having been enabled to measure here a quantity which is so small as to be altogether inappreciable at lower altitudes."

Of the other observations made at Guajara, the abstract given in the Report attests the excellence of this station for various scientific researches:—

"Closely connected with radiation is the quantity of the light emitted by the heavenly bodies, and this was examined frequently, in the case of the sun and moon and different parts of the sky, by observations of Frauenhofer's lines in the spectrum. Stokes's spectrum was also examined, as recommended by the Royal Society, and was found to be traceable beyond the furthest point previously ascertained elsewhere. Means of photographing this spectrum were also prepared, and some pictures of it on glass obtained, showing many of the dark lines beyond H, the usual limit of vision.

"At the upper station, with the larger telescope, the definition proved admirable; so much so, that not only once, but every night for a week, I could see that difficult test, B and C of γ Andromeda, as two distinct stars; nor could I find any objects in the lists of the 'Cycle' that were not separated by the telescope and with ease.

"Equally with regard to the range of visibility did the atmosphere approve itself; for the very faintest star to the practised eye and powerful telescope of the observer of the 'Cycle,' proved easy to even an inexperienced person in the Pattinson equatorial.

"Directing them to planetary bodies, the fine division of Saturn's ring—a much contested matter—came out unmistakeably, and revelations of clouds appeared on Jupiter's surface which were eminently similar in form, and as continually interesting in their changes as those of the sea of lower clouds brought about Teneriffe daily under our eyes by the N.E. trade-wind."

The expedition returned to England in October after an absence of 117 days, of which 36 were spent at sea, 18 in the lowlands of Teneriffe, 37 at the height of 8,870 feet, and 26 at the height of 10,900 feet. The reduction of the observations is now in progress, and a detailed report is being drawn up for presentation to the Admiralty. If the expedition should be renewed another year—for which the present report gives every encouragement—the experience of Prof. Smyth will enable him to take fuller advantage of the time and instruments that may be at his disposal.

Astronomers are now eagerly on the look-out for the expected return of the comet of 1556. The evidence of the identity of that comet with the one which appeared in 1264 is now generally admitted. From the computation of the perturbations due to planetary attraction between 1264 and the present time, it is believed that the course of the comet has been accelerated, and therefore a speedy re-appearance is probable. Mr. Hind published in the "Monthly Notices of the Royal Astronomical Society," in 1847, an orbit, founded upon a rough chart of its path, copied into various works from an original publication by Paul Fabricius, attached to the court of Charles V. Subsequent inquiries, through the aid of Prof. Littröw, the Director of the Imperial Observatory at Vienna, led to the recovery of the original chart of Fabricius, and brought to light a still more important treatise, by Joachim Heller, astronomer, of Nuremberg, copies of which exist in the ducal libraries of Wolfenbuttel and Gotha. The observations of Fabricius extend over less than a fortnight: whereas those of Heller give the positions of the comet during an interval of fifty-three days. The exact alterations in the orbit required by the calculations founded on Heller's observations are not yet determined; but the principal correction is a diminution of the comet's path to the ecliptic to the extent of about one degree, which Mr. Hind views in connexion with the acceleration of its return.

At a late meeting of the Royal Society, a communication was read from Prof. Phillips, entitled, "Observations on a Drawing of the Lunar Mountain, Copernicus," by Professor Secchi, Director of the Observatory at Rome. This drawing is the result of a long series of observations made by means of the fine telescope at the command of Professor Secchi. The drawing is on a scale of ten geographical miles to an inch, and all the objects are laid down by triangulation. This is by far the most perfect representation of any portion of the moon's surface that has been executed, and is highly honorable to Professor Secchi. Prof. Phillips remarks:—Drawings of this nature are of priceless value, and if engraved and circulated among astronomers, it would be a most effectual stimulant to further research.

A bill to incorporate and endow an Agricultural College in Maryland, appropriating six thousand dollars annually from the State Treasury in support of the same, has been passed during the past year by the Legislature of that State. Commissioners have also been appointed to locate the proposed institution, and establish regulations concerning it. As an illustration of what the Maryland Legislature expect their Agricultural College to do, we quote *Section* 6 of the act of incorporation:—

"*And be it enacted*, That it shall be the duty of the said board of trustees to order and direct to be made or instituted on said model farm annually a series of experiments upon the cultivation of cereal and other plants, adapted to the latitude and climate of the State of Maryland, and cause to be carefully noticed upon the records of said institution the character of said experiments, the kind of soil upon which they were undertaken, the system of cultivation adopted, the state of the atmosphere and other particulars which may be necessary to a fair and complete understanding of the result of said experiments; and they shall also require the instructor of chemistry, as far as may be consistent with his other duties in said institution, to carefully analyze all specimens of soil that may be submitted to him by any citizen of this State, free of charge, and specially furnish the applicant with an accurate statement of the result."

The Legislature of New York has passed a bill to loan to the New York State Agricultural Society $40,000 without interest, for the purpose of aiding in the purchase of a farm, and the erection of buildings for a College. The citizens of Ovid, Seneca County, have raised $40,000 additional towards the object, and there is no longer a doubt in regard to the establishment of an Agricultural College and Model Farm in the Empire State.

The State of New York has also erected for the use of the Agricultural Society and the State Collection of Natural History, a spacious new building. It is represented as an imposing edifice, 81 by 50 feet, with a wing 68 by 40 feet, the whole four stories high.

New York also, following in the footsteps of Massachusetts, has recently made liberal appropriations for the purpose of disseminating correct and practical information relative to the insects of that State which affect vegetation injuriously or beneficially. The task was assigned to Dr. Asa Fitch, and his first report has been recently published. Instead of classifying the insects by their scientific divisions, Dr. Fitch first considers the insects which infest fruit trees, commencing with those which occur in the apple, and noticing in succession the varieties which affect the root, the trunk, the twigs, the leaves, and the fruit. In the same order insects which occur upon the pear, the plum, the peach, cherry, &c., are successively taken up. From fruit trees, a transition is made to the species of insects infesting forest trees, field crops, and garden vegetables.

This method of arrangement of the several topics is perfectly intelligible to every reader, and with the assistance of a brief heading which precedes the account of each species, he is enabled to turn at once to any insect which he wishes to find, and which is described in the report.

This report is included in the transactions of the New York State Agricultural Society, but is also printed separately.

A new Museum has recently been projected in London under fair auspices, to be called the Scriptural Museum; and its purpose is to afford a series of illustrations of Bible history, geography, and manners. The Society propose to embrace the following subjects in their collection:—Landscape Scenery of Palestine—Models of Jerusalem—Productions, Vegetable, Animal, and Mineral—Illustrations of the Civil and Ecclesiastical Polity of the Hebrews—Military Discipline—Sacred Antiquities of the Israelites, Assyrians, Egyptians—Tabernacle—Temple, Proseuchæ, and Synagogues—Dress of Priests—High Priests and Levites—Temple Vessels—Musical Instruments—Domestic Antiquities—Tents, Houses, and Furniture—Dress—Coverings for the Head, Phylacteries, Raiment of Camel Hair—Signets, Rings, Sandals—Literature, Science, and Art—Writing Materials and Implements—Sinaitic and other Inscriptions—Manuscripts—Poetry—Painting and Music—Agricultural Implements—Arms and Chariots of War—Weights, Measures, Coins, and other articles relating to Commerce—Treatment of the Dead, and Funeral Rites. It is proposed to establish a library in connexion with the Museum; and also to organize courses of lectures on the topics illustrated by the articles in the Society's collection.

The Herbaria, belonging to the London Horticultural Society, have been brought to the hammer; they were the collections of the officials sent abroad, and were made in order that the officers might be able to ascertain the names and value of the seeds which were sent home; that purpose served, they became mere records of past discovery, of very great botanical interest, but with no further bearing upon the objects of their owners. Douglass's collection, formed in Northwest America and California, amounting to 500 species, was purchased by the British Museum for $150. Hartweg's, for $100. The whole realized about $1,200.

The last priced catalogue, published by Groom, lately deceased, near London, contained three varieties of the tulip, at the enormous figure of five hundred dollars each; they were all of his own raising; there is also one at two hundred and fifty dollars, twelve at a hundred dollars, and four at fifty dollars each. Mr. G. succeeded best by mixing large quantities of coarse river sand in his soil. His whole stock has been dispersed since his death.

The Imperial Agricultural Society of Paris has been trying to discover why seeds, apparently all alike, do not germinate all at the same time. The conclusion is that the latest are so tightly inclosed in their envelope, as to prevent or check the penetration of moisture, and they are now inquiring whether the tardy seeds are the heaviest or the lightest, and whether they are obtained from one part of a plant more than another.

The Belgian Government offers a prize of two thousand dollars to any one who will discover a way to make starch for manufacturing purposes from a non-alimentary substance. Enormous quantities of flour are used in the cotton manufacture alone.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

THE RECENT PROGRESS OF SCIENCE.

At the meeting of the British Association, at Cheltenham, for 1856, the President, Dr. Daubeny, presented, as the subject of his annual address, the following retrospective view of the recent progress of Natural Science.

CHEMICAL PROGRESS.

Beginning then with Chemistry, let me remind you that at a period not remote, all of it that could be quoted as really worthy the name of a science was comprehended within the limits of the mineral kingdom. Here at least the outline had been traced out with sufficient precision—the general laws established on a firm basis—the nomenclature framed with logical exactness—the facts consistent with each other, and presented in a scientific and luminous form. Thus a philosopher, like Sir Humphrey Davy, who had contributed in so eminent a degree to bring the science into this satisfactory condition, might, at the close of his career, have despaired of adding anything worthy of his name to the domain of chemistry, and have sighed for other worlds to subdue. But there was a world almost as little known to the chemists of that period as was the Western Hemisphere to the Macedonian Conqueror—a world comprising an infinite variety of important products, called into existence by the mysterious operation of the vital principle, and therefore placed, as was imagined, almost beyond the reach of experimental research. This is the new World of Chemistry, which the Continental philosophers in the first instance, and subsequently those of our own country, have during the last twenty years been busy in exploring, and by so doing have not only bridged over the gulf which had before separated, by an impassable barrier, the kingdoms of inorganic and of organic nature, but also have added provinces as extensive and as fertile as those we were in possession of before, to the patrimony of Science.

It is indeed singular, that whilst the supposed elements of mineral bodies are very numerous, the combinations between them should be comparatively few; whereas amongst those of vegetable and animal origin, where the ultimate elements are so limited in point of number, the combinations which they form appear almost infinite. Carbon and hydrogen, for instance, constitute, as it were, the keystone of every organic fabric; whilst oxygen, nitrogen, and less frequently sulphur and phosphorus, serve almost alone to build up their superstructure. And yet what an infinity of products is brought about by ringing the changes upon this scanty alphabet! Even one series of bodies alone, that known by the name of the Fatty Acids, comprises several hundred well ascertained combinations, founded however upon a single class of hydro-carbons or compound radicals, in which the carbon and hydrogen stand to each other in equal atomic proportions, and are in each case acidified by the same number of equivalents of oxygen. These acids are all monobasic, or combined with only one proportion of base; but add to any one of them two equivalents of carbonic acid, and you obtain a member of a second series, which is bibasic, or is capable of forming two classes of salts. The above, therefore, constitute a double series, as it were, of organic acids, the members of which are mutually related in the manner pointed out, and differ from each other in their mode of combining according to the relation between their respective elements. But already, by the labors of Hofmann and of other chemists, two other double series of acids, the one monobasic, the other bibasic, mutually related exactly in the same manner as those above, have been brought to light; each series no doubt characterized by an equally numerous appendage of alcohols, of æthers, and of aldehydes, to say nothing of the secondary compounds resulting from the union of each of these bodies with others.

Hence, the more insight we obtain into the chemistry of organic substances, the more we become bewildered with their complexity; and in investigating these phenomena, find ourselves in the condition of the explorer of a new continent, who, although he might see the same sun over his head, the same ocean rolling at his feet, the same geological structure in the rocks that were piled around him, and was thus assured that he still continued a denizen of his own planet, and subject to those physical laws to which he had been before amenable, yet at every step he took was met by some novel object, and startled with some strange and portentous production of Nature's fecundity. Even so the chemist of the present day, whilst he recognises in the world of organic life the same general laws which prevail throughout the mineral kingdom, is nevertheless astonished and perplexed by the multiplicity of new bodies that present themselves, the wondrous changes in them resulting from slight differences in molecular arrangement, and the simple nature of the machinery by which such complicated effects are brought about. And as the New World might never have been discovered, or, at all events, would not have been brought under our subjection, without those improvements in naval architecture, which had taken place prior to the age of Columbus, so the secrets of organic chemistry would have long remained unelicited, but for the facilities in the methods of analysis which were introduced by Liebig. Before his time the determination of the component elements of an organic substance was a task of so much skill as well as labor, that only the most accomplished analysts—such men, for instance, as Dr. Prout, or the great Berzelius—could be depended upon for such a work; and hence the data upon which we could rely for deducing any general conclusions went on accumulating with extreme slowness. But the new methods of analysis invented by Liebig have so simplified and so facilitated the process, that a student, after a few months' practical instruction in a laboratory, can, in many instances, arrive at results sufficiently precise to be made the basis of calculation, and thus to enable the master mind, which is capable of availing itself of the facts before it, to breathe life into these dry numerical details. And as the established laws and institutions of the Old World have been modified—may I not say in some instances rectified?—by the insensible influence of those of the New, so have the principles that had been deduced from the phenomena of the mineral kingdom undergone in many instances a correction from the new discoveries made in the chemistry of the animal and vegetable creation. It was a great step indeed in the progress of the science, when Lavoisier set the example of an appeal to the balance in all our experimental researches, and the Atomic Theory of Dalton may be regarded as the necessary, although somewhat tardy, result of the greater numerical precision thus introduced. But no less important was the advance achieved, when structure and polarity were recognised as influencing the condition of matter, and when the nature of a body was felt to be determined, not only by the condition of its component elements, but also by their mutual arrangement and collocation—a principle which, first illustrated amongst the products of organic life, has since been found to extend alike to all chemical substances whatever.

Formerly it had been the rule to set down the bodies which form the constituents of the substances we analysed, and which had never yet under our hands undergone decomposition, as elementary; but the discovery of cyanogen in the first instance, and the recognition of several other compound radicals in organic chemistry more lately, naturally suggest the idea that many of the so-called elements of inorganic matter may likewise be compounds, differing from the organic radicals above mentioned merely in their constituents being bound together by a closer affinity. And this conjecture is confirmed by the curious numerical relations subsisting between the atomic weights of several of these supposed elements; as, for example, between chlorine, bromine, and iodine; an extension of the grand generalization of Dalton, which, although it might very possibly have been repudiated by him, had it been proposed for his acceptance, will be regarded by others as establishing, in a manner more conclusive than before, the soundness of his antecedent deductions.

What, indeed, can be a greater triumph for the theorist, than to find that a law of nature which he has had the glory of establishing by a long process of induction, not only accommodates itself to all the new facts which the progress of discovery has since brought to light, but is itself the consequence of a still more general and comprehensive principle, which philosophers, even at this distance of time, are still engaged in unfolding? It is also curious to reflect, that whilst the bold speculations of Democritus have been realized by the Manchester philosopher, the reveries of the alchemists derive something like solid support from the minute investigations of his successors. We may remark, indeed, as not a little remarkable, how frequently the discoveries of modern days have served to redeem the fancies of mediæval times from the charge of absurdity. If the direction of a bit of steel suspended near the earth can, as Colonel Sabine has proved, be influenced by the position of a body like the moon, situated at a distance from it of more than 200,000 miles, who shall say that there was anything preposterously extravagant in the conception, however little support it may derive from experience, in the influence ascribed to the stars over the destinies of men by the astrologers of olden time? And when we observe a series of bodies, exhibiting, as it would seem, a gradation of properties, and, although as yet undecompounded, possessing a common numerical relation one to the other, who will deny the probability that they are composed of the same constituents, however little approach we may have as yet made towards the art of resolving them into their elements, or of forming them anew? Organic chemistry has also considerably modified our views with respect to chemical affinity. According to one view, indeed, which has been supported of late with considerable talent and ingenuity, the law of elective attraction, to which we have been in the habit of referring all the changes that are brought about by chemical means, is a mere figment of the imagination; and decomposition may be accounted for, without the interference of any such force, by regarding it simply as the result of that constant interchange which is supposed to be going on between the particles of matter—the atoms even of a solid body being, according to this hypothesis, in a state of incessant motion. But passing over these and other speculations which have not as yet received the general assent of chemists, let me advert to others of an older date, possessing, as I conceive, the strongest internal evidence in their favor which the case admits, from the harmony they tend to introduce into the chaos of facts which the late discoveries in organic chemistry have brought to light. Amongst these, one of the most generally received, and at the same time one of the most universal application, is that which represents the several combinations resulting from organic forces, as being put together according to a particular model or type, which impresses upon the aggregate formed certain common properties, and also causes it to undergo change most readily through the substitution of some other element in the place of one of those which already enters into its constitution. And this principle, having been established with regard to one class of bodies, has since been extended to the rest; for it now begins to be maintained, that in every case of chemical decomposition a new element is introduced in the place of one of those which constituted a part of the original compound, so that the addition of a fresh ingredient is necessarily accompanied by the elimination of an old one. The same doctrine, too, has even been extended to the case of combination with a body regarded as elementary, for here also the particles are considered as being in a state of binary combination one with the other, owing perhaps to their existing in opposite electrical conditions, and therefore possessing for each other a certain degree of chemical affinity. Thus, when we unite hydrogen with oxygen, we substitute an atom of the latter for one of the former, previously combined with the same element. The type therefore remains, although the constituents are different. When, in the formation of alcohol, we combine the oxide of the compound radical æthyle with water, there is still only a substitution of the former for one of the atoms of water previously united together, two and two; and when we form ether, we eliminate the second atom of water, and replace it by another atom of the same compound radical. Thus the type of water still remains, although none of the materials of the original fabric continue; or, if I may adopt the metaphor of a building, although the original bricks which composed the structure may have been all replaced by other materials, the latter, however differing in their nature, always correspond, in point of shape, dimensions, and number, with the parts of the edifice which have been removed to make way for them. It is on this principle that Prof. Williamson has propounded a new theory of ætherification, regarding the process as resulting from the alternate replacement of hydrogen by æthyle, and of æthyle by hydrogen, in the sulphuric acid concerned,—a view which best harmonizes with the composition of the new æther he hit upon in the course of his investigations. The same principle may even be extended to bodies of the same type as ammonia; for inasmuch as this body is made up of a union of an atom of nitrogen with three of hydrogen, it is easy to conceive that a variety of different compounds might be formed by the substitution of one, two, or three atoms of other radicals for the same number of atoms of the original hydrogen. How beautifully this idea has been carried out in the recent researches of Hofmann, and how happily it serves to elucidate the formation of the various vegetable alkaloids, which, from their energetic action upon the animal economy, have of late excited so much interest in the public mind, is sufficiently known to those who are chemists, and could not be rendered intelligible to those who are not, without entering into details which would be out of place on the present occasion. I must not, however, pass over this part of the subject without remarking, that the adoption of Prof. Williamson's æthyle theory would establish a still nearer analogy between the constitution of organic and of mineral compounds than is at present recognised, since in that case alcohol and ether would stand in the same relation one to the other, and belong to the same class or series, as the acids and their salts.

ARTIFICIAL FORMATION OF NATURAL PRODUCTS.

To some, however, it may be more interesting to consider those practical results bearing upon the arts of life, which have either been actually deduced, or may be anticipated as likely to accrue, from the discoveries in question. Of these perhaps the most important is the possibility of forming by art those compounds, which had been formerly supposed to be only producible by natural processes, under the influence of the vital principle. The last two years have added materially to the catalogue of such bodies artificially produced, as in the formation of several species of alcohol from coal gas by Berthelot, that of oil of mustard by the same chemist, and the generation of taurine, a principle elaborated in the liver, by Strecker. And if the above discoveries should strike you at first sight rather as curious than practically useful, I would remark, that they afford reasonable ground for hope, that the production of some of those principles of high medicinal or economical value, which Nature has sparingly provided, or at least limited to certain districts or climates, may lie within the compass of the chemist's skill. If quinine, for instance, to which the Peruvian bark owes its efficacy, be, as would appear from recent researches, a modified condition of ammonia, why may not a Hofmann be able to produce it for us from its elements, as he has already done so many other alkaloids of similar constitution? And thus, whilst the progress of civilization, and the development of the chemical arts, are accelerating the consumption of those articles, which kind Nature has either been storing up for the uses of man during a vast succession of antecedent ages, or else is at present elaborating for us in that limited area, within which alone the conditions would seem to be such as to admit of their production, we are encouraged to hope that Science may make good the loss she has contributed to create, by herself inventing artificial modes of obtaining these necessary materials. In this case we need not so much regard the exhaustion of our collieries, although Nature appears to have provided no means for replenishing them; nor even be concerned at the rapid destruction of the trees which yield the Peruvian bark, limited though they be to a very narrow zone, and to a certain definite elevation on either side of the equator. Already, indeed, chemistry has given token of her powers, by threatening to alter the course of commerce, and to reverse the tide of human industry. Thus she has discovered, it is said, a substitute for the cochineal insect, in a beautiful dye producible from guano. She has shown, that our supply of animal food might be obtained at a cheaper rate from the antipodes, by simply boiling down the juices of the flesh of cattle now wasted and thrown aside in those countries, and importing the extract in a state of concentration. She has pointed out, that one of the earths which constitute the principal material of our globe contains a metal, as light as glass, as malleable and ductile as copper, and as little liable to rust as silver; thus possessing properties so valuable, that when means have been found of separating it economically from its ore, it will be capable of superseding the metals in common use, and thus rendering metallurgy an employment, not of certain districts only, but of every part of the earth to which science and civilization have penetrated.

AGRICULTURAL IMPROVEMENTS.

And may I not also say, that she has contributed materially towards the advancement of those arts in which an agricultural county like this is especially interested? Who has not heard of the work of Baron Liebig, which, at the time of its first appearance, made such a sensation, and stirred up the dormant energies of the agricultural public, not less thoroughly than the subsoil plough, of which he explained the advantages, elicited the latent treasures of the land? It is well known that a controversy has been going on for some time past, between this distinguished foreigner and certain experimental agriculturists of England, with regard to the principles upon which the manuring of our land ought to be regulated. In this dispute, however, you will not expect me to take part, for it would be obviously improper. But I may be permitted to remark, that whilst some points of difference between them still remain open for further investigation, a much nearer correspondence of opinion exists with respect to others, than the public in general, or even perhaps the disputants themselves, are inclined to allow. In so far, indeed, as relates to the relative advantages of mineral and ammoniacal manures, I presume there is little room for controversy; for although most soils may contain a sufficiency of the inorganic constituents required by the crop, it by no means follows that the latter are always in an available condition; and hence it may well happen that in most cases in which land has been long under cultivation, the former class of manures becomes, as Baron Liebig asserts, a matter of paramount necessity. Now that the same necessity exists for the addition of ammoniacal manures can hardly be contended, when we reflect, that at the first commencement of vegetable life, every existing species of plant must have obtained its nourishment solely from the gaseous constituents of the atmosphere, and from the mineral contents of the rock in which it vegetated. The only divergence of opinion, therefore, that can arise, relates to the degree of their respective utility in the existing state of our agriculture, and to the soundness of Baron Liebig's position, that a plant rooted in a soil well charged with all the requisite mineral ingredients, and in all other respects in a condition calculated to allow of healthy vegetation, may sooner or later be able to draw from the atmosphere whatever else is required for its full development. And does not, I would ask, this latter position derive some support from the luxuriant vegetation of the tropics, where art certainly contributes nothing towards the result? and is it not also favored by such experiments as those carried on at Lois Weedon in Northamptonshire, where the most luxuriant wheat crops have been obtained for a number of consecutive years without manure of any kind, simply by following out the Tullian system of stirring up and pulverizing the soil? How, too, are we to explain that capacity of subsisting without any artificial supply of ammonia, which Mr. Lawes is led by his experiments to attribute to turnips, and other plants of similar organization, unless we assume that the power residing in the leaves of absorbing ammonia from the air may render plants, in some cases at least, independent of any extraneous aid? Be this, however, as it may, there is at least a wide distinction between this opinion and the one attributed to Baron Liebig by many, who would seem to imagine, that according to his views, ammonia, if derived from artificial sources, was in a manner useless to vegetation. As if it could be a matter of any moment, whether the substance which in both cases afforded the supply of nitrogen, and which in both cases also was primarily derived from the decomposition of organic substances, had been assimilated by plants directly upon its being thus generated, or had been received into their system at a later period, after having been diffused through the atmosphere? To suppose that Baron Liebig should have attached any moment to this distinction seems inconsistent with many passages in his work, in which, although the paramount importance of mineral manures may be insisted upon, and the success which had in certain cases attended the use of one compounded only of mineral ingredients may be put forward as a motive for further trials, the utility of ammoniacal substances in all their several forms is at the same time distinctly admitted. Still the practical question remains, whether, admitting the theoretical truth of Baron Liebig's position, a larger expenditure of capital will not be required for bringing a given farm into a condition to dispense with ammoniacal manures, than for procuring those materials which contain that ingredient ready for use. And here experimental researches, such as those conducted on so extended and liberal a scale by Mr. Lawes and Dr. Gilbert, come in aid of theory. They stand, as it were, midway between the abstract principles which science points out to the farmer, and the traditional usages with respect to his art which have been handed down to him from one generation to another. They bear the same relation to the farmer, which the records of the clinical practice in a large infirmary do to the general principles of medicine expounded by the modern physiologist. It is true, that the experience of a particular hospital may not at all times coincide with the anticipations which science holds out; but this discrepancy only suggests to us the imperfections of our present knowledge, and it is not allowed to disturb the confidence of the physician in principles already established on incontrovertible evidence. On the contrary, whilst he modifies his practice from time to time by the experience he has gained by actual observation, he feels at the same time the fullest conviction, that these results will be found eventually reconcilable with the general principles which a still more extended series of induction may have established. I need not occupy your time by applying the same method of proceeding to the recent researches alluded to, but I will carry the analogy between the science of Agriculture and Therapeutics one step further. You may recollect, that in a report on the progress of husbandry, drawn up some years ago by one of the most enlightened and zealous promoters of the agricultural interest in Great Britain, it was asserted that chemistry had done nothing for the farmer, except in teaching him to use sulphuric acid with his bones, and to take advantage of the refuse flux liquor formerly thrown away and wasted. Now a statement of this kind, although it might be literally true in the narrow sense in which the author doubtless intended it,—namely, as referring merely to the introduction of new specifics or recipes into farming—was calculated, when put forth on such high authority, to foster that tendency in the human mind to which we are all more or less prone, that of sparing ourselves the trouble of thought and reflection in shaping the course of our conduct, by leaning blindly upon certain rigid and unvarying rules already chalked out to us by others. Grant that science has as yet supplied us with only two infallible recipes for the improvement of our land, the agricultural chemist may derive credit from the reflection, that medicine too, since the days of Hippocrates, has lighted only upon two or three specifics for the cure of disease; and that the most enlightened physicians of the present day, in the spirit which we would fain see actuating the leaders of the agricultural body, depend not upon the efficacy of *nostrums*, but upon their sagacity in referring the varying conditions of each case which comes before them to those principles of physiology which modern science has established. And has not science also unfolded principles which may be called in to aid and direct the practical labors of the agriculturist? I need not go further than the works of Baron Liebig for an answer to this question. I may appeal, for instance, to the extensive employment of guano at the present time, first introduced in consequence of his suggestions; I may refer to the substitution of mineral phosphates for bones, founded upon his explanation of the sources from which the latter substance derives its efficacy as a manure; and I may allude more especially to his refutation of the humus theory, to which even the great Saussure gave his adhesion, and the reception of which was calculated to vitiate, not a few processes only, but the entire system of our husbandry.

But it is time to hasten on to certain other departments of Natural Science.

DISCOVERIES IN BOTANICAL SCIENCE.

In Botany and Vegetable Physiology it cannot perhaps be said, that whole provinces have been added to the domain of the science within twenty years, as we have seen to be the case in our review of the progress of chemistry. The improvements in the microscope which have since taken place render us familiar with particulars relating to the structure and functions of the vegetable creation, which the ruder methods of investigation before resorted to would never have revealed to us. We owe to them the interesting discoveries of Brown and Adolphe Brongniart, as to the mode in which the pollen is brought into immediate contact with the ovules, by means of the tubes which it protrudes by a prolongation of the innermost of its two investing membranes. Thus much, at least, appears to be fully ascertained; but, in alluding to the observations of others, who have endeavored to push their scrutiny still further, it becomes me to speak with more diffidence, inasmuch as the office which the pollen discharges in the act of fecundation is still a matter of dispute between such men as Schleiden and Schacht on the one side, and Hofmeister, Moll, &c., on the other. Whilst, however, this controversy continues, it is something at least to know that the vivifying principle, whatever it may be, is actually transmitted to the part where its influence is to be exerted, and not kept apart from it, as we were formerly compelled to assume, by that long intervening plexus of fibres, or tubes, which constitutes the style. To the microscope also we owe all that is as yet known with respect to the reproductive process in cryptogamous plants, which are now shown to possess a structure analogous to that of flowering ones in respect to their organs of reproduction; not, indeed, as Hedwig supposed, that parts corresponding to stamens and pistils in appearance and structure can be discovered in them, but that as the primary distinction of sexes seems to run throughout the Vegetable Kingdom, new parts are superadded to a structure common to all as we ascend in the scale of creation, until from the simple cell, which, in consequence of some differences of structure, to our eyes inappreciable, appears to exercise in one case the function of the male, in another of the female, as is found the case in certain of the Confervæ, we arrive at length at the complicated machinery exhibited in flowering plants, in which the cell containing the fecundating principle is first matured in the stamen, and afterwards transmitted, through an elaborate apparatus, to the cells of the ovule, which is in like manner enveloped in its matrix, and protected by the series of investing membranes which constitutes the seed-vessel. Thus, as Goethe long ago observed, and as modern physiologists have since shown to be the case, the more imperfect a being is, the more its individual parts resemble each other—the progress of development, both in the Animal and Vegetable Kingdom, always proceeding from the like to the unlike, from the general to the particular. But, whilst the researches of Brown and others have shown that there is no abrupt line of division in the Vegetable Kingdom, and that one common structure pervades the whole, the later inquiries of Suminski, Hofmeister, Unger, Griffith, and Henfrey, have pointed out several curious and unlooked-for analogies between plants and animals. I may mention, in the first place, as an instance of this analogy between plants and animals, the existence of moving molecules, or phytosperms, in the antheridia of ferns and other Cryptogams, borne out, as it has been in so remarkable a manner, by the almost simultaneous observations of Bischoff and Meissner on the egg, confirmatory of those formerly announced by Barry and Newport, and by the researches of Suminski, Thuret, and Pringsheim, with respect to the ovule of plants. I may refer you also to a paper read at the last Meeting of the Association, by Dr. Cohn, of Breslau, who adduced instances of a distinction of sexes which had come under his observation in the lower Algæ. In like manner a curious correspondence has been traced between the lower tribes of animals and plants, in the circumstance of both being subject to the law of what is called alternate generation. This consists in a sort of cycle of changes from one kind of being to another, which was first detected in some of the lower tribes of animals; a pair of insects, for example, producing a progeny differing from themselves in outward appearance and internal structure, and these reproducing their kind without any renewed sexual union,—the progeny in these cases consisting of females only. At length, after a succession of such generations, the offspring reverts to its primæval type, and pairs of male and female insects, of the original form, are reproduced, which complete the cycle, by giving rise in their turn to a breed presenting the same characters as those which belong to their own progenitors. An ingenious comparison had been instituted by Owen and others between this alternation of generations in the animal, and the alternate production of leaves and blossoms in the plant; but the researches to which I especially allude have rendered this no longer a matter of mere speculation or inference, inasmuch as they have shown the same thing to occur in ferns, in lycopodia, in mosses, nay, even in the confervæ. We are indebted to Prof. Henfrey for a valuable contribution on these subjects, given in the form of a Report on the Higher Cryptogamous Plants; from which it at least appears that the proofs of sexuality in the Cryptogamia rank in the same scale, as to completeness, as those regarding flowering plants did before the access of the pollen tubes to the ovule had been demonstrated. Indeed, if the observations of Pringsheim with respect to certain of the Algæ are to be relied upon, the analogy between the reproductive process in plants and animals is even more clearly made out in these lower tribes than it is in those of higher organization. It also appears that the production in ferns and other Acrogens of what has been called a *pro-embryo;* the evolution of antheridia and archegonia, or of male and female organs, from the former; and the generation from the archegonia of a frond bearing spores upon its under surface, is analogous to what takes place in flowering plants in general; where the seed, when it germinates, produces stem, roots, and leaves; the stem for many generations gives rise to nothing but shoots like itself: until at length a flower springs from it, which contains within itself for the most part the organs of both sexes united, and, therefore, occasions the reproduction of the same seed with which the chain of phenomena commenced. This is the principle which a learned Professor at Berlin has rather obscurely shadowed out in his treatise on the Rejuvenescence of Plants, and which may perhaps be regarded as one, at least, of the means by which Nature provides for the stability of the forms of organic life she has created, by imparting to each plant a tendency to revert to the primæval type.

DISTRIBUTION OF PLANTS.

To the elder De Candolle we are also indebted for some of our most philosophical views with respect to the laws which regulate the distribution of plants over the globe,—views which have been developed and extended, but by no means subverted, by the investigations of subsequent writers; amongst whom Sir Charles Lyell, in his "Principles of Geology," and the younger De Candolle, a worthy inheritor of his father's reputation, in his recently published work on Botanical Geography, have especially signalized themselves. But it is to the late Prof. Edward Forbes, and to Dr. Joseph Hooker, that we have principally to attribute the removal of those anomalies, which threw a certain degree of doubt upon the principles laid down by De Candolle in 1820, in his celebrated article on the Geography of Plants, contained in the "Dictionnaire des Sciences Naturelles," where the derivation of each species from an individual, or a pair of individuals, created in one particular locality, was made the starting-point of all our inquiries. These anomalies were of two different kinds, and pointed in two opposite directions; for we had in some cases to explain the occurrence of a peculiar Flora in islands cut off from the rest of the world, except through the medium of a wide intervening ocean; and in other cases to reconcile the fact of the same or of allied species being diffused over vast areas, the several portions of which are at the present time separated from each other in such a manner, as to prevent the possibility of the migration of plants from one to the other. Indeed, after making due allowances for those curious contrivances by which Nature has in many instances provided for the transmission of species over different parts of the same continent, and even across the ocean, and which are so well pointed out in De Candolle's original essay, we are compelled to admit the apparent inefficiency of existing causes to account for the distribution of the larger number of species; and must confess that the explanation fails us often where it is most needed, for the Compositæ, in spite of those feathery appendages they possess, which are so favorable to the wide dissemination of their seeds, might be inferred, by their general absence from the fossil Flora, to have diffused themselves in a less degree than many other families have done. And on the other hand, it is found, that under existing circumstances, those Compositæ, which are disseminated throughout the area of the Great Pacific, belong in many cases to species destitute of these auxiliaries to transmission. But here Geology comes to our aid; for by pointing out the probability of the submergence of continents on the one hand, and the elevation of tracts of land on the other, it enables us to explain the occurrence of the same plants in some islands or continents now wholly unconnected, and the existence of a distinct Flora in others too isolated to obtain it under present circumstances from without. In the one case we may suppose the plants to have been distributed over the whole area before its several parts became disunited by the catastrophes which supervened; in the other, we may regard the peculiar Flora now existing as merely the wreck, as it were, of one which once overspread a large tract of land, of which all but the little patch upon which it is now found had since been submerged. However, upon this subject our opinions may in some measure be swayed by the nature of the conclusions we arrive at with respect to the length of time during which seeds are capable of maintaining their vitality; for if after remaining for an indefinite period in the earth they were capable of germinating, it would doubtless be easier to understand the revival, under favorable circumstances, of plants which had existed before the severance of a tract of land from the continent in which they are indigenous. An inquiry has accordingly been carried on for the last fifteen years under the auspices of this Association, the results of which, it is but fair to say, by no means corroborate the reports that had been from time to time given us with respect to the extreme longevity of certain seeds, exemplified, as it was said, in the case of the mummy-wheat and other somewhat dubious instances; inasmuch as they tend to show, that none of the seeds which were tested, although they had been placed under the most favorable artificial conditions that could be devised, vegetated after a period of forty-nine years; that only twenty out of two hundred and eighty-eight species did so after twenty years; whilst by far the larger number had lost their germinating power in the course of ten. These results, indeed, being merely negative, ought not to outweigh such positive statements on the contrary side as come before us recommended by respectable authority, such, for instance, as that respecting a Nelumbium seed, which germinated after having been preserved in Sir Hans Sloane's Herbarium for one hundred and fifty years; still, however, they throw suspicion as to the existence in seeds of that capacity of preserving their vitality almost indefinitely, which alone would warrant us in calling to our aid this principle in explaining the wide geographical range which certain species of plants affect. Let us then be content to appeal to those ingenious views which were first put forth by the late Professor Forbes. By the aid of the principles laid down, he was enabled to trace the Flora of Great Britain principally to four distinct sources, owing to the geological connexion of these islands at one period or other with Scandinavia, with Germany, with France, and with Spain! And it was by a similar assumption that Dr. Joseph Hooker explained the distribution of the same species throughout the islands of the Great Pacific, and the contiguous continents, tracts which, as Darwin had shown, were formerly united. Nor is this mode of explanation limited to the case of the above regions; for in the "Flora Indica," Dr. Hooker, in conjunction with his fellow traveller, Dr. Thomson, has discussed the same problem with regard to the whole of India, extending from Affghanistan to the Malayan peninsula. And amongst the many services rendered to the Natural Sciences by these indefatigable botanists, one of the greatest I conceive to be, that they have not only protested against that undue multiplication of species, which had taken place by exalting minute points of difference into grounds of radical and primary distinction, but that they have also practically illustrated their views with respect to the natural families which have been described by them in the volume alluded to. They have thus contributed materially to remove another difficulty which stood in the way of the adoption of the theory of specific centres,—I mean the replacement of forms of vegetation in adjoining countries by others, not identical, but only as it should seem allied; for it follows from the principles laid down by these authors, that such apparently distinct species may after all have been only varieties, produced by the operation of external causes acting upon the same species during the long periods of time.

But if this be allowed, what limits, it may be asked, are we to assign to the changes which a plant is capable of undergoing,—and in what way can we oppose the principle of the transmutation of species, which has of late excited so much attention, and the admission of which is considered to involve such startling consequences! I must refer you to the writings of modern physiologists for a full discussion of this question. All that I shall venture to remark on the subject is, that had not Nature herself assigned certain boundaries to the changes which plants are capable of undergoing, there would seem no reason why any species at all should be restricted within a definite area, since the unlimited adaptation to external conditions which it would then possess, might enable it to diffuse itself throughout the world, as easily as it has done over that portion of space within which it is actually circumscribed. Dr. Hooker instances certain species of Coprosma, of Celmisia, and a kind of Australian Fern, the *Lamaria procera*, which have undergone such striking changes in their passage from one portion of the Great Pacific to another, that they are scarcely recognisable as the same, and have actually been regarded by preceding botanists as distinct species. But he does not state that any of these plants have ever been seen beyond the above-mentioned precincts; and yet if Nature had not imposed some limits to their susceptibility of change, one does not see why they might not have spread over a much larger portion of the earth, in a form more or less modified by external circumstances. The younger De Candolle, in his late admirable treatise, has enumerated about 117 species of plants which have been thus diffused over at least a third of the surface of the globe, but these apparently owed their power of transmigration to their insusceptibility of change, for it does not appear that they have been much modified by the effect of climate or locality, notwithstanding the extreme difference in the external conditions to which they were subjected. On the other hand, it seems to be a general law that plants whose organization is more easily affected by external agencies, become, from that very cause, more circumscribed in their range of distribution; simply because a greater difference in the circumstances under which they would be placed, brought with it an amount of change in their structure which exceeded the limits prescribed to it by Nature. In short, without pretending to do more than to divine the character of those impediments, which appear ever to prevent the changes of which a plant is susceptible from proceeding beyond a certain limit, we seem to catch a glimpse of a general law of Nature, not limited to one of her kingdoms, but extending everywhere throughout her jurisdiction,—a law, the aim of which may be inferred to be that of maintaining the existing order of the universe, without any material or permanent alteration, throughout all time, until the fiat of Omnipotence has gone forth for its destruction. The will which confines the variations in the vegetable structure within a certain range, lest the order of creation should be disturbed by the introduction of an indefinite number of intermediate forms, is apparently the same in its motive as that which brings back the celestial luminaries to their original orbits, after the completion of a cycle of changes induced by their mutual perturbations. The whole, indeed, resolves itself into, or at least is intimately connected with, that law of symmetry to which Nature seems ever striving to conform, and which possesses the same significance in the organic world, which the law of definite proportions does in the inorganic. It is the principle which the prophetic genius of Goethe had divined, long before it had been proved by the labors of physiologists to be a reality, and to which the poet attached such importance, that the celebrated discussion as to its merits which took place in 1830 between Cuvier and Geoffroy St. Hilaire so engrossed his mind, as to deprive him, as his biographer informs us, of all interest in one of the most portentous political events of modern days which was enacting at the very same epoch,—I mean the subversion of the Bourbon dynasty. It is, indeed, not less calculated to subserve the gratification of our sense of the Beautiful, than to provide against too wide a departure from that order of creation which its great Author has from the beginning instituted; and which manifests itself, not less in the geometrical adjustment of the branches of a plant, and of the scales of a fir-apple—nay, even as they have wished to prove, in the correspondence between the form of the fruit and that of the tree on which it grows—than in the frequent juxtaposition of the complementary rays of the spectrum, by which that harmony of color is produced in Nature which we are always striving, however unsuccessfully, to imitate in Art. The law, indeed, seems to be nothing else than a direct consequence of that unity of design pervading the universe, which so bespeaks a common Creator—of the existence in the mind of the Deity of a sort of archetype, to which His various works have all, to a certain extent, been accommodated; so that the earlier forms of life may be regarded as types of those of later creation, and the more complex ones but as developments of rudimentary parts existing in the more simple.

GEOLOGICAL PROGRESS.

I will only further detain you by noticing one other field of inquiry, in which

I have ever felt a lively interest, although it has only been in my power to bestow on it a casual attention, or cultivate one limited portion of the wide range which it embraces. Indeed Geology, the science to which I now allude, has, during the last twenty years, made such rapid strides, that those who endeavored from an early period of life to follow at a humble distance the footsteps of the great leaders in that science, have, if I may judge of others by myself, been often distanced in the race, and when they endeavored to make good their lost ground, found themselves transported into a new, and to them an almost unknown region. Thus the thorough exploration which has taken place of the Silurian and Cambrian systems, has added a new province—ought I not rather to say, a new kingdom?—to the domain of Geology, and has carried back the records of the creation to a period previously as much unknown to us as were the annals of the Assyrian dynasties before the discoveries of Sir Henry Rawlinson. I might also be disposed to claim for the recent investigations of botanists some share in fixing the relative antiquity of particular portions of the globe, for from the Floras they have given us of different islands in the Great Pacific, it would appear that the families of plants which characterize some groups are of a more complicated organization than those of another. Thus, whilst Otaheite chiefly contains Orchids, Apocyneæ, Asclepiadeæ, and Urticeæ; the Sandwich Islands possess Lobeliaceæ and Goodenoviæ; and the Galapagos Islands, New Zealand, and Juan Fernandez, Compositæ, the highest form, perhaps, of dicotyledonous plants. In deducing this consequence, however, I am proceeding upon a principle which has lately met with opposition, although it was formerly regarded as one of the axioms in Geology. Amongst these, indeed, there was none which a few years ago seemed so little likely to be disputed as that the classes of animals and vegetables which possessed the most complicated structure were preceded by others of a more simple one; and that when we traced back the succession of beings to the lowest and the earliest of the sedimentary formations, we arrived at length at a class of rocks, the deposition of which must be inferred, from the almost entire absence of organic remains, to have followed very soon after the first dawn of creation. But the recognition of the footsteps and remains of reptiles in beds of an earlier date than was before assigned to them, tended to corroborate the inferences which had been previously deduced from the discovery, in a few rare instances, in rocks of the secondary age, of mammalian remains; and thus has induced certain eminent geologists boldly to dispute, whether, from the earliest to the latest period of the earth's history, any gradation of beings can in reality be detected. Into this controversy I shall only enter at present, so far as to point out an easy method of determining the fact, that organic remains never can have existed in a particular rock, even although it may have been subjected to such a metamorphic action as would have obliterated all traces of their presence. This is simply to ascertain, that the material in question is utterly destitute of phosphoric acid; for inasmuch as every form of life appears to be essentially associated with this principle, and as no amount of heat would be sufficient to dissipate it when in a state of combination, whatever quantity of phosphoric acid had in this manner been introduced into the rock, must have continued there till the end of time, notwithstanding any igneous operations which the materials might have afterwards undergone. But as the discovery of very minute traces of phosphoric acid, when mixed with the other ingredients of a rock, is a problem of no small difficulty, an indirect method of ascertaining its presence suggested itself to me in some experiments of the kind which I have instituted, namely, that of sowing some kind of seed, such for instance as barley, in a sample of the pulverised rock, and determining whether the crop obtained yielded more phosphoric acid than was present in the grain, it being evident that any excess must have been derived from the rock from which it drew its nourishment. Should it appear by an extensive induction of particulars that none of the rocks lying at the base of the Silurian formation, which have come before us, contain more phosphoric acid than the minute quantity I detected in the slates of Bangor, which were tested in the above manner, it might perhaps be warrantable hereafter to infer that we had really touched upon those formations that had been deposited at a time when organic beings were only just beginning to start into existence, and to which, therefore, the term azoic, assigned to these rocks by some of the most eminent of our geologists, might not be inappropriate. The proofs of the former extension of glaciers in the northern hemisphere, far beyond their actual limits, tend also to complicate the question which has at all times so much engaged the attention of cosmogonists with respect to the ancient temperature of the earth's surface; compelling us to admit that at least during the latter of its epochs, oscillations of heat and cold must have occurred to interfere with the progress of refrigeration which was taking place in the crust. On the other hand, facts of an opposite tendency, such as the discovery announced by Captain Belcher of the skeleton of an ichthyosaurus in latitude 77°, and of the trunk of a tree standing in an erect position in latitude 75°, have been multiplying upon us within the same period: inasmuch as they appear to imply that a much higher temperature in former times pervaded the Arctic regions than can be referred to local causes, and therefore force upon us the admission, that the internal heat of the nucleus of our globe must at one time have influenced in a more marked manner than at present the temperature of its crust. On the causes of this increased temperature, whether local or cosmical, much elaborate research has been brought to bear by Sir Charles Lyell and by Mr. Hopkins. The most extensive collection of facts, however, having reference to this subject, is contained in the Reports on Earthquake Phenomena, published by Mr. Mallet, supplying, as they do, data of the highest importance to the full elucidation of the subject. For although the evidence I have myself brought together in my work on Volcanoes might be sufficient to establish in a general way the connexion of earthquakes with that deep-seated cause which gives rise to the eruptions of a volcano, yet our interest is thereby only the more awakened in the phenomena they present,—just as Dr. Whewell's inquiries into the local variations of the Tides were valued all the more in consequence of the persuasion already felt, that lunar attraction was their principal cause. But if earthquakes bring under our notice chiefly the dynamical effects of this hidden cause of movement and of change, those of volcanoes serve to reveal to us more especially their chemical ones; and it is only by combining the information obtained from these two sources, together with those from hot springs, especially as regards the gaseous products of each, that we can ever hope to penetrate the veil which shrouds the operations of this mysterious agent; so as to pronounce with any confidence, whether the effects we witness are due, simply to that incandescent state in which our planet was first launched into space, or to the exertion of those elective attractions which operate between its component elements,—attractions which might be supposed to have given rise, in the first instance, to a more energetic action, and consequently to a greater evolution of heat, than is taking place at present, when their mutual affinities are in a great measure assuaged. Within the last twenty years much has been done towards the elucidation of this problem through the united investigations of Boussingault, of Deville, and above all of Bunsen, with respect to the gases and other bodies evolved from volcanoes in their various phases of activity; the results of which, however, do not appear to me to present anything irreconcilable with that view of their causes which was put forth many years ago in the work I published. Whilst, however, the latter is offered as nothing more than as a conjectural explanation of the phenomena in question, I may remind those who prefer the contrary hypothesis, on the ground that the oblate figure of the earth is in itself a sufficient proof of its primæval fluidity, that this condition of things could only have been brought about in such materials by heat of an intensity sufficient, whilst it lasted, to annul all those combinations amongst the elements which chemical affinity would have a tendency to induce, and thus to render those actions to which I have ascribed the phenomena not only conceivable, but even necessary consequences, of the cooling down of our planet from its original melted condition.

Such are a few of the additions to our knowledge which have been made in the course of the last twenty years in those sciences with which I am most familiar. Whilst, however, the actual progress which has taken place in them is in itself so satisfactory, the change which the sentiments of the public have undergone with respect to their claims to respect, affords no less room for congratulation.

The extension, indeed, which is now given to the name of Museum in the language of naturalists, and even by the public at large, is in itself an indication of correcter views than were formerly entertained with regard to the uses of such establishments. Few, for instance, have such a notion of a Museum as Horace Walpole gave utterance to at the close of the last century, when he defined it "a hospital for everything that is singular—whether the thing has acquired singularity from having escaped the rage of time, from any natural oddness, or from being so insignificant that nobody thought it worth while to produce any more of the same." "The stuffed ducks, the skeleton in the mahogany case, the starved cat and rat which were found behind the wainscot, the broken potsherd from an old barrow, the tattooed head of the New Zealand chief, the very unpleasant-looking lizards and snakes coiled up in the spirits of wine, the flint stones and cockle-shells, &c., will no longer be seen jumbled together in heterogeneous confusion," as might have been the case at the period alluded to. The Ipswich Museum has set an example, which I have no doubt will be generally followed, of selecting for such Institutions a series of types illustrative of the mineral, vegetable, and animal kingdoms; and a Committee of this Association is now employed in the useful undertaking of preparing a list of objects best adapted to this purpose.

It begins, indeed, to be generally felt, that amongst the faculties of mind, upon the development of which in youth success in after life mainly depends, there are some which are best improved through the cultivation of the Physical Sciences, and that the rudiments of those Sciences are most easily acquired at an early period of life. That power of minute observation—those habits of method and arrangement—that aptitude for patient and laborious inquiry—that tact and sagacity in deducing inferences from evidence short of demonstration, which the Natural Sciences more particularly promote, are the fruits of early education, and acquired with difficulty at a later period. It is during childhood, also, that the memory is most fresh and retentive; and that the nomenclature of the sciences, which, from its crabbedness and technicality, often repels us at a more advanced age, is acquired almost without an effort. Although, therefore, it can hardly be expected, that the great schools in the country will assign to the Natural Sciences any important place in their systems of instruction, until the Universities for which they are the seminaries set them the example, yet I cannot doubt, but that the signal once given, both masters and scholars will eagerly embrace a change so congenial to the tastes of youth, and so favorable to the development of their intellectual faculties. And has not, it may be asked, the signal been given by the admission of the Physical Sciences into the curriculum of our academical education? I trust the question may be answered in the affirmative, if we are entitled to assume, that the recognition of them which has already taken place will be consistently followed up, by according to them some such substantial encouragement, as that which has been afforded hitherto almost exclusively to classical literature.

At any rate, I trust the time has now passed away, when studies such as those we recommend lie under the imputation of fostering sentiments inimical to religion. In countries, and in an age in which men of letters were generally tinctured with infidelity, it is not to be supposed that natural philosophy would altogether escape the contagion; but the contemplation of the works of creation is surely in itself far more calculated to induce the humility that paves the way to belief, than the presumption which disdains to lean upon the supernatural.

When indeed we reflect within what a narrow area our researches are of necessity circumscribed—when we perceive that we are bounded in space almost to the surface of the planet in which we reside—itself merely a speck in the universe, one of innumerable worlds invisible from the nearest of the fixed stars—when we recollect, too, that we are limited in point of time to a few short years of life and activity—that our records of the past history of the globe and of its inhabitants are comprised within a minute portion of the latest of the many epochs which the earth has gone through—and that with regard to the future, the most durable monuments we can raise to hand down our names to posterity are liable at any time to be overthrown by an earthquake, and would be obliterated, as if they had never been, by any of those processes of metamorphic action which geology tells us form a part of the cycle of changes which the globe is destined to undergo,—the more lost in wonder we may be at the vast fecundity of Nature, which within so narrow a sphere can crowd together phenomena so various and so imposing, the more sensible shall we become of the small proportion which our highest powers and their happiest results bear, not only to the cause of all causation, but even to other created beings, higher in the scale than ourselves, which we may conceive to exist.

It is believed that every one of the molecules which make up the mass of a compound body is an aggregate of a number of atoms, which, by their arrangement and mutual relation, impart to the whole its peculiar properties; and, according to another speculation which has been already alluded to, these atoms are not absolutely motionless, but are ever shifting their position within certain limits, so as to induce corresponding changes in the properties of the mass. Indeed, it has been imagined, that the production of different compounds from the same elements, united in the same proportions, may be one of the consequences resulting from the different arrangement of particles thereby induced. If this hypothesis have any foundation in fact, what an example does it set before us of great effects brought about by movements which, to our senses, are too minute to be appreciable; and what an illustration does it afford us of the limited powers inherent in the human race, which are nevertheless capable of bringing about effects so varied, and to us so important; although, as compared with the universe, so insignificant! We also are atoms, chained down to the little globe in which our lot is cast; allowed a small field of action, and confined within definite limits, both as to space and as to time. We, too, can only bring about such changes in nature, as are the resultants of those few laws which it lies within the compass of our power to investigate and to take advantage of. We, too, can only run through a certain round of operations, as limited in their extent, in comparison with those which lie within the bounds of our conception, as the movements of the atoms, which serve to make up a compound molecule of any of the substances around us, are to the revolutions of the heavenly luminaries.

And as, according to Prof. Owen, the conceivable modifications of the vertebral archetype are very far from being exhausted by any of the forms which now inhabit the earth, or that are known to have existed here at any former period; so likewise the properties of matter with which we are permitted to become cognizant, may form but a small portion of those of which it is susceptible, or with which the Creator may have endowed it, in other portions of the universe. We are told, that in a future and a higher state of existence, the chief occupation of the blessed is that of praising and worshipping the Almighty. But is not the contemplation of the works of the Creator, and the study of the ordinances of the Great Lawgiver of the universe, in itself an act of praise and adoration? and, if so, may not one at least of the sources of happiness which we are promised in a future state of existence—one of the rewards for a single-minded and reverential pursuit after truth in our present state of trial, consist in a development of our faculties, and in the power of comprehending those laws and provisions of Nature with which our finite reason does not enable us at present to become cognizant?

REQUISITES FOR IMPROVEMENT IN MECHANICAL CONSTRUCTIONS.

What we want is iron of great strength, free from seams, flaws, and hard places. Inferior iron (with the use of other defective and improper materials) is, perhaps, the main cause of one of the greatest errors committed in the construction of whatever in mechanism has to be kept in motion. I mean the increase of size of the parts of a machine or carriage, in order to get strength, thereby adding weight until they are considered to be strong enough. In our vehicles of draught and carriages this is strikingly the case. Now, this ought not to be. Lightness is the thing to aim at, and safety should be sought in the elasticity, form, and good quality of the material. Should a carriage be found to twist and get out of form, that would be a proof of its being too light. But to prevent a carriage breaking down by increasing the size of its parts, and thereby adding weight, is mechanically wrong. Indeed, it is quite distressing to see the enormous weight of our carriages, particularly those drawn by animal power. It should be an axiom in mechanics, that whatever has motion should be as light as circumstances will admit, and this applies equally, whatever the source of power may be, whether the motion is produced by human, horse, or steam power. I think no estimate can be formed of our national loss from the over-multiplication of sizes. Take, for instance, the various sizes of steam-engines—stationary, marine, and locomotive. In the case of marine-engines, the number of sizes up to 100 horse-power will probably not be short of thirty, where ten perhaps would be ample. If so, look at the sums expended in patterns, designs, and in the number of tools for their manufacture. Nor is this all; for, if there were only ten sizes instead of thirty, there would be three times the number made of each pattern; and, as you know, the very soul of manufacture is repetition.—*Mr. Whitworth's Address before the Institution of Mechanical Engineers, Glasgow.*

BERDAN'S COMPRESSIBLE LIFE-BOAT.

A committee appointed by the Secretary of the Navy, several months since, to test and report on the different life-boats offered to the public, has completed its experiments and made its report to the Department; the boat which received the commendation of the committee was one invented by Mr. H. Berdan, of New York City. A large number of boats were tested by the Committee, and its report describes them at length; but we simply copy a portion concerning the one to which they gave their preference, viz. Berdan's:

"This boat comes nearer the object required in our instructions than any boat presented. She is of a very ingenious construction, and may prove valuable in the mercantile marine from her compactness and buoyant properties. Her buoyancy may be judged by the following test to which she was subjected in smooth water: Fifteen men were placed in the boat offered for inspection (being twelve feet long) and two sixty-four pound weights suspended on one side, with which she floated with great ease. There was afterwards placed in the boat 500 pounds of iron, then she was filled with water, and four sixty-four pound weights suspended on one side, under which pressure she floated with her gunwales six or eight inches above water. She was put together and launched in two minutes. The following is a brief description of the boat; She is made of a strong frame of wood, modelled like an ordinary boat, covered with canvas coated with gutta-percha, a large air compartment in the shape of a cylinder outside the boat, running from stem to stern along the gunwales. The gunwales and ribs are hinged to the keel, so that when the boat is not required for use, the ribs can be thrown parallel with the keel, and thus allow the gunwales to fall down on both sides close to the keel, compressing the boat in about a fifth its size when ready for use."

NEW PLAN FOR LOWERING BOATS AT SEA.

Mr. Clifford, of London, has invented an ingenious plan for lowering boats from a vessel's side in perfect safety at sea, in any weather. The unlashing, lowering, and disengaging are done by one man only in the boat, whose simple weight is made to hold in equilibrium the weight or descending momentum of the boat with its entire crew, which he has thus the power to check or control at will. The process is as follows: One man in the boat unhitches a rope from a cleet (on the boat's seat) over which he slackens it off. The boat descends levelly, both laterally and longitudinally, frees itself from the gripes, by which it was firmly lashed to the ship's side (if there is not time to unfasten them), and letting go the rope disengages the boat from the ship. The lowering may be effected as well from one as two davits, or from a yard or spar, and with any degree of velocity, which can be checked at any part of its descent, and with the vessel going at any speed. A hollow rotary plug fixed at the bottom of the boat allows the free ingress or egress of water, which a half-turn stops; the plug is consequently never out of its place.

IMPROVEMENTS IN NAVAL ARCHITECTURE.

Iron Tubular Ships.—James Hodgson, of Liverpool, England, is now building iron screw steam-ships on a principle for which he has taken out a patent. These vessels are constructed without frames, side-frames, floorings, &c., in dispensing with which it was found necessary to increase the strength of the plating for the sides; but to double the strength it is not necessary to double the thickness of the plate, as the strength of the materials increases as the square of the thickness. The strength is further increased by a bulkhead being placed in the widest part of the ship, amidships, and by other bulkheads placed midway between the midship bulkhead and the bow and stern, and again by the interposition of stiffening plates, so as to spread the strain along the vessel's side from one to four feet from the bulkhead. As the sides of the ship, under ordinary circumstances, are much weakened by the holes cut for the bulkheads to be secured to, the patentee extends the butting piece, usually placed over the joint, along the line or strake of plates, and spreads the rivets over a wider area. By the construction of a ship in this manner—in fact, on the principle of a huge steam-boiler or tube, with rounded top and sides, capable of sustaining great pressure—the usual appendages, knees, angle-iron plates, and rivets, for gunwale fastenings, are entirely dispensed with.

Straining of Ships in Launching and Docking.—The late George Steers, who was considered the most eminent ship-builder of our own or any other times, contended that it is a common evil to strain and "hog" large ships, by supporting them too exclusively by their keels in docking. The case is nearly as bad in launching, the bilgeways being so near the keel on each side that the whole weight of the vessel is supported on a narrow line. He argued that much of the distortion observed in vessels a short time in service is due to the straining received in this manner before their completion. The steam-frigate Niagara was built without much regard to the old rules of the naval constructors, and is lighter timbered but heavier fastened than ordinary war vessels of her size; and to avoid the evil alluded to, she was strongly trussed on the inside to support the bilge before launching. The same bracing, which consisted of strong chains from the bilge passing over a tall, stiff framework erected upon the keelsons, remained in the ship during her docking, and the result was that the hull is not bent more than one inch in any direction from her form as moulded.

Hirundine Propeller.—This propeller, for which great results are claimed in England, is thus constructed: A flat, many-jointed or elastic band, representing the *leech*, is extended edgewise to the horizon in a curved undulated line, within a square-sided chamber or tube, formed through the whole length of the vessel below the water line, and open at both ends. The vessel is built without distinction of stem or stern to move in either direction. The undulatory action is produced by rods passing at regular distances from the band to cranks or eccentrics, set in a spiral series on a shaft, which runs parallel to the tube, and this at each revolution raises and depresses the band in a continuous wave-like movement throughout its entire length. By this process, the whole column of water in the tube is discharged with great impetus from one of the ends, and the ship is impelled onwards in the opposite direction.

Robinson's Screw and Side-Lever Steering Gear.—In this arrangement the steering wheel is set a little out of the keel line of the ship, on the port side; and its spindle, which is carried in two-end pedestal bearings, is cut with a stout square screw thread. This screw spindle has upon it a long traversing nut, fitted with a pair of diametrically opposed joint stud pins, for connexion with the end of the sliding lever, which forms the actual tiller. The joint end of this lever is made with a fork and straps, for embracing the stud-pins of the nut. The remaining portion of the lever is a plain cylinder, and it is entered freely through a long inclined eye-piece on the rudder-head, which is, of course, on the starboard side of the screw spindle, and opposite to the longitudinal centre of the latter. The eye on the rudder-head works on a stud pin, so that, in all circumstances, the action is easy and free from strain. As the screw spindle nut traverses forward or aft, in obedience to the turn of the steering wheel, it carries with it the outer end of the tiller, which thus acts as a lever to turn the rudder; and as the nut must always move in a straight line, the sliding tiller traverses back and forward in the eye of the rudder-head, to reconcile the right line action of the nut with the rotatory action of the rudder-head. The effective leverage of the tiller thus becomes greater as the rudder is moved from amidships to either the starboard or port side, and hence the steersman's power is increased in proportion to the external fluid resisted.

Dempster's Triangular Yacht.—A few years since Mr. Henry Dempster, of England, invented a boat of triangular shape, the stern post of which was made to rake at the same angle as the stem, so that both met and terminated at a triangular point under water, and thus formed simply an angular keel. The yacht was twenty feet in length, and had six feet beam, was iron built, and ballasted with lead. It was rigged with three masts, the main-mast being placed exactly in the centre, and in an upright position: the fore-mast had considerable rake forward, and the mizen-mast the same proportion of rake aft. Two square sails were set on the main-mast, one above the other, and a triangular sail on each of the other masts; these triangular sails were on the revolving principle, the booms being secured at the central gravity, one to a pivot on the stem, and the other to a similar pivot on the top of the stern-post; by which means they would run round and round clear of the masts, and could be trimmed to any degree upon a circle. The sails possessed a double advantage over the common rig, and with the help of the triangular hull could perform many rapid revolving evolutions. Amongst other experiments of this triangular yacht was one frequently repeated, in which two stakes were driven into the ground at low water mark, to which a strong iron bar was lashed horizontally like a leaping bar. A pole or gauge was erected alongside the stakes, marked to feet and inches, to indicate the depth of water. When the tide rose sufficiently high to show that there was one foot and a half less water than was required to sail clear of the obstruction, consequently that the vessel would strike it with her angular keel, she was sailed *stem on* at the bar, a stiff breeze blowing at the time, when she went over it by *rise* and *fall*, similar to a horse jumping a gate.

New Methods of Raising Ships.—A new method of raising ships has been invented by Mr. Foreman, of New York, in which he employs cast-iron generators, containing wet gunpowder. These are connected with a cast-iron retort or purifier, filled with water, from which passes a coil of cast-iron tube. The whole apparatus is placed in a box about six feet square and two feet high, which is filled with water. From the end of a coil, a hose, dividing in two parts, passes to casks lashed to the sides of the vessel to be operated on. The power in the generator is then ignited, and the gases generated by its combustion pass by means of the hose and pipe into the casks, and displace the water with which they are filled, holes having been made in the bottom of the cask. The buoyancy thus produced by the confined air is what raises the vessel.

A novel variety of lifting tanks for raising sunken vessels has recently been invented by Capt. Bell. These, combined, are a novel and curious apparatus —being two separate water and air-tight tanks, with straight or square sides, each having on its outer side the form of an acute angle; while the inner surface resembles an arch, which would best compare with a narrow breast-hook timber of a vessel. They are four feet six inches deep by five feet six inches wide—the whole length being fifty-seven feet, with forty-five feet from the span of the arch to the ends, and eighteen feet wide across the crotch. A bulkhead, also water and air-tight, is placed through the crotch, dividing the tank into three separate chambers, with a valve under each to admit and let out the water. The valves are opened simultaneously by a lever attached to them all, and, by letting go the lever, are closed by the pressure of the water. The tanks are to be attached one to the bow and the other to the stern of a sunken vessel, each one receiving so much of the vessel within its arch. A sufficient weight is applied to submerge them when filled with water, and when made fast to a vessel or any sunken body, the water within them is expelled by the force of air on its surface, which is to be applied by means of a pump, and which will then give to the tanks their lifting power. They are constructed in the most substantial manner, having heavy timbers with thick planking inside and out, and fastened with two hundred and one inch bolts, from five to seven feet long, over and down the sides, and four two and a quarter inch bolts, eighteen feet long, athwart the crotch. They are calculated to raise under water a barge or other vessel containing four hundred tons of cargo.

INCREASING THE SPEED OF STEAM-BOATS.

At a recent meeting of the Royal Society of Edinburgh, a paper on the above subject was read by Robert Aytoun, of which the following is an abstract:

Mr. Aytoun stated that the proposition in hydraulics, that the power required to impel a boat increases as the square of the velocity, has exercised a pernicious influence over the minds of shipbuilders in making them look upon it as hopeless to attempt any great increase of speed, which was to be attended by such enormous increase of power. This proposition, by showing the impossibility of greatly increasing speed with any of the known forms of boats, by giving them increased power, clearly indicated that the path of improvement, if any, must lie in new forms, calculated to take advantage of the new power of the marine steam-engine. It at once occurred to him, that by elongating the bow of the vessel, that water which our present steam-boats dash aside from their path with great force and velocity, and the rapid removal of which absorbs the whole power of the engine, might be laid aside comparatively slowly and gently, like the sod from a plough, however great the speed of the vessel. A diagram was shown, exhibiting three steam-boats, whose midship sections were all equal, but the lengths of whose bows were, respectively, 1, 2, 3. It was pointed out that when No. 2 had twice the speed of No. 1, it dashed aside the water in its path with no greater velocity than did No. 1, and therefore did not require more steam power though proceeding at double speed. That when No. 3 had thrice the speed of No. 1, it dashed aside the water in its path with no greater velocity than No. 1, and therefore did not require more steam-power, though proceeding at three times the speed. It thus appeared that the well known proposition above referred to, which has so long paralysed the efforts of shipbuilders, must now give place to the more hopeful one, namely, that the resistance to the motion of boats may be made the same for all velocities, by suiting the form of the boat to the velocity required of it. A similar proposition, in regard to railways, was early made by Mr. Maclaren, with the happiest results, at a time when eight or ten miles an hour was the greatest speed they were thought capable of achieving. The author stated, that it was to be hoped that enterprising shipbuilders would not be slow in realizing the same speed in steamboats which the railway engineers have done in the rail, and that by the elaboration of the self-same proposition, namely, that the resistance to motion may be made the same for all velocities. A considerable advance in speed has been attained of late years by fining the lines of steam-boats, by cutting them in two, and inserting an addition to their length amidships, or by increasing their original length, though this last is often marred by a proportionately increased breadth of beam. These were all steps in the right direction, and tend to support the principle just stated; but nothing short of an attempt to reach thirty or forty miles an hour will satisfy the occasion. Various members discussed the subject of the paper at some length; and while they admitted, as mathematicians, the correctness of the principle advanced by Mr. Aytoun, they considered that that gentleman had not given sufficient weight to other sources of resistance to the motion of boats, such as friction, which would become very formidable when boats of the great length which he advocated, were urged to great speed.

INTERESTING EXPERIMENTS WITH STEAM BOILERS.

Mr. William Radway, of England, published in the London Mining Journal the following detail of experiments recently made by him on the explosion of steam boilers:

He had a cylinder $4\frac{1}{2}$ feet long, $12\frac{1}{2}$ inches diameter, $\frac{1}{9}$ of an inch thick, of good iron, and capable of standing a pressure of 480 pounds to the square inch. This he sometimes used as a steam boiler, and had a furnace under it of $2\frac{1}{4}$ square feet. A short time since it was worked till it was empty, while a powerful fire was under it, and as a consequence, one-third of the lower surface became *red hot.* In this state 4 gallons of hot feed water were let into it slowly, which produced a roaring sound, but not sufficient steam to raise a safety valve of 10 lbs. weight to the inch. As the steam rose, the gas in the boiler was collected and tested, and was found to be only atmospheric air—not an inch of *hydrogen.* Shortly after this he evaporated nearly all the water in the boiler, and then left it to cool, with the safety valve open, to allow the free entrance of air. Next day he replaced the safety valve, loaded it with 30 lbs. to the square inch, and forced in a cubic foot of impure hydrogen gas.

He then, by a contrivance, ignited and exploded this hydrogen gas and air mixture in the boiler; a puff came through the safety valve, and a small steam engine was worked for $42\frac{1}{2}$ strokes by it, but the boiler was neither burst nor strained.

On another occasion he was conducting an experiment which required the steam to be kept up at a pressure of 50 lbs. per inch for 36 hours consecutively, but using a very small quantity of steam. The boiler was filled to within two inches of the top (10½ inches of water) and it was not fed during the 36 hours; at the end of that period it was only reduced 4½ inches, and contained 6. The feed pump was then set in motion to fill the boiler, and although the steam only fluttered gently at the safety valve all day, at the very first stroke of the feed water, the boiler commenced to roar, the engine bounded off with a higher velocity, and with the second and third strokes of the pump the safety valve was forcibly raised, the steam burst from two joints in the top of the boiler, and Mr. R. declares that had he not quickly opened a ¾-inch steam way, he believes the boiler must have exploded, as it exhibited great spasmodic action. He did not anticipate such a result, and the peculiar fact led him to reflect as to the cause. He came to the conclusion that, the water in the boiler might have attained to a higher temperature than 280° Fah.—the heat at 50 lbs. pressure—and if so, a rapid evaporation of steam would be caused when the feed water was supplied, thus suddenly generating a great pressure. He, however, could not satisfy himself of this without an experiment. As he required more steam than his small boiler furnished, he put up two others, side by side, in line with it, and placed the furnace under the end of one of the new ones, which we will call No. 1; then the flues were deflected and passed under the middle one, No. 2, then returned under No. 3, and into the chimney. The feed water entered No. 3 only, and passed thence by a pipe to No. 2, and from it by a pipe to No. 1. The steam was carried by a small pipe from each, and was collected in a larger one for use. A thermometer was placed in each boiler through a stuffing-box, and dipped low down into the water. The boiler No. 1, with the furnace under it, had its steam up in 1 hour; No. 2 had its steam up in 1 hour 40 minutes; No. 3 in 2½ hours, at which period the three thermometers indicated 212°—an equality of heat. At the end of the first six hours the thermometer in No 3 indicated 280° Fah., in No. 2, 288°, in No. 1, 290°. The bulbs of the three thermometers were then slid upwards to raise them out of the water, when the temperature of each fell to 280°—that of the steam in each boiler at 50 lbs. pressure. The thermometers were slid down into the water again, and the experiment continued for 6 hours longer, when they were examined again. The thermometer in No. 3 indicated 282°, in No. 2, 290°, in No. 1, 300° Fah. The thermometers were again raised out of the water, when they all fell to 280°. This, he states, convinced him of the *rationale* of many mysterious steamboat explosions; but his chemical experiments not being finished, he again restored the thermometers, and left them for 18 hours longer. On examining them again, thermometer No 3 was standing at 285°, No. 2 at 298°, and No. 1 at 312°. They were again raised out of the water and fell to 280°—the steam in each boiler being at the same pressure, although there was a difference of 27° between the water in No. 1 and No. 3.

From the above experiments Mr. Radway deduces the following conclusions:

"Here we have conclusive data suggesting certain rules to be rigorously adopted by all connected with steam boilers who would avoid mysterious explosions: First, never feed one or more boilers with surplus water that has been boiled a long time in another boiler, but feed each separately. Second, when boilers working singly or fed singly are accustomed, under high pressure, to be worked for a number of hours consecutively, day and night, they should be completely emptied of water at least once every week, and filled with fresh water. Third, in the winter season the feed water of the boiler should be supplied from a running stream or well."

ON THE USE OF HIGH PRESSURE STEAM.

The following views have been recently expressed by Mr. Fairbairn, the eminent English engineer, on the use of high pressure steam for economic purposes:

"Taking into consideration the superior economy of high steam, *worked expansively*, it is quite evident that in all future construction, either of boilers or engines, we must look forward to the use of a greatly increased instead of a reduced pressure of steam. Indeed, I am so thoroughly convinced of the advantages inseparable from this application, as to urge upon you the necessity of preparing for greatly increased progress, and greatly increased pressure in all the requirements, appliances, and economics of steam as a motive power. It must appear obvious to every reflecting mind, that steam generated under pressure, and compressed into one-fifth or one-sixth the space that it formerly occupied, and that again applied to an engine of little more than one-third the bulk, must be a desideratum in the appliance of an agent so powerful and so extensively used. Look at our locomotives at the present day, and tell me whether we are or are not successfully progressing in effecting a clearer alliance between the two sister sciences of mechanics and physics; and tell me whether or not the community is secured equally well from risk, and greatly benefited by the change? Let us calculate, for example, the duty performed and the force applied to one of our largest class of locomotive engines, travelling with a train at the rate of 45 miles an hour, and we shall find the amount of power given out to exceed that of 700 horses, or as much as would be required to drive the machinery in some of our largest factories. And why not work our factories upon this principle? and why not propel our largest ships by engines of this description? There is no reason why it should not be done, and that with greatly increased economy, by introducing a well directed system of condensation along with that of highly attenuated steam."

THERMOGENIC ENGINE.

The above name has been given to an arrangement invented by Messrs. Beaumont & Mayer, for producing heat sufficient to generate steam capable of application to practical purposes by mere friction.

The construction is simple enough. A boiler is made, traversed by a conical tube of copper, 30 inches diameter at the top, 35 inches at the bottom, inside of which a cone of wood of the same shape is fitted, enveloped in a padding of hemp. An oil vessel keeps the hemp continually lubricated, and the wooden cone is so contrived as to press steadily against the inside of the copper, and to rotate rapidly by means of a crank turned by hand or horse-power. The whole of the boiler outside of the copper cone is filled with water. Thus constructed, the machine, with 400 revolutions a minute, makes 400 litres* of water boil in about three hours by the mere effect of the friction of the oiled tow against the copper. When once the boiling point is reached, it may be maintained for any length of time, or as long as the movement is continued. It is quite easy to keep the steam in the boiler at a pressure of two atmospheres.

SIEMENS' REGENERATIVE ENGINE.

The following is a description of Siemens' Regenerative Engine, as given by the inventor at a late meeting of the Royal Institution, London. The engine described was the result of experiments instituted to endeavor to produce an engine as far as possible a practical application of the dynamic theory of heat. After giving a sketch of the gradual improvements in the application of steam as a source of power from the time of Hero to Watt, and alluding to the researches of Joule, Thomson, and others on heat, he proceeded to consider the identity of heat and mechanical force, to which end their researches lead. He supposed a hammer suspended *in vacuo*, without any friction on its bearings, to fall on a perfectly elastic anvil, and which would rise to precisely the point from which it started. If a piece of copper were placed on the anvil, the hammer would cease to rebound, the copper becoming the recipient of its force. Let now a machine be applied to raise the hammer to its first position; let it strike the copper any number of times; and let the copper be turned on the anvil, and made to assume the same shape at the end of the operation as it had at the beginning. In this case the sole expression of the force which has been used to lift the hammer will be found in the heat which has been conferred upon the copper by the repeated blows. If it were possible to use the heat thus produced as the motive power of the machine which lifts the hammer, a perfect dynamic engine would be obtained, and such an engine would consume only one-fourteenth part of the fuel required by a perfect Boulton & Watt's condensing engine. Mr. Siemens then explained in detail the engine of which he was the inventor. The principal parts are the following, viz.—1. A cylinder termed the *Regenerator*, having a piston moving in it. This cylinder, into which the steam from the boiler is first admitted, is connected at the top with—2. A cylinder of cast iron, of peculiar form (the end of which is exposed to the direct action of the fire, but the temperature of which is moderated by the proximity of the boiler), inclosing another open cylinder, which also contains a piston. The regenerator is connected at the bottom with another cylinder, exactly similar to the preceding. These two are the *Working Cylinders.* 3. An apparatus termed a *Respirator*, disposed around each working cylinder, being the communication between the cylinders and the regene-

* A litre is about a quart.

rator. The respirator consists of a number of layers of wire-gauze, or metal plates, which become highly heated at one end from their proximity to the fire. High-pressure steam being admitted into the regenerator, passes through the respirator into the working cylinder. Arriving there in a highly-heated and compressed state it raises the piston. Becoming cool by expansion, it again passes into the regenerator, at the temperature of saturated steam and of atmospheric pressure. Being pressed back into the working cylinder after the piston has recovered its return stroke, it is mixed with a small additional amount of steam from the boiler. It thus recovers its tension, and again expands and becomes heated in the working cylinder. Although high temperature is resorted to in this engine, all its working parts are of the ordinary temperature of saturated steam. Mr. Siemens stated that this engine would consume much less fuel than Watt's, and that several engines had been erected in France, Germany, and England, which had hitherto worked very satisfactorily.

RECENT IMPROVEMENTS IN STEAM ENGINES.

Stevens' Improved Steam Boilers.—A patent has been recently granted to J. Lee Stevens, a well known English inventor, for an improved combination of the parts of a boiler by which air is to be more advantageously applied and combined with the products of combustion; the boiler is formed with a water space above the furnace, and above this space there is a return flue through which the products of combustion pass to a chamber called "the igniting box." From this chamber the tubular flue passes to a chamber flue at the opposite end of the boiler. In front of the "igniting chamber" there is a double cover pierced with holes through which streams of air pass, to mix with the products of combustion before they pass through the tubular flues.

New Method of Stopping Steam Engines.—Mr. Dugdale of Paris, France, has invented some improvements in the construction of locomotive engines, applicable in part to marine and stationary engines, which relate to a novel mode of stopping or retarding the progress of locomotive steam engines. In effecting this object, the steam is converted from a propelling to a resisting medium, and thereby suddenly presents an elastic obstruction to the advancing piston in the steam cylinder. Over the steam ports of the working cylinder a slide valve is applied, composed of iron and steel plates attached together, the steel face being to receive the ordinary brass cut-off and supply valve, and the iron face lying close to the planed face of the steam ports. This intermediate valve is so arranged, that when the break is required to be put into action, it shall slide on its seat, and intercept the passage of the steam to the exhausted side of the piston, and permit the steam to be supplied to the opposite side. A cushion of steam will thus be opposed to the advancing piston, and if displaced by the impetus of the engine acting on the piston, a similar obstruction will then be offered to the other side of the piston as it advances, and so on until the action of the engine is suspended. This composite valve the inventor proposes to apply to steam engines generally, using it merely as a valve seat, which, when worn, may be readily replaced, and at little cost.

Heating the Exterior of Steam Cylinders.—*The Glasgow Practical Mechanics' Journal* gives a well attested case serving to illustrate the utility of the "jacket" formerly used to surround the cylinder with steam. A large engine tried alternately with and without steam in the "jacket" required but twenty pounds pressure to perform in the first named case the same labor as required twenty-five pounds in the second.

Improved Packing for the Slide Valves of Marine Engines.—This improved packing is the invention of Mr. Robert Waddell, of Liverpool, for several years chief engineer of the Africa, and other vessels of the Cunard line of Atlantic steamers. In these vessels, and generally in the large English steamers, the D slide valve is used for supplying the steam to the cylinders; the interior of the valve between the ports of the cylinder communicates with the boiler, and the steam escapes to the condenser beyond the end of the valve. The valve is ordinarily packed with a single strip of packing at the back opposite each port of the cylinder, to prevent the steam blowing through into the condenser; but with this arrangement, the total pressure between the valve and the port faces, on which it slides, varies from nothing to several tons in the large engines at different points of the stroke. The result is an unequal wear of the two edges of the port, which have been worn so much out of level in a single voyage across the Atlantic and back, as to cause serious leakage of steam into the condenser, and much trouble in the repairs. The new plan of packing consists in employing two strips, instead of a single strip, one opposite to each edge of the port, a free communication being maintained between the port and the space between the packings. By this means the valve is perfectly balanced, and the pressure between the rubbing faces is reduced to merely the amount required to prevent the steam blowing through, causing a great reduction in the wear of the faces. The new mode of packing is applicable also to single slide valves, and has been tried for more than a year in the Columbian, with complete success.

Horizontal Cylinder Engines.—The horizontal single cylinder engine is gaining ground in Europe on the double cylinder vertical engine. At one time, the great objection to horizontal engines was the excessively unequal wear of the piston upon the lower side of the cylinder; but owing to the accuracy with which pistons are now made, the wear and tear upon cylinders is greatly reduced. In France the consumption of coal per horse power, in the most common steam engines, is very low—only about three pounds, and the makers of them guarantee that they will not exceed that amount. The steam is used at about 50 lbs. pressure on the square inch, and is cut off at one-fifth of the stroke; and, so far as economy of fuel goes, they are equal to an engine with two cylinders, the one for high pressure, and the other for expansion—the well known Wolfe principle.

New Safety Valve.—The following is a description of a new safety valve, recently brought out in England. A small cylinder, occupying the place of the common safety valve, is bolted to the top of the boiler, and it has a small flange on its top, carrying a standard on which is secured the end of a lever working on a pin. In the small cylinder there is a packed piston, having its rod connected to the lever mentioned, a short distance from its jointed end. This lever is extended horizontally forward, and its other end secured to a spring balance. There is a small chamber in which there is a plunger valve inserted in a vertical tube passing down to the bottom of the boiler and open to the water. The rod of the valve is also connected with the lever mentioned. This valve covers the mouth of a bent tube, which passes down into the fire box. The spring balance is set at the pressure to be carried—60 or 80 lbs.—and the valve then covers the tube leading into the furnace. Whenever the pressure in the boiler on the small piston exceeds that at which the spring holds it down, the piston will rise, and also the valve which covers the mouth of the tube leading to the furnace. The superincumbent pressure of the steam then forces the water in the boiler through the tube into the furnace. and extinguishes the fire.

Improvement in the Construction of the Governors of Steam Engines.—In the ordinary steam engines, no provision is made for the control of the engine in case the governor becomes suddenly inoperative. If, by reason of its driving belt or gear giving way, or by other accidental causes. the governor is stopped, it leaves the throttle-valve wide open, and the steam full on the engine. An increase in the speed at once takes place, which often results in doing much injury to the machinery. An invention by John Tremper, of Philadelphia, Pa., has for its object the detachment of the governor entirely from the valve the instant it becomes inoperative, and at the same time to close the valve by means of a spring or weight applied for that purpose, and thus stop the engine. Another object is to regulate the movement of the valve while the governor is in operation.

Improved Engine Connection for Transmitting Motion to Shafts.—An invention for effecting the above purpose, by Thomas Doyle, of New York, consists in the arrangement of two beam engines in line with each other—that is to say, with their beams in the same plane—and with the cylinder ends of the engines contiguous to each other. and connecting their piston rods or beams by an intermediate beam. By this means the two shafts which are parallel with, and at some distance from each other, are caused to rotate at a uniform speed. The main object of this invention is its application to drive two pairs of paddle wheels to propel a vessel. but it may also be used for driving two parallel shafts for other purposes. With the above method of connecting the engines, the cranks of the two shafts are always kept in opposite positions, and when one piston is descending the other is always ascending. This mode of connecting the engines appears to form a simple and effective arrangement for driving two shafts, to which it causes the power to be transmitted equally, if the resistance be equal, or always in proportion to the relative amount of resistance.

Packing Pistons for Steam Engines.—An improvement, patented by J. W. Pettis, of Hillsdale, Michigan, is intended to enable the engineer to tighten the packing of the piston, without going to the trouble of removing the cylinder head, and various other appurtenances. This is done by making the piston rod hollow, and passing a solid rod down its centre to the piston head. The packing is metallic; within the head are four arms, connected by joints at one end with the packing, and at the other with the central rod before named; by raising or lowering the rod, the packing will be loosened or tightened; the engineer, therefore, when he desires to move the packing, merely turns a nut at the top of the piston rod.

Improved Slide Valve for Steam Engines.—In this invention, by E. D. Leavitt, Jr., of Lowell, Mass., the back of the valve is fitted to the cover of the steam chest, between which and its seat it works steam-tight. The improvement consists in a certain method of compensating for the wear of the valve and the two faces between which it works. There is an arrangement whereby the valve is more perfectly balanced than by the ordinary method. The valve is made tapering in a transverse direction, but in a longitudinal direction its two faces are parallel. By thus tapering the valve, one of its sides is caused to have a greater area than the other, and the steam, by exerting a greater pressure on the larger area, tends to force the valve between the faces in which it moves, and thus keeps it always tight.

RECENT IMPROVEMENTS IN STEAM BOILERS.

New Condenser for Marine Steam Boilers and Furnaces.—James Biden, of Gosport, England, has obtained a patent for feeding fresh water to marine steam boilers, which water he obtains by the condensation of the steam after it has been employed in the cylinders of the engines. This he carries into effect as follows: He leads a pipe from the cylinders into the water outside of the ship at one side, and after carrying it round the stem of the vessel, he causes it to enter the vessel at the other side, and open into a reservoir in the hold of the ship. A pipe opens from the reservoir to the atmosphere, to allow any uncondensed steam to pass off. As the steam from the cylinders passes through the water of the ocean outside of the ship, it becomes condensed, and the fresh water thus produced flows into the reservoir, from which it is pumped into the boilers. This invention is really an outside condenser—the ocean being made the grand cooler. The condenser pipe must be set on an incline, to allow the condensed water to flow into the reservoir.

Duppa's Furnace.—An improvement by Thomas Duppa, of France, consists in arranging and combining several upright cylinder boilers in a circle. Each boiler has its furnace at the lower end. At the upper part of each fire-box a series of tubular flues rise to the upper part, where they communicate with a chamber which is surrounded with the steam in the upper part of the boiler. The heated air and products of combustion then pass down from each boiler to the outside of a cylindrical vessel, into which the steam from the series of boilers is conducted, then they pass off to the chimney. The object of this arrangement of boilers is to superheat the steam, and economize horizontal space, by employing a number of vertical boilers instead of horizontal ones.

Safety Boiler Apparatus.—The following is a description of an arrangement recently brought out in England for preventing explosions in steam boilers. The apparatus consists of an elbow-pipe, connecting the furnace with the side flue; it is fixed just below the water level in the boiler, but may be fixed at any elevation, or in any position requisite, and can be applied to any kind of boiler, as an opening into a side or centre flue is all that is required. The pipe is perforated with a number of holes, half an inch in diameter, so placed as to be subject to the immediate action of the furnace fire. In these holes are metal plugs, more or less fusible, according to the working pressure of the boiler. The moment the water in the boiler, from neglect or otherwise, is below the level and leaves this pipe bare, the heat from the furnace acts upon the plugs, which melt, and the steam, oozing through the holes, immediately relieves the pressure in the boiler and extinguishes the fire, thus preventing the possibility of an explosion.

Smoke Consumer for Steam Boilers.—Mr. J. L. Jeffree has secured a patent in England for placing at the back of the fire-box of tubular marine boilers hollow flattened pipes, which communicate, through air flues, with the atmosphere. These tubes become hot and heat the air which flows in to mix with the smoke from the fires, thus supplying it with sufficient oxygen to promote perfect combustion and consume the smoke. It is applicable only to steamers using bituminous coal.

Prevention of Boiler Incrustations.—An invention by Thomas Sloan, of St. Louis, consists in providing a tank or vessel, the upper part of which is in free communication with the steam space of the boiler, and the lower part with the water space thereof. The vessel is furnished with a certain arrangement of pipes and other appliances, by which the feed water is introduced near the top of the said vessel, and caused to descend in a thin sheet through the steam space. During this transit through the steam, the water becomes heated to 212°, at which temperature the mud and other impurities separate and fall to the bottom of the vessel, which is cooler, and there remain, while the purer water above is fed into the boiler. The purifying tank may be cleaned of its deposits without trouble, as often as required. We are informed that this invention renders Mississippi river water so pure, before it reaches the boiler, that scarcely any trouble is experienced from incrustation. —*Scientific American.*

PRESSURE OF STEAM IN BOILERS.

A pamphlet has been published in England, by Mr. Anderson, the well known machinist, on the management of steam boilers, in which he says that the pressure within a boiler is greater than is generally supposed. With a pressure of 50 pounds per square inch, it amounts to 7200 pounds on every part of the surface exposed to the steam, amounting frequently to many thousands of tons in the boiler, thus accounting for the enormous havoc made by explosions. The joints are weaker than the solid parts; good solid plate will withstand from 56,000 to 60,000 pounds per square inch of sectional area—the joints will give way at about 34,000 pounds, which shows the importance of seeing that the rivets and other fastenings are always in sound condition. Mr. Anderson divides explosions into four classes, viz. from want of strength, deficiency of water, heating of plates, and the variety of other circumstances.

GOLD'S AUTOMATIC STEAM HEATING APPARATUS.

There has recently been introduced into the Irving House, New York, a warming apparatus, the invention of Mr. S. J. Gold, of New Haven, which involves a new method of managing the boiler and also of dispensing the heat to the apartments. In parting with its heat steam changes into water, and provision is made for allowing the water to trickle back to the boiler from all parts of the building without difficulty.

We will describe each portion separately, and first the automatic or self-regulating boiler. The ash-pit is closed by a tight-fitting door, and all the air allowed to enter is drawn in through a tin pipe some four or five inches in diameter. The pipe is crooked. It first leads up nearly to the ceiling, next descends nearly to the same level as that of the water within the boiler, and then ascends again, leaving the end open. A connection is made by a small pipe from the lower bend to a point in the boiler somewhat below the proper water level, and the moment the pressure of the steam becomes sufficient to force the water up and fill the bend of the air-pipe, the draught is entirely stopped. As usually operated, the bend is partially filled, and every fluctuation of pressure is followed by a change in the draught, which by checking or increasing the fire restores it to its proper condition. Water may be poured at any time in the open end, and it immediately passes through the small pipe into the boiler. The coal is supplied to the furnace in the usual manner about two or three times a day, and if by any possible carelessness, such as leaving the ash-pit open, too much steam is generated, the only effect will be to throw out at the open end of the air-pipe first a quantity of water, and then all the steam which is generated.

The steam, thus uniformly maintained at the very moderate pressure of one-half pound or less per square inch above that of the atmosphere, is conveyed in pipes of from one to two inches in diameter to all the apartments or halls to be heated. In each room is placed a "radiator," any portion or the whole of which may be made to diffuse heat like a stove, but with less intensity. These radiators consist of broad flat plates set on edge and supported by indentations and rivets. Each is perhaps 6 feet long, 3 feet high, and half an inch thick. The heat is adjusted by hand. There are two cocks at the base of each radiator, one connecting with the steampipe and the other with the air of the apartment. By opening both the steam drives out the air and fills the whole of the thin space; but by closing the air-cock at a proper moment a quantity of air may be retained which by its greater specific gravity fills the lower portion and only allows the upper parts to be warmed. If less heat be required, the steam-cock is shut and the air-cock opened, and in this condition, as the steam gradually condenses, air is drawn in to any extent desired.

The addition of a small cock to permit the steam continually to escape and moisten the air of the apartment, would probably be a valuable improvement; and with this or some similar means of regulating the hygrometric condition of the vital fluid, the apparatus would be nearly all that could be desired.

FACTS IN RAILROAD MANAGEMENT.

The following facts regarding eight of the principal railroads of Massachusetts are developed by the recent reports to the Legislature of that State:—

1. The cost of passenger transportation is 1.062 cents per passenger per mile.

2. The cost of merchandise transportation is 3.095 cents per ton per mile.

3. In passenger transportation $41 98 per cent. of the receipts therefrom are absorbed in expenses.

4. In merchandise transportation $89 52 per cent. of the receipts therefrom are absorbed in expenses.

5. The expenses of railroads are almost invariably determined by the weight carried over the rails. For instance; The Eastern road, upon which passenger traffic predominates, is operated at an expense of $3,670 per mile of the length of the road; whilst the Lowell, upon which merchandise traffic predominates, is operated at an expense of $12,478.

6. The cost of renewal of iron upon railroads is an infallible index of the magnitude of expenses. For the preceding reasons, the cost of that item on the Eastern road is but $390 per mile of the length of the road, while upon the Western it is $1,390.

7. Of the expenses of railroads, thirty per cent. is absorbed in maintenance of way, or road bed; twenty per cent. in fuel and oil; twenty per cent. in repair of engines, tenders and cars; ten per cent. in special freight expenses, and the remainder in passenger, incidental and miscellaneous expenses.

8. The weight of the engines, tenders and cars upon passenger trains is nine-fold greater than the weight of the passengers.

9. The weight of the engines, tenders and cars upon freight trains, is scarcely one-fold greater than the weight of the merchandise.

10. For cheapness, railroads cannot compete with canals, in transportation of heavy descriptions of merchandise; the cost of carrying merchandise upon the Erie canal ranges from two to sixteen mills per ton per mile; whilst upon several of the principal railways of New York and Massachusetts the cost of carrying merchandise ranges from thirteen to sixty-five mills per ton per mile.

COAL BURNING LOCOMOTIVES.

Mr. D. K. Clark, author of the valuable treatise on locomotives known as "Clark's Railway Machinery," states, as the result of recent experiments on English railways, that the perfect combustion of coal and the consequent prevention of smoke in locomotives can be secured by the adoption of very simple means of equalizing the temperature. He employed fire bricks, which serve to absorb the heat when in excess, and give it out when, by reason of a fresh supply of fuel or otherwise, the temperature of the smoke was too low. A pile of fire bricks through which the products of combustion must pass was deposited in a combustion chamber joining the fire box and the tubes, and the hind compartment of the fire box was also arched over with fire bricks. This is known as Beattie's system, and he urges that it is completely successful, and that it raises the efficiency of coal to an equality with coke, pound for pound. The fire brick lining in the back side of the fire box would seem necessarily to prevent the generation of an equal amount of steam in the same time, but the performance of the engine as given in the recorded experiments seems to have been very nearly or quite equal to the average of locomotives burning either of the more combustible fuels, coke or wood.

RAILWAY IMPROVEMENTS.

Loughridge's Self-acting Car Brake.—Mr. William Loughridge, of Weverton, Maryland, is the inventor of a method of stopping a train of cars at the will of the engineer, radically different from any of the several inventions for the purpose heretofore described. The cars are stopped by the friction of the ordinary brakes, but the power actuating them is derived directly from a drum shaft on the locomotive. This shaft, or rather a pulley keyed thereon, is pressed into contact with the flange of the driving wheels, and is thus compelled to revolve and wind up a stout chain running the length of the train. This chain applies the brakes of all the cars. To prevent pulling too severely, and fracturing some portion of the mechanism, provision is made for limiting the extent of its action by causing it to release its hold of the driving wheel so soon as a certain portion of the chain is taken up. The point at which this unshipping movement comes into play is previously arranged by the engineer, so that however excited in view of danger, or careless and bungling, he cannot endanger the integrity of any important part. A somewhat ingenious arrangement is adopted for causing one continuous chain to supply all the brakes. A stout lever, some three or four feet long, is hung under each car, and provided with sheaves or pulleys at each end, around which the chain makes a curve like the letter S, and continues on to the next. When the chain is pulled by the winding of the shaft, this lever is moved by the tension, and forces the brakes into contact with the wheel.

Safety Attachment to City Cars.—Mr. C. Mahan, of Washington, D. C., has recently patented a device for removing obstructions from before the wheels, and thus to prevent the possibility of crushing any unfortunate child or adult who may fall in a dangerous position beneath the car. It consists of a plough-like attachment on each brake which, by the aid of a point travelling in the groove of the rail and provided with two small wheels, one placed horizontally and one vertically to diminish the friction, throws out with a kind of plough-like action every obstacle of whatever nature. In a trial recently made in New York City, the effigy of a man was made up of heavy material so as to weigh 150 pounds, and repeatedly thrown in various positions upon the track, but was in every instance quietly removed without injury to itself or the apparatus. Stones of various sizes were also placed in the grooves and were removed with the same ease.

Railroad Car Springs.—India rubber came quite rapidly into use for car springs a few years ago, but appears now to be going into disfavor. Vegetable gum is not the thing; it is too lively, and dances a car about too much it is short-lived—becoming dead or crushed down to an inelastic mass in a little over a year; it is liable to accident from cracking or bursting open, and it freezes stiff when it is needed most, when the track is rigid with frost, and when the rails, wheels, and axles are brittle as pipe stems. The single elliptic spring, steadily used in England, and the double elliptic, frequently used in our own country, are free from most of these objections, but are more expensive, and occupy more space, as they require to be of considerable length. The friction of the plates of steel upon each other prevents the occurrence of the repeated boundings observed with the gummy supports; and, although slightly stiffer and brittler in severe cold weather, the difference in this respect is not practically appreciable. The volute spring recently patented and introduced by Mr. F. M. Ray, of New York, appears to combine all the qualities desired in a very high degree—being a stout steel ribbon coiled up into as compact a form as a rubber spring, and possessing the frictional qualities desired in the very best degree. The pressure comes upon the centre of the coil, and tends to push it through—an action which not only brings into play to a proper degree all the elasticity of the metal, but, by a happy coincidence, tends to bind the coils of steel together, so that the friction increases with the load. This action, also, by constantly tending to coil the steel tighter when the strain is applied, humors the nature of the metal, which, having its particles compressed, or "upset," on the inner side of each coil in the act of manufacturing the spring, would be soon broken by any force tending to straighten the same. A form of volute spring has also been used to a limited extent for some time in Great Britain; but the American form is understood to be far superior in the form of the ribbon, which is swelled in the middle, instead of flat, before winding up, and in the provision for equalizing its action by allowing it a partial support under its base as the load is increased, so that its action is pretty nearly the same under all loads.

Improved Railway Apparatus for Ascending Grades.—A gentleman of the name of Henfrey has taken out a patent, in Piedmont, for a very ingenious method of carrying railway trains over Mont Cenis, or any other similar mountain pass. A railway, of the usual description, will be laid down in a direct line from the bottom to the top of the ascent. The acclivity in the case of Mont Cenis, will be from one in ten to one in twelve. Between these two rails a canal is to be dug, three feet nine inches in width, and about thirty inches in depth, which is to be lined and made completely water-tight with iron plates of the description called by engineers "boiler plate." The motive power to be employed is a stream of water, about a foot deep, flowing —or rather rushing—down this canal. It is clear, therefore, that an abundant supply of water on the summit to be reached is a necessary condition of the scheme. Mont Cenis, however, affords every facility in this respect. On the outside of the railway another cogged rail will be laid down on either side. On the arrival of the train at the bottom of the hill, the steam engine, which has so far brought it on its journey, will be exchanged for a machine of a very simple and far from costly construction. In the middle of a frame, about the size of an ordinary steam engine without its tender, a water wheel, adapted to the above-described canal, will be fixed, having a diameter of twelve feet. On the same axis will be fixed two cogged wheels, to work in the cogged rails, of six feet diameter. With this apparatus it seems clear that the descending stream must force the water wheel to make revolutions towards the top of the hill, and to carry round with it the cogged wheels in the same direction. As the diameter of these is to be half that of the water-wheel, the rate of ascent will, of course, be half that at which the diameter of the water wheel moves. It is calculated that the latter speed will be ten miles an hour, and the former therefore five. It is further calculated, that a machine of these dimensions will carry up the proposed acclivity a weight of from fifteen to twenty tons, or say from sixty to eighty passengers. Should it be required to transport a greater weight, as many other such engines may follow each other, at intervals of 150 feet, as may be required. Reckoning the ordinary present rate of travelling up the mountain at two miles and a half an hour, and considering that the direct rail will, between the bottom and the top, traverse a space not more than half the length of the winding post road, it will be seen that the ascent will be achieved in one quarter of the time now occupied. For the *descent*, the water wheel, moving through and against the stream, will act as a restraining force to moderate and regulate the speed.

Improvement in the Manufacture of Railroad Rails.—Mr. W. Bayton, of Staffordshire, England, has patented a highly important improvement in the manufacture of T rails, by which it is claimed that the base, or flange, of the rail may be made at once from ordinary puddle iron, instead of from re-heated, as at present; or by using the same quality of iron as is now employed, the rail may be made with a much deeper web and wider flange than is now attainable, while the loss from cutting up rails with torn flanges, patching, &c., is wholly avoided. For this purpose differently shaped grooves are employed in the rolls, both roughing and finishing. The pile, in passing through the rolls on its flat, is made to present on both its upper and lower surfaces (which are subsequently to become the head and flange of the rail) a hollow and concave, instead of a plane and straight surface; which hollow concavity is filled up by the iron displaced from the throat of the rail in finishing it on its edge. A much more regular draught is thus obtained, and all danger of ripping the flange avoided.

Railway Wheels.—S. Sudbrook, of London, has recently obtained a patent for an invention which consists in forming the periphery or outside edge of railway wheels with wood, forced and pressed into and between suitable plates and chambers in such a manner as to form a very hard and compact surface, with the end of the wood so placed as to run on the rail; it is the same application of wood to the tread of railway wheels that has been applied to the bearing boxes of shafts.

Iron Block Railway Chair.—Mr. Stephen Reed, of England, has directed his attention to the construction of iron railway chairs and sleepers, to be substituted for wood. In lieu of only a 4-inch bearing of the ordinary rail upon the sleeper, the bearing is increased to 21 inches, with permanent stability so insured at the joints, that three chairs are enabled to be fixed instead of four, now required, according to the old method. Mr. Reed's block chair of cast iron spreads so as to occupy a resisting surface of 462 inches superficial, being 22 inches long by 21 inches in breadth, ⅝ in. in thickness, and turned up with a margin ⅝ in. high. The boss which carries the chair is hollow; the sides and brackets are ⅝ in. thick; the 21-inch bearing is ½ inch thick. The weight of the joint chairs is 1 cwt. 1 qr. 7 lbs. each, and that of the intermediate chairs 1 cwt. 0 qr. 26 lbs. The weight and size, however, can be modified according to circumstances. This system requires neither spikes, tie-bars, wood pins, nor screw bolts. The permanent way may be made even of sand in the absence of ballast, and the chairs, once imbedded, will continue firm and undisturbed in wet weather, or during frost or thaw. By a judicious arrangement of the permanent way, and the formation of a bed of sand below the sleeper, all rigidity is removed, and a smoothness of transit is afforded for the trains, which very considerably tends to the diminution of the tear and wear of the rolling stock. Time has tested the value of this mode of construction, it having been extensively used in the north of England. Timber laid lines require re-laying almost periodically, and although the cost of the iron chair in the first instance may be greater than wood, on the ground of durability, the advantage in the long run is with the iron sleeper.—*London Mining Journal.*

New Girder Rail.—A new girder rail has been invented by Mr. W. B. Adams, of London. It is similar to the ordinary one, but two inches deeper, being seven instead of five inches. There is a flange at the top and bottom, and on each side angle brackets, one side of which fills up the space between the flanges, secured to the rail by bolts, the other extends outwards, forming a sort of longitudinal shelf at each side, level with the ballast, so that when packed, all that is seen is two and a half inches rising above the brackets. These form a secure bearing of thirteen inches wide. The ballast is packed from each side, and thus secures the permanent way. The gauge is kept correct by the rods, about nine feet apart, no wooden sleepers are employed, and the entire rails and appendages, consisting of rails, brackets, bolts, and tie-bars, are of wrought iron—the whole, when complete, forming one compact mass. This rail is expensive at first, but is said to be the cheapest in the end, enduring longer and requiring less repairs.

Cast Iron Sleepers for Railways.—An improved cast iron sleeper, the invention of a Mr. H. Greaves, of England, has been applied with success of late on many of the English and continental railways. The form of the sleepers is semi-spherical, which thus admits of the smallest amount of metal for a given strength. Those intended to receive the tie-bars are cast with an opening through them, and the ties have but to be keyed to secure the rails firmly at the proper distance apart. These sleepers, by this method of tying them, are suitable for any gauge, and allow of the rails being laid with remarkable facility. The chairs to receive the rails are so formed as to allow of the removal of a defective or worn out rail, without disturbing the sleeper. The oscillation of rails causes the wear and tear of locomotives and cars, but these sleepers are stated to preserve the rails perfectly firm, and as not being liable to spring like wooden ones. As these sleepers have a broad base, they tend to impart solidity to the whole track. The rails are fastened in the chairs with wooden keys; each sleeper weighs 100 lbs., and is buried a considerable distance in the ground, which, with its great breadth of surface, tends to prevent all lateral motion.

Excluding Dust from Cars.—The following is a device of Joseph Woods, of Jersey City, N. J., for excluding dust from railway cars. He incloses all the open space below the car with lattice work, arranged like the lattices of common Venetian blinds. The inclosure extends from the base of the car down as near to the ground as safety permits, the wheels, &c., being covered in.

The inventor alleges that the dust is raised by the air which rushes in to fill the vacuum occasioned by the rapid passage of the car, as it sweeps over the surface of the ground. It is also said, that the lattice-work serves to cause a suction from both sides inward, underneath the car, and that the two currents of air, when they meet, unite, and rush backwards to the rear end of the train. The dust, as fast as it rises, is thus drawn in beneath the cars, carried back, and discharged at the rear. The improvement is applicable, at very small expense, to all of the ordinary passenger cars.

Railway Night Signals.—The following improvement in night signals has been introduced on the South Western Railroad of England. Two lights, one red and the other white, are to be fixed to an arm at a certain distance from each other, and at a certain angle, and to be connected with the axle of one of the wheels of the last carriage of each night train, and caused to revolve by the motion of the train. The speed at which they turn will be governed by the speed of the train, which it will also indicate, to warn and guide the drivers of trains coming after. The present lights on railway carriages can at a distance be scarcely distinguished from fixed lights, and it is impossible at times to guess, until a collision is imminent, whether the light seen ahead is the one attached to the first or last carriage of a train, and consequently whether the train with such a light is coming towards or going from another. To obviate this inconvenience and danger the revolving lights will be most effectual, for even if a train is stopped and the revolving lights are at rest, the angle at which they are placed will render them distinguishable and easy of recognition.

HOT AIR LOCOMOTIVE.

Captain Phineas Bennett, of New York, is the inventor of a new locomotive constructed within the last few months, and which has been tried to some extent on the New York and Erie track, but we regret to say so far without any strong prospect of final success. It is a full sized, very handsomely finished engine, with two pairs of six feet driving wheels adapted to the broad 6 feet gauge, and is driven partly by air and partly by steam, the two elements being mingled together and worked off in the usual manner by the aid of cylinders and pistons. The steam is generated in a stout chamber immediately over the fire, the water being kept up in the usual manner by a force pump connected with the machinery. The air is heated *by passage directly through the fire.* It is in fact the same air which usually enters the fire through the grate to support combustion, and which usually escapes, highly heated, through the chimney. In order to make this heat available in impelling the engine, this air is compressed to a high tension, and forced in under the grate by a large pump connected directly to the piston-rod, and is not allowed to escape into the chimney until it has passed through the cylinder and impelled the piston. By this means all the expansion due to the change of temperature serves to develop power in the propulsion of the machine, and if, as is the case in fact, the mixture of steam and heated air be cut off early, and consequently be worked very expansively in the cylinder, so as to reduce it nearly to the pressure of the external atmosphere, the gain due to the use of the air is very considerable. One great evil arising from this arrangement is the too high temperature of the air. It was contemplated to overcome this by diluting it with a greater or less quantity of equally compressed air not passed through the furnace, and also by showering upon it a small quantity of water, which, by absorbing the heat and changing to steam, would cool the gaseous matter, and would itself impel the engine in the usual approved style. These latter features are new, we presume, and peculiar to the inventor, but the use of smoke or air heated in this manner has been treated before, and like Ericsson's, abandoned as impracticable, although affording undoubtedly some degree of economy over the yet triumphant steam. The difficulties experienced in former trials arose from the scratching and destruction of the interior surface of the cylinder, and in spite of all the precautions described, the same difficulty exists in the machine under notice, to such extent as to render its success extremely doubtful unless some new expedient can be adopted either to free the gases from particles of coal and grit, or more efficiently and constantly to lubricate the working surfaces. In short, the results so far have demonstrated that, as has been the case with all previous efforts in this direction, the saving in fuel by the introduction of heated air, has been far more than counterbalanced by the increased expense and rapid destruction of the machinery.

LEE AND LARNED'S STEAM FIRE ENGINE.

A new steam engine, differing in almost every respect from all others within our knowledge, has lately been constructed in New York, and several times exhibited with apparently the most complete success.

As originally constructed the steam could not be kept up to the proper point, but rapidly declined whenever the full power was applied, so that its performance resembled that of the usual man-power machines, requiring intervals of rest. This difficulty has now been overcome by fixing a grate in the furnace, an addition not previously supposed necessary with wood fuel, and it is now able without any artificial draught to generate steam as fast as it is consumed, while throwing to a great height a steady stream through a one and a quarter inch nozzle for a half day at a time. Messrs. Wellington Lee and J. G. E. Larned, of New York, are the inventors of this combination, the whole of which weighed, before the grate was added, but 6,500 lbs., and is designed to be easily and rapidly hauled in any ordinary condition of the streets by two horses, without assistance from the firemen.

The boiler is of course the most important element in the combination. This is the invention of Mr. Larned alone, and consists almost entirely of tubes through and around which the flame is carried in such a manner as to generate steam in the most rapid manner possible. It is common to employ tubes to a great extent in steam boilers, the same serving in some instances, as in the common locomotive, to carry the flame through the water; and in others, as in some ocean steamships, to carry the water through the flame. Either plan presents great heating surface, and when, as in the barrel of a locomotive boiler, the space is nearly filled with tubes, and the quantity of water is consequently small, steam is generated very quickly, and supplied very efficiently. There is an additional advantage, however, growing out of the use of tubes in the other form—containing the water inside; this is the diminished danger in case of explosion. The rupture of a small tube is of little moment, so far as danger to the surroundings is concerned, and it is for this reason that Mr. Fisher, the great modern advocate of steam carriages, makes his boiler a mere cage of tubes with the fire in the inclosed space. The boiler now under notice is a compound of both. A wall of upright tubes, tightly packed together, surrounds the fire, while above the furnace the flame acts both on the inside and outside of a double tube. By a double tube is meant, in this case, a large tube inclosing a small one; the annular space between being filled with water, and the whole provided with every facility for rapid circulation by receiving water freely, laterally, and from below. A strong water bottom, liberally punctured with short tubes to supply air to the fire, and a large chamber above to separate and dry the steam, completes the description of this boiler, which is probably the most powerfully efficient, for its size and weight, in the world. Economy of fuel, the great point aimed at in most steam apparatus, has been entirely set aside in this construction, and although from its arrangement the amount consumed is not probably excessive, the whole end and aim is attained in a boiler, light, strong, and durable, which will generate dry steam at a high pressure with the greatest possible rapidity. The time elapsing between the lighting of the fire and the starting of a vigorous stream has varied from ten to twelve minutes, so that steam would probably be raised while the machine was being hauled a mile.

A steam fire engine must embrace three distinct parts, the boiler, the engine or engines, and the pump or pumps. The machine under notice employs two of Reed's patent oscillating engines, one of the simplest forms known, both connected at right angles to the same crank. The shaft requires no balance-wheel, but is keyed directly to a large and strong rotary pump, Carey's patent, the effect of which is to force a continuous stream of water through the hose without racking the machine or exhibiting violent action of any kind. With dry pine fuel, little smoke or other annoyance is experienced; and as a means of subduing extensive fires, or all such as cause a signal of general alarm, the steam machine may be considered as having to a great extent established its reputation.

THE DRAINAGE OF THE LAKE OF HAARLEM.

M. D'Endegeest, President of the Commission for the Drainage of the

Haarlem Lake, has published a final report on the condition of the enterprise. The total expense of the undertaking, from 1839 to 1855 inclusive, has been 8,981,344 florins; the revenue proceeding from the land redeemed and sold is estimated at 8,000,000 florins. The land was at first valued at 200 florins per hectare (2,471 English acres). Subsequent examination proved that the soil laid bare by the draining operations was of far greater value than was originally supposed. Thus in 1853, 784 hectares brought 575,000 florins, or 733 florins per hectare; and though subsequent sales have not realized such large prices, yet the land commanded a much higher price than the first valuation. "This result," says M. D'Endegeest, "surpassed all expectation, inasmuch as the grand object of the drainage was rather to put an end to the encroachments of the lake, than to make a lucrative speculation of it." It is stated that a great number of farms are springing up on all sides, and that the cultivation of the rich land is affording employment to many hundreds of laborers. The total amount of land available for agriculture is estimated at 18,000 hectares; and by proper care and supervision it is confidently expected that no water overflows will take place.*

BEARINGS FOR JOURNALS.

Boxes composed of brass, or of brass lined with soft metal, have long been used for supporting revolving shafts, but of late years iron boxes have been considered by many nearly as good, if kept well oiled. The very latest change seems to be a tendency to go back to the still more ancient practice of employing hard wood as the material for this purpose. The British steamer Himalaya, having had the old brass bearings removed, substituted lignum vitæ bearings to her screw shafting, which have operated much better. A correspondent of the London Artisan thus describes the results of their application:

"Since the application of this material the vessel has run about 30,000 miles, during which time the engines have made about 8,000,000 revolutions. The total wear down in the stern post does not exceed $\frac{1}{8}$ inch, which is, of course, very trifling for the work done. The screw shaft is lined with brass at the part bearing on the wood, and this bearing is 18 inches diameter by four feet long. The lignum vitæ is inserted into the cast iron stern pipe in segments, each piece being the whole length of the bearing, and about 3 inches wide by $\frac{3}{4}$ inch thick, so that the segments combine into the form of the pipe, in a somewhat similar way to the staves of a cask. The abutting edges of these segments are rounded off to form water-ways, and their surfaces are also scored in several places, to allow a free circulation of water on every part of them. These segments are prevented from running round with the shaft through its friction by a strip of metal, which is pinned on to the upper side of the stern pipe, and against the edges of which the lignum vitæ segments abut. They are kept in at the inner end by a shoulder in the stern pipe, and at the outer end by a ring, which is screwed on to the stern post."

* See Annual of Scientific Discovery, 1853, pp. 31–34.

The question has also been recently tested in New York, on a small scale, by running a shaft with one end between wood and the other between brass bearings, both equally loaded by levers like safety valves, and covered with water to insure coolness. During 18 hours the brass wore off about 1-16th of an inch, while the wood had not worn to any extent that was appreciable. It is now being tried with a harder kind of brass.

PERRY'S VALVE MOTION.

The engines employed in the screw propellers on our Upper Lakes have usually been single high-pressure cylinders, mounted perpendicularly over the crank, but this style is now giving way for the introduction of the more compact oscillatory. An extremely simple valve-motion for this style of engine has been lately devised by Mr. H. O. Perry, and which has become very popular. An oscillating engine is hung on trunnions like a cannon, and its rocking motion as the crank revolves seriously deranges all the usual methods of working the valve. Mr. Perry employs a rotating or partially rotating valve, serving its purpose in a manner precisely similar to the ordinary slide-valve employed on locomotives and small stationary engines. The ports are arranged as usual, but the cylinder-face, on which the valve rests, is curved instead of flat, and the valve is in short a slide bent to fit the cylinder-face. These curved surfaces form a portion of a true cylinder, and the desired sliding motion is obtained by partially revolving a shaft which extends along its axis. It must be understood that this shaft extends across and not lengthwise of the main working cylinder, and projects at the side rather than at the end of the steam-chest. On the projecting portion of this shaft is a swell containing a socket in which the starting bar may be inserted for working by hand, and also two arms extending in nearly opposite directions, with a wrist-pin at each extremity. By connecting one of these wrist-pins to any fixed point the rocking of the cylinder gives a motion to the valve which would be exactly the motion desired except for the absence of what is technically termed "lead." To obtain just the proper motion the pin is connected by a suitable rod, not to a fixed point, but to a small excentric on the main shaft, the excentric being keyed in such position as to give the lead, or in other words, make the valve uncover the port and admit steam to the cylinder a little before the commencement of the stroke. In backing the engine this rod is thrown out of use, and the other wrist-pin is connected in a similar manner to another excentric, by which means a perfect reverse motion is obtained.

The great simplicity of the arrangement will at once be obvious. A steam-chest of little more than the ordinary height, with a slight shaft protruding through a stuffing-box in its side, a couple of short arms thereon (that extending upward being somewhat the longer to compensate for the increased motion of that point, due to its greater distance from the line of the trunnions), and two excentrics, with suitable excentric rods and hooks connected together, constitute the whole of this ordinarily complex apparatus. The overhanging end of the rocking shaft being of considerable length an additional support is usually provided, consisting of a suitable arm rising from the trunnion.

THE FRENCH FIELD HOSPITALS, OR AMBULANCES.

The word *Ambulance*, or field, or flying hospital, is very familiar to most of our readers; but many are, perhaps, not aware of the actual manner in which these hospitals are organized and conducted.

The principle upon which the whole arrangement rests is that the medical officer—viz. the scientific man, should not be harassed with anxiety about stores and packages, and that those matters should rest entirely with responsible agents, whose duty it is to attend to his directions, within the limits of the regulations. Hence we have the following practical divisions:—

The medical officer at the bedside is invested with the whole control and management of his patient. The pharmacien, upon the surgeon's prescriptions, prepares the medicines; the clerk sees to the procuring and proper use of the required articles of furniture, and to the carrying out of the diet cards filled up by the medical officer; the ward attendant takes the immediate charge of the sick or wounded man; the Sisters of Charity and chaplains aid in the work of benevolence and kindness; the assistant-commissariat officer, who receives orders from his superior, watches over the management of the whole; and the regular working of all these secures a perfect unity of action.

The ambulances, temporary hospitals, and convalescent depôts are intended, during a campaign, for the reception of the wounded or sick soldier. If the seat of war is too distant from the frontier of France, where hospitals are organized for the reception of the sick or convalescent, an eligible locality is chosen for the erection of temporary hospitals; hence the great central nosocomical establishment of Constantinople. Now, these various modes of relief for the soldier—viz. the ambulance, the temporary hospital, the convalescent depôt, and the permanent hospital, have each a peculiar organization.

The ambulance is the movable hospital which follows the army in all its movements. There are ambulances for the infantry, and others for cavalry all connected with the different divisions. At head quarters there is, besides, a reserve of surgeons, and two ambulances of infantry and one of cavalry, always ready to go forward at a moment's notice. It was important, in order to insure lightness and rapid movements from one place to another, to arrange the packages so that they might not prove cumbrous under any circumstances. Everything must, therefore, be reduced to the least volume, and all the requisites for dressing wounds are disposed in panniers, the weight of which is so calculated as to suit the strength of the pack horse, in case the usual wagon breaks down, or cannot be got through a difficult country.

Only five carriage boxes are allowed for the reception of the following articles:—amputation and trephining cases, tents, litters, splints, solidified broth, brandy, linen and lint, medicines, &c. These five boxes or cases constitute an infantry ambulance, and provide 8900 dressings. Three cases, with 4900 dressings, form a cavalry ambulance. These ambulances are subdivided into active and reserve sections. The reserve section, which comprises two cases for the infantry, and 3500 dressings; and one case, with

1500 dressings, for the cavalry, remains generally with the wagons attached to the corps, and is kept ready to supply the active section with any article that may be wanted. The latter is again subdivided into ambulance depôt and flying ambulance.

The depôt ambulance settles down at a convenient distance from the battle-field, and the attendants immediately take down the cases from the wagons, prepare the linen, lint, dressings, &c. They light a fire, and immediately make, with their solidified broth, a good saucepanful of soup. This is called the precaution soup, and thus they have at once what we should call beef tea for the wounded. Everything being thus prepared, a red flag is unfurled, to apprise the wounded men where they can get relief. The flying ambulance goes, in the meanwhile, to the immediate rear, within the enemy's range, to attend to the men who receive dangerous wounds. At the same time clerks, under the command of commissariat officers, and accompanied by medical officers, proceed along the lines, and cause the wounded to be taken up by the attendants and the drivers. This latter arrangement is especially intended to prevent the soldiers from yielding to compassion, and succoring their fallen comrades, no man being allowed to leave the ranks, however desirous of aiding the wounded.

The ambulances just described are called the European ambulances, but there is another kind, called African ambulances, which latter have been instituted to serve in countries devoid of roads and destitute of accommodation. An ambulance of this kind, calculated for a corps of 10,000 men, contains 6500 dressings, and requires 364 pack mules. Twenty-four of these carry iron litters, on which soldiers who have had a limb amputated may be placed; and 250 carry little arm chairs made of iron and leather, which may be unfolded, slung, and fastened to the pack saddle, and will take a patient on each side of the mule. The rest of the mules carry the casks of diet drinks, the stretchers, the blankets, the leather covers for the sick, the tents, the surgical boxes, the cases containing the drugs, &c. Sixteen medical officers, seven clerks, and 104 attendants on the sick or wounded, are attached to this ambulance, which is mainly intended by its fleetness for vanguard service, and for picking up the wounded on the field of battle. Both the European and African ambulances were used in the Crimea with the best effects.

Light carts have also been sent to the seat of war. Three wounded men can be accommodated on the front seat; there is a case behind, properly secured, which is so made as to contain two stretchers; and boxes, surrounded by wire work, are intended for the guns and sacs of the soldiers.

Such are the characters of the ambulances, the peculiarity of which is to move rapidly from place to place, and to be ready for all the emergencies of war.

DEVELOPMENT OF HEAT IN STEAM BOILERS.

The editor of the Railroad Record thus describes the results of some experiments undertaken by him, for the purpose of testing the alleged rapid development of heat in steam boilers when covered according to Harshman's method with a loose copper casing. He says:—Our boiler is an upright tubular one, with flues of one inch opening each. The boiler was thoroughly cleaned and put in the best possible order. The engineer was then directed to run for one week, carefully weighing his coal, as well that used in getting up steam as the consumption to do the work. The result of the week's experiment was an average of 750 lbs. of coal consumed per day, the quantities varying from 25 to 50 lbs. per day according to the work to be done. We should here state that the engine had also been put in good repair. At the expiration of the week, having satisfied ourselves of the average consumption, we directed the copper casing to be tied around the boiler; the engineer continuing as before to weigh carefully the fuel consumed.

The result of the first week's consumption after the copper was put on was 475 lbs. per day. The second week and each succeeding week showed an average of 450 lbs. per day. The consumption of fuel and the comparative advantages gained by the copper covering, would therefore be represented as follows:

Consumption without copper casing	750 lbs.
Do with copper casing	460 ,,
Saving	300 lbs.

or 40 per cent. of the ordinary consumption of fuel in the furnace.

This result was to us, who paid the coal bills, highly satisfactory. But apart from its economy, it presents an interesting subject for consideration. That a steam boiler does not radiate 40 per cent. of the heat received must be evident. If it did, inclosing the boiler in wood or other non-conducting substances would show an equal saving in the consumption of fuel. Yet such is not the fact. We are informed by practical men that a wooden case effects a saving of from 5 to 10 per cent. It is also stated that a sheet iron casing will effect about an equal saving. The saving of 40 per cent. by a copper casing wrapped loosely around the boiler is a fact for the consideration of the curious and philosophical.

BLANCHARD'S TIMBER BENDING PROCESS.

By Blanchard's timber bending process (see Ann. Sci. Dis. 1855, p. 38), now effectually proved and established, it is stated that the strength of the wood is increased at least seventy-five per cent. at the point where strength is most required. The curve, moreover, never relaxes. The timber, as in the old process, is first subjected to the influence of steam, which softens the whole mass, and puts it in a fit state for the action of a machine. The principle of bending, as employed in this new application, is based on end-pressure, which, in condensing and turning at the same time, destroys the capillary tubes by forcing them into each other. These tubes are only of use when the tree is growing; and their amalgamation increases the density of the timber, the pressure being so nicely adjusted that the wood is neither flattened nor spread, nor is the outer circumference of the wood expanded, though the inner is contracted. Now, the error of the former process, as expounded by competent judges, has arisen from the disintegrating of the fibre of the wood by expanding the whole mass over a rigid mould. Wood can be more easily compressed than expanded; therefore, it is plain that a process which induces a greater closeness in the component parts of the piece under operation—which, as it were, locks up the whole mass by knitting the fibres together—must augment the degree of hardness and power of resistance. The wood thus becomes almost impervious to damp and to the depredations of insects, whilst its increased density renders it less liable to take fire; and the present method of cutting and shaping timber being superseded, a saving of from two to three-fourths of the material is brought about. The action of the machine throws the cross grains into right angles; the knots are compelled to follow the impulse of the bending; the juices are forced out of the cells of the wood, and the cavities are filled up by the interlacing fibres. In the same way, you may sometimes see in the iron of which the barrels of muskets are made, a kind of dark grain which indicates that the particles of the metal, either in the natural formation or in welding, have been strongly clenched in one another. These specimens are always greatly valued for their extraordinary toughness, as well as for a certain fantastical and mottled beauty.

Another of the good results of this new method is, that the wood is seasoned by the same process as that which effects the bending. The seasoning of the wood is simply the drying of the juices, and the reduction of the mass to its minimum size before it is employed, so that there shall be no future warping. The compression employed in the process of bending at once expels the sap; and a few hours are sufficient to convert green timber into thoroughly seasoned wood. Here is an obvious saving of time, and also of money, for the ordinary mode of seasoning, by causing the wood to lie waste for a considerable period, locks up the capital of the trader, and of course enhances the price to the purchaser. Time also will be saved in another way, in searching for pieces of wood of the proper curve, for carrying out certain designs. An English engineer (Mr. Charles Mayhew) remarks that one of the advantages of the American method is that, "in its application to all circular, wreathed, or twisted work, it not only preserves the continuous grain of the wood, which is now usually and laboriously done by narrow slips of veneer glued on cores cut across the grain, with many unsightly joints, ill concealed at best; but it will materially reduce the cost of all curved work, which now varies according to the quickness of the sweep, and will give the artist greater freedom in his design, by allowing him to introduce lines which are now cautiously avoided in order to prevent the cost of their execution."

IMPROVEMENTS IN STEAM PUMPS.

Ball's Steam Safety Pump.—This is a contrivance for making the supply of feed water in a steam boiler self-regulating. The pipe through which the steam is received for impelling it is connected with the boiler at just the level where the water surface should be. When the water rises too high the pipe takes water instead of steam, and as the contents are compelled to travel through cocks nearly closed, so little of the heavy fluid passes in any given time that the pump works very slowly; but the moment the water gets a little low, so that steam is supplied, the superior ability of this subtle fluid to crawl through small passages guarantees a liberal supply, and the pump works rapidly. Whether it be steam or water which comes from the boiler, it is alike discharged into a feed heater, together with the additional water required, and is finally pumped back into the boiler at a temperature nearly up to the boiling point.

Holly's Elliptic Rotary Pump and Steam Engine.—In this invention the principle is that of two gear-wheels meshing into each other within a tight case, and bringing up at each revolution as much water as can be contained in the cavities between the teeth; but there are several points in which it differs from this ancient device, one of which is the giving of the gear-wheels substantially an elliptic form, the points, so to speak, of one touching against the flat or rather the *hollow* sides of the other, and *vice versâ.* The whole is ingeniously and carefully packed, especially when to be used as a steam engine, and a very novel idea is adopted in working the steam condensingly when the steam engine and pump are intimately connected. For this purpose the exhaust steam, instead of being discharged into the atmosphere, is turned into the suction-pipe, where it is instantly condensed, and all the suction or vacuum there existing is felt on the exhaust side of the pistons to aid the working of the engine.

IMPROVEMENTS IN GRATES AND FURNACES.

Novel Fire Grate.—By B. F. Foering, of Philadelphia, Pa.—Certain kinds of anthracite coal, when burned in stoves, produce a clinker, or lava, that adheres to the sides of the stove, or fills the interior, and prevents good combustion. The clinker generally forms at the lower part of the fire. If there were any means of holding up the fire so that the ash grate could be removed, the clinker stuff might all be easily taken out from below at pleasure. At present, the clinker cannot be well removed until the fire is extinguished, and it is then hard, flinty, and liable to injure the lining of the stove in being broken off. This improvement is intended to remedy the above defects. Apertures are made in one side of the stove, just above where the clinkers form, and through these holes suitable bars are introduced; when the bars are pushed in they form a temporary grating, which supports the fire while the ash grate below is taken out for the removal of the clinker refuse.

Crampton's Improved Furnace.—T. R. Crampton, of London, has patented an improvement in locomotive and other boiler furnaces, which consists in employing a series of flat bars arranged transversely in a furnace of a steam boiler, one bar below another, and somewhat forward of each other, thus producing a shelving grating, with spaces for the passage of air horizontally between the bars. At the lower part of such series of shelving bars is a series of ordinary fire bars, which receive the well ignited fuel descending down the shelving bars, and which are so connected with an axis as to allow fire to be dropped upon them when desired.

Improvement in Smelting Furnaces.—A patent has been taken out in England, by Mr. A. Jenkins, for the following improvements in the above-named furnaces:

The principal feature in the improved reverberatory furnace is, that one fire serves the double purpose of reducing and calcining the ore. The fire is contained in an ordinary fireplace situate at one end of the double furnace. The gases and flame from this fire pass through a lateral opening or flue into the reducing or flowing furnace, and, after passing over the surface of the ore contained therein, enter by another opening or openings into the calcining furnace, which is placed upon the same level, or nearly so, with the flowing furnace, the gases passing off by a suitable flue or flues to the chimney. In the passage or passages which conduct from the flowing furnace to the calcining furnace there are placed suitable doors or dampers, which are so arranged that by opening or closing certain of them, the gases or flame may either be directed into the calcining furnace or cut off and turned into a waste flue leading to the chimney.

Spence's Furnace for the Consumption of Smoke.—In this furnace, invented by Messrs. Spence & Sons, of Boston, the smoke and gases, when the furnace damper is closed, are kept revolving directly over the fire in a large dome, and can escape only through a tapering tube, the bottom of which is very near the fire, and only one and a half inch in diameter. It is evident there must always be a slight escape of smoke and gases to keep up a draught to the fire; but this tube, being so small in diameter, allows only enough to escape to keep up the draught; the remainder of the smoke and gases is consumed. The power and economy thus gained are surprising.

MACKENZIE'S BLOWING MACHINE.

The blowers now in use are of two classes: the bellows and the fan. The fan blower in various forms and proportions is driven at a high velocity, and drives a large volume of air with a force sufficient for ventilating mines or buildings, blowing away the chaff in winnowing grain, or enlivening the fires of a blacksmith's open forge. But where the air is to be driven with any considerable pressure or force, as in supplying divers at considerable depths in the sea, or blowing blast furnaces for making iron, some form of the bellows or of the pumping cylinder is almost invariably employed. The interior of a blast furnace is filled some forty feet in height with a mingled mass of ore, coal, and limestone, and the blast forced in near the base requires a pressure of from one and a half to nine pounds per square inch to rise through it. Fan blowers rarely yield a pressure of more than from three to ten ounces per square inch, but the pumping cylinder may compress the elastic fluid to any extent desired. The fan is, however, much smaller and cheaper—a fact which has induced an attempt to increase the pressure by blowing from one fan into another, thus raising the pressure a few inches with each lift. This is an English plan, and the effect observed was an increase of pressure pretty nearly equal for each fan passed through. In this country our blast furnaces are generally blown by pumping, and our cupola furnaces, which require less pressure, by fans.

Mackenzie's blower includes two cylinders placed excentrically, one within the other. The outer one is fixed, but the inner revolves, and in doing so protrudes blades or wings to such an extent as always to just wipe the interior of the first. The ends being closed, and two liberal openings made in the sides of the external cylinder, the air is drawn through one opening and expelled through the other, whatever may be the degree of resistance interposed.

The fixed cylinder or external case of a blower at Hoe's foundry, in New York, is forty inches in diameter, and thirty-six inches long. The internal cylinder is thirty inches in diameter, and carries three wings of half-inch boiler iron. The centre on which the internal cylinder revolves is five inches from the true centre of the case, and the surfaces, consequently, are in contact at one point, while on the opposite side they are ten inches apart. The protrusion and withdrawal of the wings is performed by a very simple device, in which consists the chief novelty of the invention as compared with other winged rotary devices. The inner cylinder is penetrated by a fixed shaft, which shaft is bent to one side after passing through the end until it coincides with the centre of the large cylinder or outer case. To this portion of the fixed shaft the wings are connected, and their extremities are thus made to travel in a perfect circle in close contact with the inside of the outer case. The inner cylinder thus gives motion to the wings, and in every revolution its periphery is slid outward and again contracted upon them. It is not strictly true that the wings are thrust outward and withdrawn, although it is so relatively to the inner cylinder. The passage of the wings through the latter is packed in a very ingenious and perfect manner, to allow for the varying angle which it continually assumes, and the whole machine appears to involve but a moderate degree of cost, either for construction or repairs. The inlet and outlet openings are made, of course, near the point where the two cylindric surfaces are in contact; and the blast of wind is very nearly steady and continuous, a slight fluctuation of pressure occurring with the commencement of each wing to cross the delivery opening. This fluctuation is due to the regurgitation or back flow of the air until the space between the wings is compressed to the extent required for delivery. The air in the blower at Hoe's is compressed to about one pound plus of pressure, and the variation alluded to in the intensity of the blast, is too slight to be any annoyance. The blower described is driven about seventy-five turns per minute, and requires only from one-fifth to one quarter the power formerly consumed in obtaining the same effect from a very large and well constructed fan.

Cooper's Improved Blast Pipe.—Mr. W. E. Cooper, of Dunkirk, N. Y., has introduced a form of blast nozzle which has been applied to several engines on the New York and Erie Railroad with great success. It has heretofore been common to discharge the steam into the chimney through a round opening. Mr. C. simply forms it into a ring or annular passage, so that the escaping current presents a great surface both on its exterior and interior sides to act on the smoke and drag it up the chimney.

IMPROVEMENTS IN GEARINGS AND BEARINGS.

New Frictional Gearing.—Where high speed and little force are required in transmitting power from one wheel to another it is common to provide no teeth, but simply to let their smooth surfaces rub together. A Mr. James Robertson has lately introduced in Scotland a "grooved surface frictional gearing" similar to the above, except that the surfaces are let into each other in grooves. Messrs. Dron and Lawson, of Glasgow, are using this gearing with great success in driving large planers, as it never slips, and is particularly well adapted to easy reversing, &c.

Leather Bearings for the Axles of Carriages.—A recent English patent proposes to use bearings of leather in the place of metallic bearing surfaces; the object being to render the bearing surfaces of blummer blocks and axle boxes more durable and less costly than heretofore. In carrying out this invention, ox or cow hides are preferred, either tanned, tawed, or otherwise prepared; and for one class of bearing the hides are cut up into pieces of suitable size for lapping half, or nearly half, round the journals to which they are to be applied. These pieces are compressed in half round moulds to bring them severally to shape; and the required thickness of bearing is obtained by cementing two, three, or more thicknesses of leather together, piling them in layers one above the other, and then submitting the combined thicknesses of leather to pressure in a suitably shaped mould for the purpose of solidifying the same. These bearing surfaces may be backed or cased with metal.

IMPROVEMENTS IN THE MANUFACTURE OF RAILWAY BARS, AXLES, &C.

Improvements in the Manufacture of Railway Bars.—In the process of manufacturing malleable iron rails as at present practised, the small fragments of puddled iron which are collected together to form a puddle ball are more or less oxidized on their exterior surfaces, and are otherwise coated or mixed with scoria and other extraneous matters. In the squeezing or rolling process which follows, a large proportion of these extraneous matters are driven out, but so much of them is often retained as to prevent an equal and perfect union of the surfaces of all the numerous pieces of which the mass of iron is composed. In the operation of rolling, a considerable elongation of the metal takes place, and consequently those parts of the iron which are prevented from uniting by the scoria, oxide, or other matters, are also much elongated, forming what are called flaws or sand cracks, and giving a more or less detached or feebly coherent lamellar texture to those parts of the iron. The rolling of heavy wheels over such a material, tends to elongate the upper stratum, which ultimately becomes loosened and detached from the general body of the rail, and which defect is augmented by the soft and malleable condition common to iron that is entirely deprived of its carbon. Mr. H. Bessemer, of London, proposes to lessen or remove these defects, and produce, as nearly as may be, a homogeneous mass of metal, free from the admixture of oxide, scoria, &c., and at the same time combined with as much carbon as will give it greater hardness and power to resist the laminating action of the wheels which pass over it. In practice, refined iron is put into the ordinary puddling furnace, where it is at first treated in the usual way, being raked about until it has thrown off the greater part of its carbon; but care should be taken not to carry this process of decarbonization too far; about 1 per cent. of carbon should be retained. A knowledge of the most advantageous point to leave off the puddling operation will be readily acquired in practice, a good test to the workmen being the facility with which the metal will fuse in the succeeding operation. The metal having been brought to the desired point of decarbonization, is raked out of the puddling furnace and allowed to cool; these products may be mixed in large quantities to equalize the quality, or it may be drawn into the fire clay crucibles, arranged in furnaces such as are now commonly employed for melting steel; a little charcoal, or other carbonaceous matter, is to be thrown into the crucibles among the pieces of metal, which will assist in reducing the oxide formed by the previous operation. The fires in the melting furnaces are to be kept up vigorously until the complete fusion of the metal takes place; it is then to be poured in a fluid state into iron ingot moulds, placed vertically, or nearly so, with open tops, the shape of the mould being such as to give the ingot of cast steel more or less the intended form of the rail; the ingot being, however, much more massive, in order that it may afterwards be reduced in thickness and increased in length, by rolling, in a similar manner to that already practised in rolling railway bars formed of malleable iron. The raw ends of the steel bars may be cut off and remelted by mixing them with fresh portions of the metal from the puddling furnace. The combination of such a quantity of carbon with the iron as to constitute steel will greatly increase its power of resisting the laminating action of the engine and carriage wheels, and at the same time add to its stiffness and cohesive strength, as compared with malleable iron rails of the same sectional area. In carrying out a second modified process, the puddling operation is continued until the carbon is dissipated as far as practicable, the iron being reduced to a dry and powdery state, when it is to be raked out of the puddling furnace, and afterwards converted into steel by cementation with powdered charcoal in close vessels, after the manner employed in the making of blister steel, or, by preference, by a continuous operation in vertical retorts. In lieu of the puddled iron, small pieces of scrap iron may be used alone, or mixed with a portion of puddled iron, and then converted into steel by cementation with charcoal.

ROLLING RAILROAD RAILS.

An invention by Mr. John W. Brown, of Mount Savage, Md., has for its object the rolling of the rails into such forms successively as to cause all parts of the rail to be submitted, in the rolling process, to a uniform degree of drawing and compression, thereby preventing the separation of the head and flange, making all parts of the rail of equal density, &c. It enables rails to be made perfectly sound with crystalline iron in the heads, which is far superior to fibrous iron, as the latter laminates or peels off, as many of our readers will doubtless have noticed on roads that have been in use for some time.

The present improvement consists in forming a groove or cavity along the centre of the base of the rail after the reduction to form the head has been, to a certain extent, effected by the rollers, but before the further reduction to form the neck is commenced. By the subsequent operation of the rolls the middle of the bar is reduced, to form the neck which brings the rail nearly to the proper shape, drives the metal towards the base, and fills the cavity in the base before mentioned.

IMPROVED CONSTRUCTION OF GIRDERS, AXLES, AND SHAFTS.

A patent has been taken out in England by Mr. James Fenton for a mode of manufacturing axles, piston rods, and shafts, girders, and other like articles, by rolling up or coiling a plate of iron, of any required thickness and size, into a compact roll or coil; next bringing it to a welding heat in a suitable furnace, and then drawing it to the required shape under a hammer; or by passing it, when at a welding heat, through a pair of rolls. The welding may be carried completely through or only partially, say half, through the mass; if the latter, a compound axle or other article will thus be formed, neither solid nor hollow, which it will be nearly impossible to break. The mode of operating is as follows:—A plate of iron is prepared, of a suitable length, width, and thickness to form a compact roll or coil, containing sufficient metal for the production of the intended axle or other article. The thickness, and consequently the other dimensions of the plate, will depend upon the quality of the iron employed. This plate is heated to a red heat (when needful), and two or more workmen with tongs or pincers, turn up one of the edges; hammer men then bend down this turned up edge on to the side of the plate, so as to form the commencement of a roll or coil; after which the operation is continued in the same manner until the whole of the plate has been rolled up; and it may then be passed through a pair of rolls, if considered necessary. A compact roll or coil of metal being thus produced, it is heated to a welding heat in an air or other suitable furnace, and then welded and drawn down under a hammer to the required form. The welding and shaping of the axle or other article may also be performed by passing the roll of metal, when at the welding heat, between a pair of rollers, having sets of grooves of gradually decreasing diameter, in the manner commonly practised when rolling bars and rods of iron; or the roll or coil may be submitted first to a hammering process, and then passed between grooved rollers until it is reduced to the required shape. The plate of iron employed for forming a coil or roll which is to be manufactured into an axle or other like article, may be a compound one—that is, it may be composed of iron of different qualities, and in this case the plate should be so rolled up as to bring the iron of superior quality at the outer surface. In some cases, also, a small solid or hollow core or centre may be employed, and the plate of iron may be coiled around it, until a mass has been produced of sufficient size for the production of the intended axle or other light article. The process of manufacture is then concluded as above directed.

PRESENT ANNUAL PRODUCTION OF IRON.

Mr. Hewitt of New York, in a paper recently presented to the Geographical and Statistical Society, furnished the following memoranda respecting the production and manufacture of iron. Cast iron can only be traced back to the 13th century. Previously, the ore and charcoal were placed in alternate layers in a rude oven, and there smelted by a blast injected by a bellows worked by hand. Even so late as 1740, the total annual product of England was but 17.350 tons, made by 59 furnaces at the rate of 294 tons per annum to each furnace—say one ton per furnace for each working day. Mr. Hewitt estimates the entire annual product of Europe at that time at 100,000 tons, 60,000 of which were made in Sweden and Russia, and one half of this exported to England. The total consumption of iron in England at that day (only 116 years ago, or since the birth of some persons yet living) was not 15 pounds per head per annum, and that of all Europe but *two* pounds per head. The whole human race did not then annually require or produce so much as *one* pound of iron per head. Now Mr. Hewitt produces data showing an annual production of *seventeen* pounds per head for the whole human family, or seven millions of tons in the aggregate, of which Great Britain produces rather more than one-half, and consumes at least one-fourth. The total product of 1856 is estimated by Mr. H. from imperfect data as follows:—

	Tons.		*Tons.*
Great Britain	3,585,000	United States	1,000,000
France	650,000	Prussia	600,000
Belgium	255,000	Germany (bal. of)	200,000
Russia	300,000	Austria	200,000
Sweden and Norway	179,500	Spain	27,000
Italy and Elba	72,000	Denmark &c.	20,000
Total	6,889,000 tons.		

Asia, Africa, and America outside of the United States, may possibly raise this aggregate to 7,000,000 tons.

The annual production and consumption of the several countries is estimated as follows:

	Produces. per head, lbs.	*Consumes. per head, lbs.*
Great Britain	287	144
United States	84	117
Belgium	136	70
France	40	60
Sweden and Norway	92	30
Germany, including Prussia	50	50
Austria	12½	15
Russia	10	10
Switzerland	—	22
Spain	4½	5

The rest of the world too little to be computed.

The intimate relations of iron to industrial progress and efficiency, as exhibited by this table, need here only be suggested.

Iron is now relatively one of the cheapest of metals, costing from about a cent a pound in its crudest and lowest state (pig), at the points of its cheapest production, up to five or six cents per pound for its purest and rarest qualities. In its refined and carbonized form of steel, it was not long since worth twenty-five cents per pound at retail in this country; but the cost of the steel making processes has been rapidly reduced by recent discoveries and improvements, until steel is hardly double the value of the better qualities of iron. New steel making processes—several of them originating in this country—have recently been patented and are now being reduced to practice, by which it is believed that the price of steel will be still further reduced and the qualities essentially improved. How any one of these processes may succeed, we know not; but there is great inherent probability that bar iron may within a lifetime be converted into steel at least as cheaply, pound for pound, as pig is now transformed into bar.

Unless we are greatly misinformed, the difficulties under which the manufacture of steel labors in our country, arise entirely from the small scale on which it has so far been conducted. The English steel works, although, we believe, possessing to a great extent a monopoly of the famous Danamora iron, are able to command the market only by the superior uniformity of the product, and not by any actual superiority in the metal when properly carbonized. In the cast steel, for example, each bar, as broken and mixed in England, is rapidly assorted into several varieties, some of which are finally made into different qualities of steel, or if not, are compelled to undergo somewhat different processes in the manufacture. The American Works, on the contrary, too often adopt the temporary system of waiting for an order and then carbonizing as well as may be and mixing all together—a process which cannot produce as uniform results. Different bars of iron even from the same bloom will become steelified in different degrees, but it is easy to see that all the lack of uniformity ever charged upon the American article springs directly from the moderate scale on which the business is conducted, and this again from a feeling of insecurity and uncertainty in the protection. The great fact established beyond a doubt that we have the materials and the skill, a settled feeling that the duties on iron and steel are not to be meddled with, and giant establishments may be expected gradually to develop themselves, which would soon put the business beyond the fear of foreign competition.

IMPROVEMENTS IN THE QUALITY OF IRON.

At a time when so much competition is springing up in the iron and hardware as well as most other trades, it is important that every hint that science affords for the improved manufacture of such goods should be regarded with every attention. The truth is now rapidly gaining ground that wherever mechanical strength is desired, an alloy is preferred to a pure metal. One of the greatest obstructions to the mechanical value of iron is its tendency to crystallize. Whether the article be a monster gun or a ship's cable, the result is the same. One would have thought that the success of Mr. Muntz's "yellow sheathing" which has for ever superseded pure copper for shipping purposes, would have turned the attention of the manufacturers of iron and iron goods into the direction to which we point; but much movement has not yet been made by them towards that point. Now, the tendency of iron to crystallize, there is no question, may be prevented by the admixture of other metals. In almost every direction "Nature has placed certain metallic masses, to which the name 'meteoric iron' has been given, on the supposition that these masses have fallen from the atmosphere." The composition of meteoric iron, wherever found, is chiefly of iron and nickel, the latter varying from two to ten per cent., with small quantities of cobalt and (it is said) chromium. Science has made artificial meteoric iron, and it has been tested.

Its qualities have proved identical with those of the native compound. In addition it is more ductile and has more tenacity than pure iron, and is not so liable to rust or oxidize. Possessing such qualities, meteoric iron is certain to become a branch of national industry. A mixture of ninety-eight parts of iron and two of nickel has all the peculiarities of best meteoric iron. A few years ago an ore of sulphuret of nickel, devoid of arsenic, was found in Inverary, in Scotland, and by its means meteoric iron has been made of the best quality.—*London Engineer.*

It is stated, as a curious fact in the iron manufacture, that within the last twelve or fifteen years cast-iron contracts less by one-half than it did formerly. Experts are disposed to attribute this to a difference in the mode of manufacturing iron employed in the present day from that which formerly prevailed.—*Editor.*

PRESENT POSITION OF THE IRON MANUFACTURE.

From a paper recently read before the Society of Arts, by Mr. J. K. Blackwell, "On the present position of the iron manufacture," we derive the following extracts:

Mr. Blackwell sets the total annual production of pig or crude iron at 6,000,000 tons, of which Great Britain produces 3,000,000, France 750,000, the United States 750,000, Prussia 300,000, Austria 250,000, Belgium 200,000, Russia 200,000, Sweden 150,000, the smaller German States 100,000, and other countries 300,000.

Mr. Blackwell thinks that in Great Britain the most favorable localities for the iron industry are already fully occupied, but that in Ireland there exist immense deposits of clay carbonate of excellent quality, which are now entirely unworked, and he suggests it as a very important subject for inquiry whether the immense resources of vegetable fuel in the form of peat with which Ireland abounds, might not be advantageously applied to the production of first-rate iron from them. He enforces this suggestion by stating that pig iron is smelted with carbonized peat in Bohemia.

The iron produced in France is smelted in nearly equal proportion with coke and charcoal; that a large proportion of the charcoal pig iron is subsequently converted into bar iron solely with charcoal; and that the charcoal pig iron is for the most part made in close proximity to some of the most important coal fields in France. This latter consideration points, in Mr. Blackwell's opinion, to an early transformation in the French iron industry. From the limited extent of Belgium he anticipates that the production of iron will remain nearly stationary there; whereas in Prussia he states that it is rapidly increasing, the chief obstacles being the nature of her widely spread, ill connected territories, and the want of facilities of intercommunication and of access to markets. The latter class of drawbacks he notices as restricting the production in Styria, Carinthia, and Bohemia: and from similar causes, and the absence of mineral fuel, he anticipates that the iron manufacture in Russia and Sweden—neither of which countries possesses mineral fuel conveniently situated—will long remain comparatively stationary.

The iron industry of the United States is already highly important, and capable of great extension, which must in a great degree be determined by the available means of transport, and the facility with which the ore can be brought in proximity with the fuel.

He next proceeds to an examination of the various processes adopted in the manufacture of iron and to their susceptibility of improvement. Mr. Blackwell says that the differences in chemical nature of the various elements forming, on the one hand vegetable, and on the other mineral fuel, are only in degree, and not in kind, except in so far as regards the composition of the earthy residuum of ashes left after the volatilization of the other elements. It may therefore be in the different nature of the substances present in the ashes of wood and of coal that we must seek for the explanation of the causes which produce such a widely different quality in iron smelted with these two species of fuel. He considers that sufficient attention has not been hitherto paid to this subject, or to the mechanical operations by which a large part of the earthy impurities of all coal seams of a caking nature, might be separated from them before they are converted into coke. Again, he says that, notwithstanding the great extent to which raw coal and partially torrefied wood have been long used in the blast furnaces both in England and abroad, on a careful consideration of the process to which both coal and wood must be subjected before the carbon they contain can be utilized in the reactions of the furnace, it appears that their carbonization may be effected with most economy, and that the quality of the charcoal or coke which results from this process will be best, when effected in close ovens prior to the introduction of the fuel into the blast furnaces, and not within the furnace itself. After pointing out the source of some of the losses sustained by iron masters in England and in South Wales, especially from imperfect smelting, he remarks that much controversy has taken place with respect to the difference in quality supposed to exist between pig iron smelted with cold and with hot blast. It was generally considered that the pig iron smelted with hot was inferior in quality to that produced with cold air, but he had attributed this impression to ignorance of the facts of the case. Furnaces blown with heated air exerted so great a reducing power, that refractory ores calculated to produce inferior iron were now easily smelted, and thus had arisen the opinion alluded to. At the same time, he admitted that the more elevated temperature of the hot blast furnace had a tendency in a slight degree to increase the quantity of silicium and other cognate metals which formed alloys with pig iron in the smelting process.

In treating of the operations for converting carbonized crude iron into malleable, he mentioned that at several works on the Continent the attempt to arrest the process of decarburation in the puddling or boiling furnace at that point at which the conversion has proceeded so far as to leave the iron in the state of steel or subcarburet, was believed to have been successful, and that a valuable natural or puddled steel, not requiring cementation before conversion into refined cast or steel, had been the result. He cited as a proof of the faultiness of the present mode of operating, that in some of the largest iron making districts of Great Britain, the production of one ton of inferior wrought iron was only obtained by the consumption of one and one half tons of pig iron. The crude iron from which wrought iron of the best quality is produced, is that possessing a medium degree of carburation, usually termed grey pig iron, while iron which possesses an inferior degree of fluidity, is what is generally used for the manufacture of wrought iron, especially when the conversion is effected by the single operation of boiling in the puddling furnace; but it is always more impure than grey, and does not produce the best wrought iron. In those countries where the pig iron is smelted with charcoal, and where coal is available for conversion into malleable iron, the charcoal refinery is generally abandoned for the puddling furnace, it being found that the quality of the iron is sufficiently insured by its previous treatment. In Great Britain, where the smelting process is almost exclusively conducted with coal or coke, nearly the same result is obtained with reference to the quality of the bar iron produced by the treatment of the pig iron in the charcoal refinery with charcoal; it therefore becomes an important subject for investigation, to ascertain what are the precise causes to which this amelioration of quality from the use of vegetable fuel is due, when used in the treatment of iron in processes which have no analogy to each other. He considers that the circumstances of the two cases point to the possibility, that the eliminated effect exercised as fluxes in both instances by the ashes of the vegetable fuel employed, may have some influence in producing this improvement in quality, and that, should such be the case, we may replace charcoal as fuel with advantage by artificial fluxes producing an equivalent effect. The charcoal refinery in general use in those countries where mineral fuel is not accessible for the conversion of crude into malleable iron, is still extensively employed in Great Britain, when it is desirable to produce iron of the best quality. Mr. Blackwell points out that grey pig iron smelted with coke may be converted into malleable iron by the boiling process, thereby avoiding the serious waste from oxidation in the coke refinery, and it becomes important to inquire whether any ameliorations can be introduced which would enable it to be more universally adopted than it hitherto has been. He remarked, however, in general terms, that the principal mechanical agents in these operations are the hammer and the rolls, and that it is by a proper combination of both that all the requisite qualities of well manufactured iron can be obtained. He observed that in England latterly, there had been a tendency to supersede the use of the hammer by that of the rolls, not only in small sizes, where the immense command of power rendered it practicable to do so, but in larger sizes also as, for instance, rails, large bars, plates, and thick sheet iron, where it was not practicable, if soundness was to be secured.

TEST OF STEEL MANUFACTURES.

A correspondent of the Journal of the Society of Arts (London) publishes the following method of testing the quality of steel by means of nitric acid. "I first carefully clean the articles from all grease with a little turpentine, as grease resists the action of acid on metals, and then immerse about two inches of their length in acid, which should be slightly warmed, as it 'bites' better when tepid. If the acid be too strong, its biting will be rather slow, in which case a little water can be added. After they have been in the acid about ten minutes, the acid will be found to have penetrated to nearly the sixteenth of an inch, according as the steel is good, bad, or indifferent. They should be then taken out, and carefully immersed in water, to stop the action of the acid, and then examined as to the quantity of carbon each contains, which should be duly notified—a sufficient quantity will be left on the etched steel for this purpose—the carbon undergoing no change from the action of the acid. I would then rinse and dry them; after this they can be safely examined; the faults of each will be plainly palpable. The best will be evenly etched, and dark in color, from the exposure of the carbon. The next will be more uneven in surface, with more or less of carbon, according to its manufacture. The next and worst will be rougher still, scabby, rough, or rotten, as the case may be. If one should be found to be iron, it will be deeper etched, whitish colored, and stringy in the grain. These are a few of the distinguishing peculiarities which the acid brings to light. By this process all the properties of steel or iron are exposed. If the steel be 'burned,' one or two minutes' immersion will be sufficient to detect it,—its surface will be etched in lines considerably apart, corresponding to the patched surface which the steel exhibits previous to polishing."

Purchasers of either iron or steel in large quantities should invariably use it, as no imposition can be exercised without detection. Critical expedients for detecting the qualities of metal are rather numerous—as weight, for instance. No two pieces of metal of exactly equal bulk, if of different qualities, are of the same weight, &c.

By the acid process, it will be seen that either natural or cemented steel can be advantageously subjected to this test in its manufacture. The process of decarbonization in the former, and of carbonization in the latter case, instead of being left, as is now done, to the doubtful skill of the workman, can be subjected to the unerring test of the acid. The manufacturer of steel might get a scale of qualities which have been subjected to this test, marked Nos. 1, 2, &c., with such remarks to each piece as may be a guide to the workman—as to the time in its manufacture, the quantity of carbon found, and foreign matter introduced, &c. Such remarks, with the decided peculiarities of each quality of metal, will be a guide to any intelligent workman.

WHAT IS THE ANNUAL WASTE OF IRON ON A FARM?

The London *Mark Lane Express* publishes the following communication from an eminent English ironmaster and agriculturist, in answer to the question, "*What is the annual waste of iron per acre in the cultivation of land?*"—the answer being based upon the careful examination of the accounts of a farm in Bedfordshire, England. The farm consists of 330 acres of arable land and 120 acres of meadow or permanent grass. The following is the list of the implements employed upon it:—

6 Iron ploughs	1 Reaping machine
2 Ridging do.	2 Horse hoes
2 Double furrow do.	10 Carts
1 Broad share do.	1 Waggon and 1 van

1 Clod crusher
1 Iron and 3 wood cylinder rollers
4 Sets of iron harrows
2 Scarifiers or cultivators
8 Sets of iron whiffletrees
1 Land marker
1 Corn drill
1 Liquid drill
1 Turnip drill
1 Grass seed drill
1 Liquid manure cart
1 Water cart
1 Liquid manure pump
1 Weighing machine and weights
1 Horse rake
1 Hay-making machine
1 Steam engine
1 Combined threshing machine
1 Flour mill
1 Linseed mill
1 Bean splitter
2 Chaff machines
1 Cake breaker
2 Winnowing machines
1 Corn blower
1 Barley hummeller
4 Turnip cutters and pulpers
20 Iron troughs
Shepherd's field house
Sheep racks and cribs
Hand tools, chains, &c.

The estimated weight of iron in these implements is 20 tons, and to it there may be added at least 4 tons for iron work in farm buildings, gates, &c. The estimated annual consumption of iron in order to keep these implements good is about 6½ cwt., or rather more, per annum of wrought iron, and 7 cwt. of cast iron. The number of horses kept is 14; each of them on an average uses 32 shoes per annum, weighing about 2 lbs. each of them; about one-eighth are lost, and the average weight of the old shoes worked up is about ¾ lb. each. From these data it is calculated that nearly 5½ cwt. of wrought iron are annually used in horse shoes alone. This makes the total consumption of wrought iron 12 cwt., and of cast iron 7 cwt. per annum. We are not informed as to the quality of the soil—the number of horses would lead one to suppose it heavy—but from their being spoken of as "pairs," and from the use of double furrow ploughs, we suppose it to be light, and the latter is more probably the case.

On this farm in Bedfordshire it appears that on 450 acres there is a consumption of rather more than 4 lbs. of iron per acre per annum. It must be remembered, however, that the relative proportions of arable and pasture on this farm are not those which obtain over the country generally, and that the stock of iron implements upon this farm very far exceeds the quantity generally in use. On both these grounds we have little doubt that in this experience there is nearly double the consumption of iron which generally obtains per acre; and, therefore, that this, over the country generally, ought to be assumed rather as being between 2 and 3 lbs. per acre yearly than as between 4 and 5.

ON THE UTILIZATION OF CAST IRON TURNINGS.

It is common to consider the fine turnings, clippings, and filings of iron nearly or quite valueless, on account of their disposition to blow up the chimney or stick and clog the draught, on attempting to remelt them; but two methods have been lately invented, either of which renders it perfectly practicable to remelt these particles, even if, as usual, there are considerable quantities of wrought iron and dirt intermingled. The first is by Mr. Abiel Pevey, of Lowell, and consists in providing a lot of cheap hollow castings, of any convenient form, and filling them with the fine particles and placing them in the furnace, where the whole melts together. The second is by Mr. Edward Lyon, of New York, and consists in merely piling the fine particles in a compact mass as near as possible to the centre of each charge, so that the draught may rise freely through the coal around it. Both methods are successful in practice, and patents, we believe, are granted or pending for each. The latter and obviously cheaper method is probably somewhat more wasteful of the metal than the former, but the material is cheap, and the Lyon process may be generally preferred. Turnings are valued, at many shops, at only $4 or $5 per ton, while pig iron of the same kind is worth $30.

In this connexion we would notice a well founded prejudice which is beginning to prevail against the use of scrap iron for the construction of axles, shafts, &c. Scrap iron has been generally well worked over, and is in that respect superior to that just from the puddling furnace, but the unequal character of the fragments, causing some to burn before others are soft enough to weld, induces, in many cases, the most fatal accidents by failure, where it could not by any care have been anticipated. Good American iron—which, by the way, is somewhat softer and considerably stronger and tougher than English—well worked over by repeated rolling and piling, is, without doubt, the most reliable material. Scrap is liable to contain all manner of faults, and is notoriously too unequal in texture to bear case hardening without warping.

Steel Castings.—The well known establishment of Naylor & Co., at Sheffield, England, is now producing " cast steel forgings" of large size by a new process of casting the fluid metal in sand somewhat like cast iron. The product is reported in *The Glasgow Practical Mechanics' Journal* as a new material stronger and sounder than perfect wrought iron, and free from the imperfections to which heavy masses of the latter are often subject. It would seem to be a great desideratum for steamship shafts and the like.

IMPROVED CHAIN MAKING MACHINE.

An ingenious machine for the manufacture of chains, has recently been invented by Edward Weisenborn, of New York City. The chain made by this machine is not like that in common use, but is of a peculiar kind, which may be called " double link chain;" it is made, not of pairs of links, but strictly of double links, each consisting of only one piece of metal. The links are faggoted and welded before being put into the chain, and to make them inclose each other, only require to be bent. It is in a great measure owing to the manner of making the links which gives the chain the superiority which it is claimed to possess over the common kind of chain. This machine performs the whole of the process of making this chain from the forging of the links to putting them together. The first operation which takes place at one end of the machine, is that of winding up a small piece of small flat iron rod till it forms a coil of several thicknesses of metal. This coil is taken to a proper fire and heated to a welding heat, and then put in another part of the machine, by which it is welded into a ring which is equally strong at all points. From the last named part of the machine the ring is taken by automatic devices to another part, where it is elongated in one direction and closed in a direction at right angles to it, till it forms a link which resembles the figure 8, except that the two sides do not cross in the middle. It is then taken by other devices and bent at the middle of its length, and then, by hand, put through another link and placed in another part of the machine, by which its looped extremities are drawn close together, which finishes it. The next link passing through these looped ends secures them, and thus the chain is formed. All the operations are performed with great rapidity.

HARDENING CAST STEEL FOR CUTTING.

Kieser, of Issy, in Switzerland, prepares admirable hardened razors, penknives, &c., from English cast steel, by plunging the blades at a dark cherry red heat into a bath made of fourteen parts by measure, of yellow rosin in fine powder, two parts of fish oil, and one part hot molten tallow; they are then allowed to cool perfectly, and, without wiping them, are reheated to a low red heat and immersed in water, in the usual way of tempering such articles. The edge of the blade treated in this manner is said to be very fine, and the hardening more uniformly done than by any other process.

IRON CHURCHES.

Mr. Skidmore, a gentleman who is celebrated in England for the extreme beauty and excellence of his ecclesiastical metal works in the Mediæval style, has excited considerable interest by a proposal to erect churches of iron instead of stone. In the course of a recent address he says:—"I will undertake to make a church capable of holding eight hundred, with enrichment equal to a church costing, in stone, £7,000, for one-third less than this amount. If iron is to be considered a material of our age and locality—and to be used as our forefathers used every material of their day, giving it its natural expression, adding art and beauty to the constructive form, it would be unlike their actions and unworthy of ourselves to use a new—for, considering the facility of its production in this day, and its great and extended use, it may fairly be ranked as a new—material, only as a cheap expedient, instead of giving to it that development in Christian art of which it is so capable. The interior would afford ample scope for carrying out that floral treatment so much used in the fourteenth century. The iron also would require coating with pigments to preserve its surface, and would form a ready means of illumination; the renewed use of crystals and gems, as in ancient metal work; the use of enamels would present facilities which permit to a greater extent even than in ancient work; the covering of the wall surfaces with tapestry having historical subjects, reredos of brass, or silver and brass combined, are also objects to be aimed at." It is thought that by a liberal use of crockets and finials, executed in sheet or wrought iron, properly foliated, the great objection which has been urged against the use of cast iron for structural purposes can be avoided, namely, the expense of patterns which necessarily involved endless repetition, and thereby to a certain extent either ignored or limited the exercise of the ideal faculty. The mouldings may be cast, but they can also be rolled with due attention to their relief and projection, and fitted together in parts. Rusting can be prevented by the use of the new metal aluminum as a coating, and this process, if not too costly, would be far more effective even than galvanizing. By the electro-deposit process the spire might be gilt upon its entire surface.

ELLITHORP'S IRON PAVEMENT.

This form of pavement, said to be the best yet brought out, is made of a series of groined arches, alternating in position in each adjoining row, to make a surer foothold for horses travelling over it, and to prevent the wheel of a vehicle from jamming in it. The blocks are kept in place by a flanged projection catching over one block and under the next, so that when once properly placed, there is no chance of their being disturbed by the travel upon them, while they can be readily taken up and replaced when required.

IMPROVEMENT IN THE MANUFACTURE OF GUNPOWDER.

E. Hall, of Dartford, England, has obtained a patent for an improved method of sprinkling the gunpowder materials while under the milling process. Under the old system of wetting with a watering pot, the distribution of the water was not uniform, and the powder was not properly damped. Mr. Hall's apparatus consists of a pump, which slowly conveys water to a cistern above each mill, and having a series of sprinkling pipes, connected with an index nicely adjusted, and a stop cock to take off the supply while one is being taken off and another put on.

Mr. Henry Drayson, of England, has patented an improvement in the manufacture of gunpowder, which consists in dissolving the saltpetre used in its manufacture, and combining the solution with the charcoal and sulphur, and then grinding the mixed ingredients under the mill, in place of grinding undissolved saltpetre with the other ingredients. For this purpose, the saltpetre, having been dissolved by heat in as little water as may be, the charcoal and sulphur in a pulverized state are immediately and intimately mixed therewith. The mixed materials are then ground under the mill, until the combination of them has become sufficiently intimate, and the manufacture is then completed in the ordinary manner. The saltpetre is dissolved in about half its weight of water, and the temperature of the solution raised to the boiling point, but the inventor does not confine himself to this particular temperature or proportion of water. It is preferred to employ saltpetre that has not been melted, but only purified and crystallized. The requisite process of milling may be shortened by first artificially drying off part of the moisture in the mixed materials.

TO ASCERTAIN WHEN A NEW BUILDING IS DRY ENOUGH TO BE INHABITED.

The *Foerstler Bauzeitung* states that the Administration of Jails at Geneva, after a careful examination of the subject, establishes the following rules:—

1. In the newly erected building, sundry rooms, apparently the most dry, and sundry others, apparently the most humid, are to be selected.

2. In the neighborhood of the new house, several rooms are selected, which have been inhabited already a considerable time, so that the sanitary condition of the latter can be ascertained; after that, of their inhabitants. In this selection, care must be taken that among the inhabited rooms in which the experiments are to be made, there be both those which are well ventilated, dry, and healthy, as well as so badly ventilated, and so damp, that the effects thereof be apparent on the inhabitants.

3. Twenty or more rooms in the new house and in the neighborhood being thus selected, an equal quantity of vessels of precisely the same capacity, form, and opening, are filled either with fresh-burned quicklime, coming from the same kiln and finely pulverized, or with sulphuric acid of commerce; five hundred grains is about the right charge for a vessel, either for lime or for the acid; but it is necessary, in either case, that the charges be weighed with the most exact balance.

4. The vessels thus filled have to be placed in all the selected rooms. Trustworthy persons have to care that said vessels be placed in the midst of the rooms, and that windows, chimneys, and doors, be carefully closed as soon as the vessels are thus placed. In rooms to be furnished with bedsteads close to the walls, the above vessels are to be placed close to such walls.

5. Twenty-four hours after the exact moment of the location of the first vessels, the removal of all the vessels is to take place in the very order of the location, and all of them are to be transferred into a room where each in its turn is to be weighed. This is to obtain the exact weight of each, twenty-four hours after its location. The weights at the moment of location, and those twenty-four hours after, are carefully recorded for each vessel, each of them being marked with a separate number corresponding with the number of the room in which it was located.

If the numbers recorded by this process be then examined, it will be found that the weight has increased; and if then the amount of the increase in the rooms of the house newly built, be compared with the amount of the increase in the several rooms of the neighborhood, due consideration taken of the sanitary condition of the latter, such comparison will indicate at once and with infallible security, whether any part of the new building, and which part, is dry enough to be used as a dwelling without danger to the inhabitants.

IMPROVEMENTS IN THE MANUFACTURE OF MILITARY IMPLEMENTS, &c.

In the recent Crimean war, great difficulty was experienced by the English Ordnance Board, in transporting gunpowder to great distances in a dry condition. Some of the powder in the Crimea having become damp in its transit, had to be removed from the barrels with pickaxes. The powder is now sent over in vulcanized canvas bags contained in barrels. The bags subsequently served many useful purposes.

Among other recent improvements in Military Science brought out in England are the following: wooden barrack buildings are rendered fire proof, or nearly so, by successive applications of soluble glass and lime wash. Minié rifle bullets are made by moulding, from perfectly pure, and consequently very soft lead, obtained by Pattinson's process. A million and a half of these bullets may now be made per week by machinery. Shrapnel shell bullets are cast from an alloy of lead and antimony. The crude alloy is obtained from Hamburg, and is cheaper than either lead or antimony. The English mix chlorate of potash, the French nitrate of potash, with the fulminating mercury used for filling percussion caps. The English caps are less liable to corrosion than are the French. The substitution, in the percussion cap department, of methylated spirit for pure spirit, has prevented that imbibition of alcohol by the work-people which it was formerly impossible to prevent. English gunpowder is as a rule denser and more uniform in its composition and effects than foreign gunpowder, and keeps much better. From the more porous condition of the foreign powder, the whole of the charge is invariably consumed; whereas, with the English powder, portions of the unconsumed charge frequently escape from the aperture of the gun, and are occasionally blown back upon the gunners by the force of the wind. The French method of purifying nitre by washing has been substituted for the English process of crystallization and fusion, with great advantage.

The subject of the recent applications of science to the art of war, is thus reviewed by a recent lecturer before the London Royal Institution:—

Infernal machines want but little to be brought to destructive perfection. Incendiary and poisonous materials have been concocted with Satanic ingenuity; and only not used because men hesitated to have recourse to such terrible instruments of killing. Gunpowder has undergone the ordeal of extended experiment with a view to its improvement; it has received powerful pressure, and thus been rendered superior in its uniformity and power of resisting the effects of transport and of exposure to the atmosphere, although the softer powder used on the Continent is superior in an economic point of view, provided it is required for rapid consumption, and also for its greater inflammability. New explosive materials have been introduced; thus, fulminate of mercury has been demonstrated to possess advantages over other detonating mixtures. Alcohol and methylated spirits have been employed in large quantities for moistening highly combustible compositions. Resin, bituminous coal, pitch, boiled oil, Venice turpentine, zinc, antimony, and coal tar naphtha have been employed or recommended as incendiary or smoke-producing agents. "In endeavoring to prepare a compound of the chlorate of copper with ammonia, as a material for a brilliant purple fire, Mr. Nicholson obtained a beautifully crystalline compound of so powerfully explosive character that even its syrupy solution detonated sharply when struck with a hammer upon an anvil."

Improvement in the Manufacture of Gun Barrels.—An English patent recently granted to Samuel Pearson, refers to the manufacture of twisted barrels and pipes. According to the method of forming such barrels as now practised, a strip of metal is wound spirally round a centre,—the edges of the strip forming butt or scarf joints, which are found in practice to be faulty. Now this improvement consists in forming barrels and pipes of two V-shaped strips of metal, which are wound spirally round a centre; the base of the V in one strip being placed nearest the centre, while the apex or narrow part of the upper V-shaped piece is placed downwards, or nearest the centre, whereby the spaces between the first strip will be filled up, and after being rolled and welded in the usual manner, or otherwise finished, will form a perfectly tight and solid barrel or pipe.

Improvements in the Manufacture of Ordnance Shells and other Hollow Vessels.—An invention of Richard Peters, London, consists in the employment of a hollow mould, made in two or more parts, into which the metal or other material to be moulded, is poured through a pipe, which descends about midway into the mould,—and imparting to the mould, after a sufficient amount of metal or other substance in a fluid or a semi-fluid state has been poured therein, two centrifugal motions at right angles or nearly so to each other. The centrifugal force acting in all directions, distributes the contents of the mould evenly all round the inside thereof, while the internal pipe acts as a vent for the escape of air and gases, and prevents any considerable quantity of material (if any) being forced therefrom. On stopping the two motions and opening the mould, the hollow article will drop out, perfectly formed. When making a shell, a ferrule, threaded on its inside, is set round the internal pipe, and being incorporated with the shell, it will be ready for receiving a fuse threaded with a corresponding screw.

Volcanic Repeating Firearm.—There has lately been commenced in New Haven, on an extensive scale, the manufacture of a rifled arm, the joint invention of Messrs. Horace Smith and Daniel B. Wesson. As the novelty consists more in the ball than in the gun itself, this may first be described. It is a complete cartridge, cased water tight in metal. The ball is in the cylindro-conoidal or Minié form, with a deep cavity in the backside in which is inserted both the powder and the percussion cap. A coating of cork intervenes between the cap and the thin metal which forms the outer covering, the softness and elasticity of which material removes all possibility of exploding the powder by any ordinary violence.

The rifle or pistol is provided with a thin case extending the whole length under the barrel. This, by a simple movement, is filled with balls which are pressed backward by a coiled spring. The barrel is open at each end, and is chambered somewhat larger at the breech to receive a ball easily. By a forward movement of a suitable lever just front of the trigger, the breech pin is drawn directly backwards, and a ball is carried up and placed in line with the bore. Next, by drawing the same lever back to its original position, the breech pin is forced to its place, driving the ball into the barrel, and at the same time puncturing by a point on its end quite through both the metallic covering and the cork, and pressing fairly upon the percussion portion of the inclosed cartridge. The gun is now loaded, and on pulling the trigger the hammer strikes fair upon the hinder end of the breech-pin and transmits a sufficient shock to discharge the piece.

The movement of the lever described in charging the rifle also pushes back the hammer, or in other words cocks the gun, but in the smallest pistols it is found easier to place the thumb on the hammer and draw it back while some of the fingers work the lever beneath. The mechanism by which the whole is accomplished is very simple and apparently durable, the movement of the breech-pin being effected by a toggle joint which is so nearly straight at the time of the discharge that the reaction produces little strain. The breech-pin fits very tightly, and it has been proved by trial that the pressure and inertia of the hammer alone will keep the breech-pin in place even if the toggle joint and all the other parts are removed. The penetration of the balls thus constructed and projected appears about equal to those of the Minié rifle, or all that need be desired. The balls are prepared at a profit for $1 per hundred, and may be discharged at the rate of one per second. The rifles hold thirty and the smallest pistols seven balls each.

Improvement in Shot Guns.—By Buckel and Dorsch, of Monroe, Mich.—This invention consists in giving the barrel of the gun a slightly undulating form, for the purpose of causing all the shot to strike within a certain circle, and prevent its indiscriminate scattering. The barrel is divided into an odd number of parts, say five, seven, or nine, according to the length, the said parts being made alternately of larger and smaller diameter. The parts next the breech and at the muzzle are of the larger diameter, and the intervening parts smaller and larger alternately, thus producing an undulating bore. Many experiments, we are told, have been made with shot guns of this construction, and the result in all cases is, that the shot fall within and evenly cover a certain sized circle, never scattering beyond.

New Bullet Machine.—Mr. Wm. H. Ward, of Auburn, N. Y., has recently invented a machine for manufacturing bullets from lead wire. The wire is coiled upon rests at the top of the machine, and suspended by means of arches, from which the lead is fed downwards into the machine, where it is measured and cut off as required for each bullet, after which it is forced forward into dies, and formed into the desired shape by compression. It makes musket, rifle, and pistol, elongated, hollow, and conical expansion bullets; also round or shell balls all at the same time. At one corner it makes round balls, at another musket, at another rifle, at the other rifle and pistol elongated bullets—each corner being double, with two sets of dies and punches, which gives eight bullets to one revolution of the machine. The machine is capable of being worked up to twenty-five turns in a minute, which is equal to 200 bullets per minute, 12,000 per hour, or 120,000 per day.

Improved Primer for Fire Arms.—In this invention, by Lieut. J. N. Ward, U. S. A., the percussion hammer is made hollow, and the priming paper rolled up and placed within. Whenever the hammer is cocked the paper is fed out for a little distance, and then cut off and exploded on the nipple by the descent of the hammer. It is certain in its operation, and the mechanism is simple. The improvement can be applied to all guns in use at a very small cost, without any alteration in the lock part, the only change being in the form of the hammer.

Reeves' Breech Loading Rifle.—In this English invention, a movable breech is employed, which is made to fit into the end of the rifle barrel, and is held in close contact with it by the lateral pressure of a wedge piece, which is hinged to the barrel and the lock frame, and which drops between the end of the breech and a false breech. To charge the rifle, this wedge piece is first withdrawn, and the breech slid back clear of the barrel into the space vacated by the wedge piece. A small finger lever at the side slides back to the breech, which is then turned up and receives the charge; then it is brought down again into line with the barrel, slid forward, and forced into position by the wedge piece described. The movable breech in this rifle is a charge chamber, and appears to be a supplementary device to Sharp's rifle.

Monster Gun.—Messrs. Horsfall, of Liverpool, England, have during the past year constructed and presented to the British Government, a piece of ordnance of most enormous dimensions. The process of fabricating this huge mass was very simple. Square slabs of metal, of about 3 feet long by 1½ broad, were welded together, and as layer after layer was added to the mass the slabs were reversed in various directions, till the bulk presented to the eye the appearance of a huge, solid lump of iron, slightly conical in form, 15 feet long, 3 feet 10 inches diameter at the thick end, and tapering to about 2 feet 10 inches at the small or muzzle end. It then weighed nearly 26 tons. Great care was taken, and all that science could suggest was brought to bear upon the process of fabrication, which lasted seven successive weeks, day and night; but the material was during that time regularly allowed to cool from Saturday night to Monday morning. Great care was taken to prevent the mass from receiving the blows of the hammer, or percussion from any other cause, while it was cold, or in a semi-heated state, in order to avoid the disintegration known to be produced in iron when hammered cold. Forty men were at times employed upon it, and the hammer used weighed nine tons, striking at every blow equal to a force of twelve tons.

After the mass had been roughly shaped, the process of boring was commenced, the first bore being with an eleven-inch cut. The material proved to be all that could be wished—not the slightest indication of crystallization, brittleness, fault, or looseness of texture was manifested. There had not been the slightest imperfection in the forging. It was next bored with a 12½ inch cut, and finally with a 13-inch—the distance bored being 13½ feet. After this process, the piece was finished in the ordinary manner, though in superior style. The nett weight of this piece of ordnance, after completion, was 21 tons 18 cwt., having been diminished a little over four tons by turning and boring. This was nearly three times the weight of the great Stockton gun, which weighed 7 tons 17½ cwt. Its diameter at the breech is 44 inches; at the muzzle 27 inches; thickness of metal at the breech from the bore to the outside, 15½ inches; thickness at the muzzle 7½ inches.

The gun is discharged by means of a percussion hammer affixed at the breech, and such is the machinery connected with the raising and lowering of the instrument that a child might almost elevate it or depress it when in the stocks. It is capable of receiving a ball 302 pounds in weight, which, with a discharge of 90 pounds of powder, is expected to be projected at least five miles. The capacity of the Princeton's gun was for a ball of 219 pounds.

MOVABLE TARGET.

The following ingenious contrivance has been adopted in the experimental gunnery ships of the British Navy: It consists of a circular target, fitted on a ball and socket support, and capable of being moved in all directions, but so arranged that upon a string being pulled its movements are suddenly arrested. The target is placed at one end of the deck, and a wooden gun pointed towards it at the other. The manual exercise is performed at this gun as at any other. When the captain of the gun comes to the final operation of pointing, he seizes the end of a long string attached to the apparatus which arrests the target, and which is passed through a ring near the screw fixing the lock to the gun: and as soon as, in his estimation, the gun bears directly on the bull's-eye of the target, he pulls this string, as he would the lock-lanyard; and in one instant the target becomes stationary. The officer superintending the exercise has now the means of examining the position of the gun, and of ascertaining whether or not it has been well pointed. This appears to form an admirable introduction to the real practice with shot.

This wooden gun, it may be mentioned, is fitted with a small eye-hole right through its length, by which an object may be looked at along the axis of the bore, and the difference of pointing by the line of metal and by a gun disparted is made at once apparent. This device was first suggested by Sir Samuel Pechell, who remarks, that "in the first place it is necessary to convince sailors practically that the thing you wish to teach them is absolutely necessary." Until, therefore, "they are shown why the line of metal will not do for a point blank shot so well as a line produced by disparting, and which shall be parallel to the axis of the bore, they will not care whether they use a sight or not."

IMPROVEMENTS IN THE MANUFACTURE OF PAPER.

Paper from Refuse Tanned Leather.—Lazare Ochs, of Belgium, has obtained a patent for making paper from the cuttings, waste leather, and scraps of tanned leather. The manufacture of paper from leather is an old story, as an American patent was obtained for such paper many years since; but M. Ochs' method of treating his leather to take out the tanning is worthy of attention for its simplicity. The scraps of tanned leather are placed in sieves on the ends of arms or spokes on a wheel, and are made to revolve in a stream of water, which operation, when continued long enough, washes out the tannin from the leather. After this about 20 per cent. of old hemp rope is mixed with the scraps, and the whole is cut up and reduced to pulp, from which the paper is made. A very strong coarse wrapping paper is made in this manner.

Paper from the Bark of the Cotton Stalk.—Experiments have been recently made to develop a hemp, suitable for paper manufacture, from the bark of the cotton stalk, with a fair prospect of success. The best period for preparing this cotton hemp is as soon as practicable after the picking of cotton has been finished. The plants should then be pulled up and dew-rotted like hemp or flax, and afterwards broken up and the bark separated from the wood of the stalk.

The following is the claim for a patent recently granted for improvements in making paper to William Clark, of Dayton, Ohio: "I do not claim the use of lime or other alkalies in the preparation of vegetable material used in the manufacture of paper. But I claim the boiling of coal tar with the straw or other vegetable material for the manufacture of paper, in the manner and form set forth, and for other similar purposes, or purposes substantially the same."

Improvement in preparing Paper pulp from the Fibres of Endogenous Plants.—The object of this invention by Francis Burke, of Montserrat, West Indies, is to convert the fibres of vegetables into pulp, without having recourse to the process of separating the fibrous matter from the other component parts of vegetable substances; and to effect this object, he adopts means for simultaneously or in one process reducing the fibres to pulp, and separating the pulp from the gummy and other vegetable matters with which they are combined. The vegetable substances to which the process is applicable, are the plants known as the plantain, the banana, and the aloe, and any other vegetable substances containing fibrous matters, from which the other matters contained therein can be separated by water, whilst undergoing the operation hereinafter described.

When necessary, the vegetable matter to be operated upon is first cut, crushed, or bruised, for the purpose of reducing it to such a state of division as will permit of its introduction into a mill to be ground. If the vegetable be plantain, banana, aloe, or any other similar vegetable substance in a green state, it is preferred to crush it between rollers, so as to deprive it of its fluid matters. To reduce the vegetable matters to pieces of a convenient size, a chaffcutter, saw, or other convenient means may be used, according to the nature of the material. The material thus prepared, is ground in a mill made of a pair of plain stones, similar to those of an ordinary flour mill, with the eye of the runner or upper stone somewhat enlarged, so as to facilitate the admission of the material. Either the upper or the lower stone of the mill may be made the runner; but it is most convenient to have the upper stone the runner, and motion may be given to it in the same way as in ordinary flour mills. The material to be ground is fed simultaneously with a stream of water into the eye of the mill; the supply of water being sufficient to convert the vegetable material when ground into a fluid pulp.

The water used may be either hot or cold, but cold water is preferred, and when necessary, any chemical agent may be dissolved in it to facilitate the separation of the fibres from the other vegetable matters with which they may be mixed. The vegetable fibres, as they are ground to a pulp, are thrown out at the periphery of the stones, round which a trough is placed to receive it; from whence it runs into suitable sieves, by which the fibrous pulp is separated from the water, which passes away carrying with it the soluble matters, and also many minutely-divided insoluble or non-fibrous matters which may have been separated from the fibrous matters by the action of the mill.

M'BRIDE'S NEW FLAX SCUTCHING MACHINE.

A new flax scutching machine has been recently brought out in Ireland, which has elicited the highest encomiums for effectiveness and economical working.

The space the machine occupies is about 17 by 10 feet; the holding of the flax is effected by means of a horizontal wheel of about three feet in diameter, having on its circumference two grooves, in which grooves, by endless ropes, kept tight by a counter-weight, the flax straw is held firmly between the grooves and ropes, to be taken slowly round to the breakers, or scutching blades. It is here that the great improvement occurs; these blades are fixed in a peculiar manner on the horizontal shafts, parallel to each other, but on different levels; each shaft carries arms, placed opposite to each other, so contrived as to pass each other without coming in contact; to these arms the scutching blades are fixed, passing each other in intersecting circles, the intersection taking place immediately *below* the circumference of the holding wheel. The blades strike the flax rapidly, but gently, on either side alternately, whilst it is slowly passed under their action in the grooves of the holding wheel; being thus cleaned at one end, it is grasped at the proper moment by the holding apparatus of the second pair of the scutchers, being counterparts of the first, but so set, that the other end of the straw is effectually cleaned, and thus the finished fibre passes out ready for the manufacturer.

The machine is perfectly self-acting, merely requiring the flax straw to be put in on one side, and the flax finished is taken from the other side. From the moment the straw enters into the machine, no further attention is necessary, and no skilled workmen are required, as any boy or girl of fourteen or fifteen can be taught to feed it in two or three hours,—the machine does it all, and delivers the flax well scutched. All clasps, or holders for fastening the straw, are dispensed with, the attendants are not liable to accidents, and the important object—security from the annoyance of dust—is attained, for by simply elevating the machine a few feet, the whole of the tow and scutching dust pass away beneath.

CALICO PRINTING.

Mr. Mercer of Manchester, England, is now engaged in superintending one of the most curious historical and scientific works of the day, viz. a "History of Calico Printing." Of the interest of such a history, even to idle readers, there cannot exist a doubt, for the history of calico printing connects itself intimately with the history of dress, of manners, and of taste, in a large portion of the habitable globe. The Manchester designer has to please the Greek prince and the Australian savage: to satisfy the King of Dahomy and the fishwife of Billingsgate. Such of our readers as have seen the magazines of a wholesale Printseller, and have noticed how curiously the taste in Fine Art varies with latitude—from the warmth of Lima and Rio to the chastity of Montreal and Dantzic,—will feel how much a series of pattern books may suggest in the way of national manners. The horseman of the Pampas and the vine dresser of Brazil—the Amokota of the Cape and the Raj of the Himalaya has each his own style, his own color, his own pattern. Calico Printing has to adapt itself to the Greek of Athens, the Arab of the wilderness, the priest of Benares: the taste of the ladies of Canton, of the Court beauties of Siam, of the harems of Persia and Turkey must be remembered under pain of loss. The records of a manufacture which has to consult so many tastes, and to satisfy such various whims, cannot fail, we repeat, to interest many persons, and to claim a place in every good library. A History of Calico Printing would be a curious, valuable, and appropriate present for Manchester to make to our Library of Contemporary History.

The plan proposed is as follows:—The work is to be divided into six parts; the first part would be an introductory history of the art from the year 1750, including every department; the second would comprise the history of the mechanical department by Mr. Bennet Woodcroft;—the third would embrace the history of the coloring matters, chemical compounds, and other materials used in calico printing, by Dr. E. Schunck; the fourth would be the history of the dyeing process, including color mixing, and the actual printing, by Mr. J. Graham;—the fifth, the artistic department; the first part of it being devoted to engraving, by Mr. Joseph Lockett, and the second to include patterns, and all particulars relating to taste:—the sixth, statistics of calico printing.

CRENNILLE CARPETS.

At a recent meeting of the N. Y. Mechanics' Club, Mr. Thomas Crossley of Boston exhibited a model of a color printing machine intended to be used in the manufacture of Crennille carpets. The machine was patented in 1854 in our own and foreign countries, but had been allowed to remain quiet until a large one could be finished and tried. This had now been accomplished with snch success that the first yard of stuff passed through the machine unexpectedly came out absolutely perfect. The manufacture of rich, many colored carpetings is usually very slow and expensive. Colors dyed in the wool are fast or transient according both to the kind of drug and the degree of heat employed in steaming. Scarlet is a fast color, as it is heated to 212°; but a buff produced by the same drug is heated only to blood-warm, or thereabouts, and is liable to fade when in use. It was very difficult to weave a large number of colors, and only a small quantity of the wool employed came in sight. To remedy all these evils, a Mr. Whytock of Edinburgh invented a process for printing tapestry carpets, and Messrs. John Crossley & Sons of Halifax had engaged very largely in the manufacture. The method was that of printing the warp alone by a slow process on a large cylinder, and afterwards weaving it as carefully as possible. In printing, the tints were impressed on the goods, and the steaming process equally applied to the whole, which rendered printed colors more enduring than dyed. The steaming in either case was supposed to open the pores of the wool and allow the coloring effect to penetrate. Rollers cannot print heavy carpets well, as the coloring matter cannot be retained, but squeezes forward as the rolls draw in the fabric. Flat blocks must be loaded very heavily with colors, and pressed very powerfully for some time upon the goods. This is now done by hand in the Crennille carpet making; but the machine under notice had proved itself capable of printing perfectly at the rate of 4,000 yards per day.

The full-sized machine weighs 30 tons, and is some 40 feet long and 12 high, and prints 6 colors. The width is such that the blocks or carved "forms" may be moved bodily out to one side after each impression to be supplied with a fresh coat of color. These blocks, when in use, are in absolute contact, and press side by side upon the carpet, but to afford sufficient room for applying the color, and also to strengthen the framing, the forms are moved out, three to one side and the alternate three to the other, so that the coloring sieves are separated by a space much wider than is necessary to prevent mixing. Mr. C. considered the machine capable of producing very fine dress goods and very rich paper hangings, such as are now only imported. He had counted on one piece of very expensive foreign goods 130 distinct colors. The great point in the goods so produced is the perfect "register" or fitting of each impression exactly to its place without any of the overlapping and distortions generally observed. This is partly owing to a peculiar method of holding and moving forward the fabric after each impression, which insures the absence of any stretch or irregularity. Another point is the practicability of printing paper hangings so far heating the table over which it moves that the color first printed would be dry before reaching the last form, ready to receive another color upon the first when necessary. It is in this way that the veins are displayed in a darker tint upon the surface of green leaves.

SEAMLESS GARMENTS.

An invention has been patented, and is now in operation for the manufacture of seamless clothing by the Seamless Garment Manufacturing Company, at Winchendon, Mass. The process is as follows: The wool, as it passes through the carding machine, is woven upon cylinders of peculiar shape, the layers of wool crossing each other at different angles, the fibres being stretched to their utmost, making a close, well woven batt, which can be formed into coat bodies; others into sleeves, pantaloons, mittens, shoes, leggings, and the like. Over these cylinders are drawn closely-fitting bags, or coverings of cloth; the whole is then immersed in water, whence they are taken and dropped into metallic tubes heated by steam. A slight vibratory motion is there given them, which felts the wool in a few minutes, leaving, when coats are to be made, the ends of the sleeves and the arm holes of the coat soft; they are then joined and firmly felted together, producing a coat perfect in shape and even in texture. They are then fulled until they become firm and solid. Most of those garments are dyed in the wool before carding; those that are not are at this stage ready for the dyer. Next they are dried on copper forms in the shape of men, heated by steam. While upon these forms they go through a finishing process, which gives them the appearance of the goods known as Beaver Cloth. They are now ready for lining and trimming, which is done according to the taste or design furnished.

REWORKING WASTE FIBRE OF CLOTH.

A patent has recently been secured in England by Mr. S. C. Lister, for reducing hard waste fibre with a twist in it, like cord, or woven cloth of cotton, silk, &c., to be worked over again. The waste is first cut in a machine in short lengths, then it is put into a machine having revolving arms, like a rotary flail, and beat for some time. This loosens the several strands in the same manner that plasterers loosen the hair used to mix with their first coat for walls. After this beating it is placed in a chamber and exposed to the action of steam, then taken out, dried, and submitted to the action of the common carding engine of a cotton factory. This process is stated to be a great improvement in the way of treating shoddy, or waste cotton twists, to be reworked and put into new fabrics.

Another foreign invention, applicable to tissues or other fabrics (whether rags or pieces of new goods) composed partly of wool and partly of vegetable fibres, consists in a mode of removing the vegetable from the woollen fibres, and thereby obtaining the latter in a suitable state for manufacturing purposes; the same, consequently, offers an easy mode for removing the threads from rags with which the seams, button holes, or other parts have been sewn. The rags or other goods, after having been cleaned to a certain extent, by any of the known means, are put into an acid bath (whether cold or suitably heated) containing one hundred parts (by measure) of water; from four to five parts of common sulphuric acid of commerce; and about one part of alcohol; and in this bath they are left as long as required for disintegrating sufficiently the vegetable fibres. The goods are then removed from the acid bath; after which, the greater part of the liquid is pressed out, and the goods dried by any suitable means—care being taken to spread them out as evenly as possible. When dried, they are submitted to a beating engine, or other contrivance, for removing the woollen fibres from the partly decomposed vegetable fibres that may still adhere to them; after which the wool is thoroughly washed in water, or in a weak alkaline or soap bath, in order to deprive it of acid; it is then again dried, and in this state is ready to be prepared for spinning or other manufacturing purposes.

The patentee claims the mode of submitting tissues or other fabrics, composed partly of woollen and partly of vegetable fibres, to a bath of diluted sulphuric acid, to which a small portion of alcohol is added; by the action of which bath, and of the processes above described, the vegetable fibres are readily removed from the wool, and leave it in a fit state for being again employed for spinning or other manufacturing purposes.

IMPROVEMENTS IN MACHINERY FOR MANUFACTURING TEXTILE FABRICS.

Carding Machinery.—W. Stevenson and William Crawford, of Lochwinnoch, Scotland, have obtained a patent for improvements in carding machinery, which appear to be novel and good. In its main details their carding engine resembles those in common use, having a feeding in and carding apparatus.

The wool or cotton passes through the machine in the usual manner, as far as the main carding cylinder, but instead of doffing or removing the sliver, as at present practised, a disk card is employed for this purpose.—This is a disk of metal covered with card teeth, and set upon a vertical rotating spindle in such a position that the card face of the disk works with a part of its area against or in contact with the wire card teeth on the horizontal main cylinder. The respective surface motions of the main cylinder and the disk card are thus at right angles with each other, and as the main cylinder revolves, the disk card revolving also across the path, as it were, of the main cylinder card surface, strips and carries away the wool or cotton from the main cylinder. The fibrous material is thus carried round by the disk clear away from the main cylinder, and one or more doffing combs being arranged to work upon the disk card face, the fibrous material is stripped off the disk card, and passed forward to a duplex endless apron arrangement. The apron arrangement has a continuous forward traverse, in the usual manner, for the conveyance of the fibrous material away from the actual carding apparatus. But in addition to this traverse it has also a lateral vibrating action horizontally, for the purpose of giving a rubbing rolling action to the fibrous material, to complete the sliver or roving. To give greater effect to this slubbing rolling process, the endless aprons are made double, the fibrous material being passed along between the two contiguous lengths of aprons, the lateral action of which is in opposite directions, and gives the requisite rubbing rolling action to the fibres, and condenses the slivers for further preparation and manufacture. And to aid the rolling or condensing action for solidifying the sliver as it issues from the endless aprons, it may be passed through a revolving tube, for the purpose of adding a further condensing twist to the fibres. Instead of traversing aprons, duplex action rollers may be used for traversing and rolling the slivers. It is intended to employ this improved machinery for textile manufactures, but it is particularly applicable in wool carding, so as to produce slivers of any length in a convenient manner.

Bag Looms.—The weaving of bags without seam is becoming quite an extensive branch of manufacture. An improvement recently patented by Messrs. Jilson and Sparhawk of Lewiston, Me., has for its object the regulating automatically the operation of the harness so as to weave a bag of any length, then to close the bottom, afterwards to commence weaving open again, and so on. It can be applied to a common loom, four or six leaves of harness being required, according to whether a plain or twilled bag is desired. The principal feature of the invention consists in a studded pattern cylinder having the studs attached to movable slides, arranged longitudinally to the cylinders. By shifting these slides in one direction, the studs are brought to a proper position to cause the harness to operate in a suitable manner to weave the open part of the bag, and by shifting them in the opposite direction, the studs are brought into a position to cause the harness so to operate as to close the bottom. These movements are all effected by self-acting devices, and can be so varied as to weave bags of any length desired.

Harvey's dead Spindle.—A spindle invented by Mr. M. B. Harvey, of Stafford, Ct., differs from any heretofore introduced among cotton spinners. It is a short spindle, costing fifty cents less per spindle in a frame than the live spindle costs. A warve is fitted to the spindle revolving around it. Projecting from the upper end of the warve is a tube, which, entering the base of the bobbin, gives motion to the bobbin in part, the other part being secured by a pin in the base of the bobbin, suited to, and entering into, a hole in the upper plane of the warve. Motion is communicated to the warve, and thus to the bobbin, in the same way as it is given on a frame of live spindles.

Improvement in Hat Felting Machines.—In a patented improvement of Jas. S. Taylor of Danbury, Conn., there is a large cylinder, having on its periphery a series of rollers, and over these is placed an elastic cover or jacket. The large cylinder rotates in one direction and the rollers in another. The hat bodies are carried around and felted by rubbing between the rollers and the jacket, and are discharged at the mouth of the machine, where they are put in. The machine is adapted especially for felting the finer quality of fur hats, for it gives a light easy motion to the felts, and works them in hot water. We are informed that two men can do three times more work with one of these machines than they can by hand.—*Scientific American.*

Flock Renovator.—An ingenious machine has recently been constructed by Mr. Charles Holt, of Stafford, Ct., for renovating the flocks used in the manufacture of woollen goods. It consists of a cylinder, fourteen inches long and twelve in diameter, covered with cast iron plates, on the outer surface of which are small conical teeth, one half inch in length. This cylinder revolves about two hundred turns per minute, in juxtaposition to an apron of iron, between which and the rotating cylinder the flocks pass, and from which they fall. While falling, they are pervaded by a strong tide of air from a blower, which runs about 800 turns per minute. By the wind of the blower the flocks are carried out through a prepared orifice, while other more ponderous and foreign matters fall under the machine. In this manner the flocks are renovated. The machine is made of iron, and costs about fifty dollars.

Napping Cloth.—Sir Charles E. Grey of England has taken out a patent for raising the nap of, and dressing woollen goods, by substituting a new material for the common teasels, which have been used from time immemorial for this purpose. He employs the prickly parts of plants known in the West Indies by the name of "nicker bush," and by some botanists called *Guilandina Bonduc.* These prickly burrs are stated to be far superior, for napping, to the teasels, and can be obtained in any quantity, and are cheaper.

Double Weaving.—William Norton of York, Eng., has secured a patent for weaving two webs of cloth at once in one loom. He employs two foundations of warps, and two shuttles, and these are placed one above the other with separate warp and breast beams. There are two shuttle raceways on the same lay, and a double dent reed is used. The two shuttles work across the web, one above the other, at the same time, and the operations are performed simultaneously. Two webs of cloth are thus produced at the same time in one loom, and thus, in a factory, space is economized by the double amount of work being executed in the same space in one loom. The looms, also, must cost less than single looms, in proportion to the amount of work they can execute. These looms, however, have this serious defect; the operative or weaver cannot well tie broken threads or notice defects in the lower web.

Twilled and Plain Weaving in one Loom.—R. A. Whytlaw and James Steven, of Glasgow, have obtained a patent for a self-acting mechanical arrangement in looms, whereby alternate twill and plain weaving can be executed in power looms. Four heddles are used, which are operated by four levers that are depressed by cams on a revolving shaft, which makes a revolution during the time that four *picks* are thrown by the shuttle. When the twilling action is required, the four heddle levers are worked separately in the proper rotation to make the twill: but when plain weaving is required on the web, the heddle levers are coupled in pairs, and the cam, as it comes round, actuates each pair at once, as with two heddles in plain work; the four heddles are then arranged precisely as in plain cloth weaving. In the loom of the inventors, the change from plain to twilled work is done by a self-acting device, and peculiar fashionable fabrics, part twilled and part plain, are thus woven.

PAPER HANGINGS IN OIL COLORS.

Mr. Peter Trumbull has secured a patent in England for the manufacture of paper hangings with oil instead of water colors. By the use of oil colors several objections to the use of paper hangings made from water colors can be obviated, such as the expedition with which the latter are obliged to be printed—the paper being necessarily wet, and each color printed separately—and which, therefore, does not admit of the proper working and classification of the colors employed, and although when dry they look rich and sightly, yet when varnished the colors sink and present a harsh appearance. The patentee, though using the ordinary paper, double coats it with composition made with a solution of india rubber, tallow, japan, soap, and size, in certain proportions, rendering the paper impermeable, strong, elastic, and durable. The paper thus prepared and dried is then (in the manner usually practised by grainers in wood) marbled, or otherwise ornamented with colors, composed of the following ingredients:—Oxichloride of lead or zinc, japan, turpentine, and raw linseed oil, mixed in the ordinary manner, to produce the desired colors. When dry they will have a gloss almost equal to one coat of varnish. Varnish can be applied to enhance the beauty of the paper, which does not require any preparation to receive it.

SUBSTITUTE FOR WOOD AND OTHER HARD SUBSTANCES.

Mr. F. C. Lepage has lately obtained a patent in England for a new composition of materials which may be employed as a substitute for wood, leather, bone, metal, and other hard or plastic substances, and the method of manufacturing which is as follows:—

It consists of a combination of sawdust and albumen. The sawdust may, if preferred, be mixed with vegetable, mineral, or metallic powders, and the albumen with any other glutinous substance: or instead of mixing the sawdust with albumen, the sawdust may be combined with any other glutinous or gelatinous substance, such as gelatine, or size, or with aluminous salts. Pure albumen extracted from eggs, blood, &c., is preferred for the purpose of the invention. The method of manufacturing the improved composition is as follows:—The patentee first soaks the sawdust (mixed with other powders or not) in pure albumen, slightly diluted and liquefied by water or otherwise. He then dries it well, and subjects it to pressure in an hydraulic press, or by any suitable means. He next places the substance in a mould of the required shape (preferring a mould made of steel) in such quantity that after forcing it into the mould it may exactly fill it, neither more nor less. While the pressure is being effected, heat is applied to the mould until the moulding is completed, by a steam jacket, hot plates, surrounding it with hot bars, by direct or radiated heat, or otherwise. As soon as the moulding is completed the mould is suddenly cooled by being immersed in cold water, by pouring water over it, or in any other suitable manner. Coloring or other substances may, if desired, be added to the sawdust and albumen. Metal castings or ornaments in relief in metal or other material may be applied on the composition before pressure, or the articles may be ornamented by engraving the inner surfaces of the moulds in which they are shaped. The new composition may be applied to the manufacture of a variety of articles for which wood, ivory, gutta percha, and other hard and plastic substances are now employed, such, for example, as pipes, chess men, picture frames, boxes, cornices, furniture, combs, knife and other handles, book covers, brooches, and various ornamental articles.

IMPROVEMENT IN THE MANUFACTURE OF SHIRRED INDIA RUBBER GOODS.

In manufacturing common shirred goods the rubber is cut up into threads by a machine which causes much waste of stock at the sides and ends of the sheet from which the threads are cut; much time is also lost in examining the threads, to see that none but perfect ones are used, and much labor is expended in the frequent sharpening required by the cutters. The threads produced by the machine are placed in a stretched state at a short distance apart between the cemented surfaces of two sheets of cambric or other cloth, and the whole is then passed through rollers, which cause the two sheets of cloth to adhere together in the spaces between the threads of rubber; but there is little or no adhesion of the rubber and the cloth, and the consequence is, that the durability of the goods is much less than it would be if all the parts of the rubber adhered to the cloth.

Mr. Richard McMullen, of New Brunswick, N. J., has recently invented an improved process whereby he is enabled to produce shirred goods with a sheet of india rubber lining the entire surface of the cloth, thereby obviating waste, and employing a much less weight of rubber to produce a fabric of greater strength, elasticity, and durability. This object has long been sought after, but all attempts to make every part of a sheet of rubber adhere between two sheets of woven fabric have failed.

The improved process is as follows: In the first place both sides of the sheet of rubber are roughened in its manufacture, by placing it between two coarse cloths and then passing it through calender or spreading rollers between the coarse cloths after it leaves the rollers; or by passing the sheet, before it becomes hard or set, between the surfaces of two rough rollers or any other surfaces suitable to produce a roughness or a series of minute cavities all over both surfaces of the sheet. It is next vulcanized, and afterwards boiled in a solution of potash to remove the sulphur which is precipitated on the surface after vulcanization, and which would prevent adhesion. After this the cement is spread over both surfaces of the rubber, and the cloth is applied in the usual way, while the rubber is kept at such a tension as is necessary to give the goods the degree of elasticity required, and the whole is passed between rollers which have plain smooth surfaces. Plain smooth rollers are the best for this purpose, as they insure better adhesion of all parts of the surface of the rubber and cloth; but a rib or figure may, if desired, be produced on the surface of the goods by grooving, embossing, engraving, indenting, or otherwise ornamenting the periphery of one of the rollers and covering the other roller with felt or some yielding substance. This rolling operation completes the process.

PERFORATED OR SOLID BRICKS.

Some experiments have lately been instituted at Belfast, Ireland, on the comparative sustaining power of patent perforated bricks and bricks of the ordinary kind. In each case a pier of four courses of the bricks to be tested was built, in Roman cement, on the table of a powerful hydraulic press, and allowed at least 24 hours thoroughly to set. A light scale board was suspended to the safety-valve lever of the press, on which there were placed successive weights, until the pier of bricks on the table of the press was crushed. The number of weights was increased a quarter of a pound at a time (being an equivalent to an increment of 10 tons on the press), commencing at 30 tons, this starting point being the effect due to the united weights of the level and scale board. The pump was worked very slowly, to eliminate the concussion produced otherwise by the inertia of the water. The first experiment was made with good ordinary brick, in a pier of 18 in. square, built in four courses. This showed symptoms of failing with 110 tons, and was crushed with 150 tons. A pier of the same dimensions of perforated bricks began to crack with 270 tons, and was crushed with 350 tons. Sir John M'Neil having expressed a desire to witness a repetition of these experiments, at his request a pier of 9 in. square of each kind of bricks was built in cement, in four courses as before, and with especial care to have the joints as thin as possible. The common bricks failed with 40 tons, whereas the pier of patent bricks sustained 120 tons before it was crushed. Reducing the result of these experiments to the effect upon a superficial foot, common bricks, in the first experiment, were crushed by $66\frac{2}{3}$ tons to the square foot, and by $71\frac{1}{9}$ tons to the second, the mean being $68\frac{3}{9}$ tons. Patent perforated bricks were crushed in the first experiment by $155\frac{5}{9}$ tons per superficial foot, and in the second by $213\frac{1}{3}$ tons, the mean being $184\frac{4}{9}$ tons.

A paper on the manufacture of bricks was recently read before the English

Society of Arts, and the importance of the trade to the country was illustrated by the following statement. The quantity of bricks made per annum in England is 1,800,000,000; Manchester alone making 130,000,000, London averaging about the same. Taking bricks at the low average of three tons per 1000, the annual weight would be 5,400,000 tons, and the capital employed 2,000,000 pounds sterling or nearly ten millions of dollars. The number of patents connected with the manufacture was stated to be 230.

PLASTIC ZINC FOR ROOMS.

At a recent meeting of the French Academy, M. Dumas communicated the particulars of a recent invention by M. Sorel, which promises to be of great advantage to plasterers and workers in stucco. He stated that the invention consisted in the discovery of a property possessed by oxychloride of zinc, which renders it superior to the plaster of Paris for coating the walls of rooms. It is applied in the following manner: "A coat of oxyd of zinc mixed with size, and made up like a wash, is first laid on the wall, ceiling, or wainscot, and over that a coat of chloride of zinc applied, being prepared in the same way as the first wash. The oxyd and chloride effect an immediate combination, and form a kind of cement, smooth and polished as glass, and possessing all the advantages of oil paint without its disadvantages of smell, &c. The inventor further suggests the employment of oxychloride of zinc as a paint for iron, and also to stop hollow teeth, for which its plasticity and subsequent hardness and impenetrability to the moisture of the mouth, render it particularly applicable.

Painting is now done in London by a hose. A reservoir of the paint or color is set on a parapet, and the workman uses a hollow brush connected therewith by means of a length of half-inch hose. The consequence is, that he works away with a never ceasing supply.

THE MECHANICAL ARTS IN JAPAN.

In the practical and mechanical arts the Japanese show great dexterity; and when the rudeness of their tools and their imperfect knowledge of machinery are considered, the perfection of their manual skill appears marvellous. Their handicraftsmen are as expert as any in the world, and, with a free development of the inventive powers of the people, the Japanese would not remain long behind the most successful manufacturing nations. Their curiosity to learn the results of the material progress of other people, and their readiness in adapting them to their own uses, would soon, under a less exclusive policy of government, which isolates them from national communion, raise them to a level with the most favored countries. Once possessed of the requisitions of the past and present of the civilized world, the Japanese would enter as powerful competitors in the race of mechanical success in the future. "Every American admired the skilful workmanship of the carpenters as displayed in the construction of the wood work in the houses, the nice adjustment and smooth finish of the jointing, the regularity of the flooring, and the neat framing and easy working of the window casements and movable doorpanels and screens. The general designs of the houses and public buildings were very inferior to the execution of the details of construction. The former were uniform, and probably in accordance with the ancient models, and showed a constraint of inventive power within rules doubtless prescribed by Government; while the latter evinced that perfection of finish which belongs to progressive experience. As in the carpentry so in the masonry, there was no freedom nor boldness of conception, but the most complete execution. Their stone was well cut, and their walls strongly and regularly built, generally in the massive Cyclopean style. The coopers were found to be very expert at Hakodadi, where a large number of barrels was constantly in the process of manufacture, for packing the dried and salted fish. The barrels are firkin-shaped, bulging at the top, and are rapidly and skilfully hooped with plaited bamboo. There are many workers in metal for ornamental and useful purposes. The Japanese understand well the carbonizing of iron, and the temper of much of their steel is good, as was proved by the polish and sharpness of their sword blades. The cutlery, however, in common use at Hakodadi was of an inferior kind, and the barber of one of the ships pronounced a razor purchased in the town as being abominably bad, neither cutting nor capable of being made to cut.—*American Expedition to the Chinese Seas and Japan.*

LIVERMORE'S BARREL MACHINERY.

It is difficult, if not impossible, to estimate how many millions of kegs, casks, barrels, butts, hogsheads, &c., in all their varieties, are annually required throughout the world. It has been said of the Chinese, whose skill in executing other impossibilities in wood is unapproachable, that they can make anything except a barrel; but throughout the rest of the civilized world we believe common consent agrees with the experience of ages in demanding for general packing purposes precisely the qualities found in these constructions, i.e. convenient size for handling, roundness for rolling, projecting chimes to be seized in hoisting, and a swelled bilge to allow of tightening by driving the hoops. Economy demands that the whole shall be of wood in separate pieces; but a due regard to efficiency and tightness requires a high degree of perfection in the workmanship. To fulfil all these conditions by machinery, and manufacture perfect barrels in any other manner than by the cooper's tools and the cresset fire, has come to be considered almost an impossibility. Machines for sawing out a form tolerably approximating to that of a stave have been put in use with good success for some purposes; and a powerful engine for biting off large shavings or chips in just the form desired has astonished the curious at all our fairs; and both these, with many others, have contributed their quota to the immense number of hooped and headed cases which inclose the flour, rice, beans, fruit, and "sundries" in transportation or storage in our widely-extended country. But the importance of tolerably tight and well made barrels for flour is plainly apparent in every warehouse, where the waste of the "double extra," "fancy," "superfine" material can be observed, and the employment of barrels absolutely water tight, by preserving the flour from damage, would under many circumstances add a large per-centage to its value. The hand made barrels generally used for good flour cost in New York State from 35 to 45 cents each, and in many milling localities as high as 60 cents; while barrels made sufficiently tight for containing oil are sold at nearly or quite five cents for each gallon of cubical contents.

A machine, or rather set of machines, designed for the purpose of manufacturing the parts of a barrel with perfection equalling or excelling that of hand labor, has been lately invented and put in use by Mr. Geo. W. Livermore of Cambridgeport, Mass. The practical working of the invention leaves no room for doubt that it is capable of producing barrels absolutely perfect in form, strength, and tightness, as well as in beauty of appearance. This last element depends in a high degree on the perfection of the planing machine previously employed upon the stuff, a species of machinery of which the powers are well understood, and therefore may be passed over very slightly.

In Mr. Livermore's invention the staves are "shaped" by a process somewhat analogous to the steaming and bending in common use, or perhaps still more to the ship timber bending about which some noise was made a few years since, but which, like the electric telegraph in the country legislator's grave opinion, "would do well enough for small bundles, but never for large packages." In one vitally important point, however, it differs from any such process, and that is its instantaneous action. The bending is accomplished in a twinkling by passing the flat sawed stave, after smoothing it in a Woodworth's planing machine and exposure to a mixture of air and steam at about 310 degrees Fah., through a series of some half dozen pairs of slowly revolving rollers, so shaped and disposed as to curl it both edgewise and endwise, and at the same time slightly compress and fill its pores. The wood slightly straightens itself again as it leaves the rolls, and then retains its form under all circumstances with a very commendable pertinacity. The previous sawing of the stuff is done as usual by circular saws, and the seasoning by a few hours' exposure in a suitable kiln. The previous planing having reduced the stuff to an uniform thickness, the only remaining operations of interest are crozing the grooves across the ends to receive the heads, bevelling the chimes, and jointing and planing the edges. These operations are all performed by the same machine, each stave being separately clamped in a horizontally swinging frame, an operation which springs it into its correct form, whatever may be the tendency of its own elasticity. This clamping is performed very rapidly by a single movement of a lever operated by hand; and by urging the frame first against a rapidly working vertical plane on one side, and then against a similar planing device on the other, the edges are jointed with perfect smoothness, and in the perfect varying bevel desired, while the operations of crozing, sawing off, and chamfering at each end, are done by circular cutters revolving on a vertical shaft, past which the stave is compelled to move in the transition. The heads are turned in a lathe, being chucked in as many separate pieces as desired, by a very simple and familiar arrangement.

In the size ordinarily wrought sixteen staves of equal size are required for a barrel. A set of machines consists of one shaper, one head-cutter, and *four* jointing machines. The shaping is performed at the rate of twenty staves, or $1\frac{1}{4}$ barrels per minute. The jointers each finish four staves per minute, and the whole operation is so conducted that eight men and four boys are able to manufacture, under favorable circumstances, the staves and heads for about four hundred barrels a day, at a cost of about six cents per barrel, to which an amount, varying with the location from 4½ to 16 cents, should be added for the expense of the lumber, and about 10 cents for hoops and putting together.

NEW GRINDING MILLS.

Mr. Thomas Blanchard, the well known inventor, has recently constructed a grain mill on an entirely new and novel principle. Instead of grinding, it saws the grain or whatever substance is put into the hopper.

For a handmill, steel disks, about two inches diameter, are struck out of sheet steel, with serrated edges, so as to make a notch or tooth every half-inch or inch around the edge. These disks are put upon an arbor with plates or washers between each pair, of the same thickness as the saws, till the arbor is covered about an inch in length. Another set exactly like this is placed upon another arbor, so arranged that the edges come between the saws on the other arbor; the two being geared together so as to make them revolve towards each other. These sets of plates may be continued to an indefinite length, each set being finer than the preceding.

The hopper is made to discharge fast or slow by the same motion of the driving crank, to suit the strength of the operator. It is also made to slide so as to bring the opening over each set of disks. Now, supposing you want to grind corn just fine enough for hominy, the hopper is set over the coarsest set of disks, and the corn run through, falling upon a shaking screen that sifts out all the finer portion. Now if you wish to grind that still finer, push the hopper forward and run the meal through again and again.

As the teeth can never touch each other, so as to wear off dull by the grinding operation, like the cast iron mills or burr stones, they will continue sharp until worn out by the grain itself, which they have failed to do in six months' use. As before remarked, the grain is not ground; it is cut up by these little circular saws, and whatever comes in contact with them is reduced to sawdust, either coarse or fine, according to the saws in operation. A mill can be built upon a large scale to go by power, so as to grind grain of half a dozen degrees of fineness at the same time.

The inventor fully believes that this principle of reducing grain to fineness will take less power than any other ever before applied to that purpose, and we believe that every one present fully concurred in this opinion. It grinds every description of grain with equal facility, and will not clog with wet oats or buckwheat.

A new mill for grinding wheat, recently patented in England, has its peculiarity in combining, in one mill, steel and stone grinding surfaces. The first and upper grinding surface is formed of a vertical steel cone which revolves in a correspondingly shaped fixed cone, and below these cones ordinary grinding stones are fitted horizontally. The corn or other grain is fed into and between the steel cones from a hopper, and in its passage through them becomes very quickly bruised and converted into meal, for which purpose it is well known that steel mills are better adapted than stones. After being so converted, the meal falls between the horizontal grindstones which reduce the meal into flour. The great advantage consists in apportioning each of the grinding surfaces to perform the portion of the grinding operations to which they are best adapted, the steel for converting the grain into meal, and the stones the meal into flour.

CHEAP ROOFING FOR HOUSES.

In all new settlements, whether timbered land or prairie, there is a difficulty in procuring building materials, and the most difficult of all is a good material for roofs, something as a substitute for shingles where shingles cannot be easily obtained. Sawed boards are often substituted, but they form a very unreliable protection; and unless the board roofs are built very steep, they are only a make-believe, and are withal quite liable to take sailing orders from a "norther" as it sweeps unobstructed across the prairie. The best substitute for shingles, probably, is a roof made of tarred paper; and it has this great advantage, that the work can be done by any common hands, and the transportation is not heavy, or the material expensive. There is a tarred paper sold at five cents a pound, one pound of which will cover a yard square, or say half a cent a foot; but we think this paper is rather too thin; we should prefer to have it twice the thickness, such as the thin, spongy straw board paper used for light cheap boxes. It does not require to be strong, and perhaps the cheap article alluded to will answer perfectly; if so, a roof can be made for one cent a foot. This paper comes in rolls, and may be laid in courses up and down or across the roof, so that the edges are lapped, and tacked with common No. 6 tacks, which would be very much improved by using leather under the heads, as is often done in tacking carpets. The composition for covering a paper roof is made of the following ingredients: good clean tar, 8 gallons; Roman cement, 2 gallons; rosin, 5 lbs.; tallow, 3 lbs.; boil and stir, and thoroughly mix all together, and use hot, spreading it evenly, in a thick coat, over the paper, which should be tacked upon thoroughly seasoned boards—kiln-dried are best—well nailed up and down on lath fastened to the rafters. The roof may be quite flat, rising only one foot in twelve. In nailing on the paper, lap the courses as you would shingles, and commence putting on the composition at the upper edge and work down, and while the coating is still hot, let a hand follow and sift on sharp grit sand, pressing it into the tar with a trowel or back of a shovel. When the first coat is cool, go over with a second, and again with a third, and afterwards once in five or six years, as long as your house stands, and you will have a tight roof.

In place of the Roman cement, you may use very fine, very clean sand, that is, silex in a state of impalpable powder. The paper is such as is used under the copper in sheathing ships; it is a soft spongy paper that soaks up the tar, which penetrates through and glues it to the boards, and the sand seems also to penetrate the substance of the paper, making it like stone. The paper should be nailed on with short tacks with flat heads. The principal objection to a paper and tar composition roof is its combustibility; but that is easily remedied, for it can be very cheaply made incombustible with Blake's paint, or with a paint made of common water lime, mixed with any cheap oil; or with the following cheap preparation. Slake good stone lime under cover, with hot water, till it falls into a fine dry powder. Sift and mix six quarts of lime with one quart of salt, in two gallons of water, and boil and skim off any impurities. Now to 5 gallons of this mixture add 1 lb. of alum, ½ lb. of copperas, and slowly, while boiling, ½ lb. of potash, and 4 quarts of clean sharp sand, and afterwards any coloring matter desired, and apply the mixture with a brush, as you would any paint, only thicker, and it forms a strong surface, impenetrable to water, and incombustible from heat or sparks that would ignite any ordinary wooden roof.

The rafters for such a roof should be stiff, but may be made of stuff 1¼ in. by 8 in., if well supported, and placed 6 feet apart, with ribs 1 in. by 2 in., set edgewise, and well nailed to the rafters, not over 18 in. apart. The boards may be thin, if well nailed to the ribs, but must be absolutely well seasoned, and if put on and covered while hot from the kiln, all the better. One of the advantages of such a roof is the ease with which it can be moved in after years, either on the building, or by transferring it in sections to another, which in all border towns is no small item of advantage.—*New York Tribune.*

INDUSTRIAL RESOURCES OF MASSACHUSETTS.

The increase in the industrial resources of Massachusetts within the past ten years is one of the most remarkable facts connected with the history of our country during this period. When the industrial statistics of the State were first collected, in 1837, they exhibited an annual production amounting to $86,282,616. In 1845 the amount was $124,749,457. It has now swelled to $295,820,681—an increase of one hundred and thirty-eight per cent. since 1845, and two hundred and forty-two since 1837; and this while the increase of population has been only thirty-four per cent. since 1845, and sixty-two in the longer period named. "And yet this result," says the Secretary, in his report, "so surprising in itself, falls manifestly below the reality. Leaving out of the account those branches which were unfortunately omitted in the specific inquiries, and making all possible allowance for the greater accuracy attained in the collection of the information embodied in the accompanying pages, it is still apparent that the truth has not been reached. It is next to impossible for the taxpayer, when called upon by the assessor to answer such questions as were propounded under the law, to divest his mind of the impression of an intimate connexion between his answers and the assessment of his taxes. Hence the general tendency to understate results, and an absolute refusal in numerous instances to answer at all. Had those branches which were overlooked been included in the returns, and honest and truthful answers obtained in all cases to the questions proposed, I am fully persuaded that instead of two hundred and ninety-five millions, we should have had an aggregate of at least three hundred and fifty millions, or considerably over one million of dollars per day of every working day in the year. As it is, the result exhibits a rapid and substantial growth in our industrial resources which is believed to be without a parallel in the history of the world."

MEANS OF ARRESTING FIRES.

Mr. D. J. Murphy of Cork, Ireland, publishes the following plan for arresting and extinguishing fires.

"It is simply saturating the water discharged from fire engines with a certain proportion of chloride of sodium (common salt) and potash, both cheap articles; and, indeed, the former alone will be found quite effectual in all ordinary cases. The proportion of these ingredients to be employed may vary from one-tenth to one-thirtieth of the weight of the water so discharged, of which it will be found that a considerably less quantity will be required, from being so saturated. In low elevations, and where the flame has not reached a great height, the stronger impregnation may be used with advantage; but when the flame has arrived at a considerable elevation, the weaker impregnation can only be employed, arising from the greater resistance of the air, the increased weight of the materials, and the augmented difficulty of the stronger impregnation passing through the valves of the fire engine: though, even then, it can be successfully discharged to attack the flame at its root or base, which is, perhaps, the best course to adopt in all cases. A fireman, in his ordinary dress, and simply armed with an elastic tube conveying this stronger impregnation, may boldly and securely face the strongest and fiercest flame, and make himself a passage through it, by commencing cautiously at first to discharge the impregnation on each side of him; for, where it falls, it not only subdues the flame, but, by leaving a coating of the materials, it prevents it from readily catching again the substance on which it previously fed; the result being that the muriatic acid becomes volatilized, and flies off, while the soda, which is indestructible, is converted into a glaze on the surface. The root or base of the flame is therefore the point to which the force, power, and efficacy of the impregnation ought always to be directed.

"This impregnation, it is to be observed, can be so managed, by the addition of other ingredients, when found necessary, or where the expense is disregarded, such as the diluted mineral acids and their salts, as to produce a temperature approaching, and even considerably below, the freezing point on Fahrenheit's scale, and yet preserve its fluidity; for it is by its chemical combination it acts against the flame, and also in serving to reduce the temperature of the surrounding heated atmosphere. The effect of several engines acting at the same time, by the weaker and stronger impregnations, must be all powerful, as may be easily conceived; and no fire, whatever degree of head it may have previously attained, can resist the power and efficacy of this impregnation for any period exceeding half an hour. Even water, saturated with finely powdered clay, chalk, slaked lime, &c., all cheap articles, and slow conductors of heat, may be employed with great advantage on flames of low elevation; for it is to be impressed that water is alone used as a medium for conveying these substances, as well as the others, to the body of the flame, or rather to its source—such as the substance on which it feeds. Let this be completely coated with these ingredients; for the water will be quickly evaporated by the intense heat, and the effect sought—namely, the extinction of the fire—will be the immediate and necessary consequence."

IMPROVEMENTS IN MUSICAL INSTRUMENTS.

Driggs's Improved Piano.—In the *Annual* for 1856, we briefly called attention to an improvement in the piano, invented by Mr. S. B. Driggs, of New York. (See *Annual. Sci. Dis.*, 1856, pp. 128, 129.) The following is an additional notice of this improvement:—

Before speaking directly of the new piano, it will be as well to examine the points in the old, which the patents are intended to supersede. The case in the old system is made very stoutly, the wood upon which the whole strain of the strings rests being some two inches in thickness; this is aided materially by an iron plate or upper frame. It must be understood that the tuning pins, to which one end of the strings is attached, are inserted in a pin block or wrest plank, and pass through holes drilled in the iron frame much larger than the pins, so that there the iron frame bears no portion of the strain, which is all upon the wrest plank attached to the case. If that gives in the least, the whole instrument is disorganized, and whether it gives or not, depends upon the ever variable quality and the seasoned age of the wood. To guard against this as much as possible, and to counterbalance the strain, which is all on the top, a bottom six inches thick is put to the piano, and heavy sustaining blocks of wood fill up the whole interior, leaving only space sufficient for the working of the action. We here find a vibrating instrument with a monstrously thick non-resonant bottom—a non-resonant case, and lumbered to its utmost possible capacity with non-resonant blocks of wood, the only actual vibrating surface being the single sounding board. Upon the slightest reflection this seems all wrong; for we might as well fill up a fiddle with blocks of wood, or stuff up the interior of a drum, and expect them under such circumstances to produce a pure and resonant tone.

In Mr. Driggs's pianos is found the exact opposite of all this. The case is a mere shell half an inch in thickness, which merely surrounds the frame. This frame is composed of upper and lower light iron plates and bars, bolted firmly together by means of connecting arms. These arms pass through the wrest plank or pin block, which is entirely disconnected from the case, and thus the whole strain of the strings is borne by the perfect iron frame (not merely an upper plate), and all the strength derived from the wood, which must ever be uncertain, and subject to changes from temperature, is avoided and dispensed with. Solid, compact, and self-sustaining, the iron frame neither yields nor gives, and the strings, when once settled to their proper tension, will remain at that pitch for months, and, practical tuners say, for years.

Instead of a bottom six inches in thickness, the bottom of Mr. Driggs's piano is but *one eighth of an inch thick.* It is pressed tightly into a slight frame of scantling, which gives it a convex form, like the back of a violin, and renders it as stiff and sonorous as a drum head. The sounding board proper is pressed into a light iron frame, and is retained stiffly in a form, convex to the bottom like the belly of a violin, and all the space between the bottom and the sounding board is clear and open. Not a block of wood encumbers its area; it is a vast sound box, with vibrating sides, vibrating top, and vibrating bottom A wooden sound post passes from the bottom to the sounding board, so that the slightest vibration on either sensitive surface is instantly communicated to the other.

One other point, and the two modes of manufacture are contrasted.

To produce a clear, pure tone—a tone which will remain clear and pure when forced with the utmost power, there should be no impediment to disturb the *direct* vibration of the strings. In the general system of manufacture, when the string reaches the bridge, its straight line is diverted by two pins which receive it to the right of one, and to the left of the other, thus forming a zig-zag, which was thought to be necessary to keep the string in its place, and prevent rattling at the bridge. This produces what is called a side bearing; that is, the direct up-and-down vibration is stopped at the bridge, a side motion given, and the struggle of the two motions resulting eventually in a disturbed rotary vibration, which is more impure the more it is enforced, and producing much loud sound, but no true note.

In Mr. Driggs's piano all this disturbing influence is obviated by means of *saddles* placed over the bridge, and fastened at each end to the sounding board. These saddles have two ridges; the foremost one is drilled, and the string passes through this, and over the other, thus preserving the tension, obviating all rattle, and allowing the string a direct unbroken run from end to end. The result of this invention is, that the blow of the hammer produces a clear, pure, and undisturbed vibration, and, no matter how hard the blow received by the string, it is not possible to knock out *noise;* and increased power will be obtained in proportion to the blow, but it will be tone, pure tone, rich, deep, and sonorous.

In this connection, we would also notice an improvement claimed in England for the construction of the sounding board, which is described as follows:

One of the greatest improvements in the construction of pianofortes has been the efficient support of the sounding board, without impairing its powers of vibration. Being a large thin piece of wood, it is peculiarly liable to be acted upon by the weather; moreover, the bridge, over which the strings are strained, exercises an enormous pressure, requiring adequate resistance to prevent starting. But every endeavor to support the sounding board against this pressure, and to keep it flat in all weathers, has hitherto interfered with its vibratory power, and injured the tone and touch of the instrument. It has been reserved for Mr. Dreaper, of Liverpool, to overcome the difficulty, and to discover a means of supporting and regulating every portion of the sounding board, in such a manner as greatly to increase the vibratory power, and, in consequence, to improve the tone throughout, and to obtain other correlative advantages. He has taken out a patent for it, and we have no doubt he will reap from his discovery as great benefit, pecuniarily, as he has conferred on the lovers of music by his improvement of that soul of private harmony—the pianoforte. Like most real improvements, it is so simple as to make every one wonder that it should not have not been discovered before. The supports, instead of being solid, as hitherto applied, are hollow, and in themselves vibratory. Mr. Dreaper calls them "harmonic chambers" and "compensating bars," which are elastic, and are so contrived as to force them against the sounding board, wherever support or resistance may be required. The sounding board is thus protected from the pressure of the bridge and the effect of the atmosphere; and, being kept more true in its relation to the strings, the sounds produced by the striking of the keys are more uniform in their results, have less tendency to get out of tune, and, from the additional vibratory structure, are fuller, rounder, and more musical in quality. The touch is correspondingly improved, as the strings respond to the slightest touch of the hammer.

Improved Violin Bow—By Samuel F. French, of Franklin, Vt. When the musician wishes to execute a delicate passage upon the violin, he turns the bow over, so that only the edge hairs will scrape the strings. The present improvement consists in attaching the ends of a few of the hairs to a spring pin, placed in the handle of the bow; whenever a fine tone is wanted the operator compresses his hand and pushes out the pin, and thus separates, or throws out beyond their fellows, those hairs that are connected with the pin. The music produced by the separated hairs will be of the most delicate nature. By loosening the hand the pin instantly flies in, and brings all the hairs instantly together again. This improvement does not interfere with the straining of the bow.

Musical Notation.—Mr. W. Striby, of London, has recently taken out a patent for a new system of musical notation, the object of which is to reduce all the musical clefs, scales, and systems to one single scale; or, rather, a single system of scales. A new shaped set of clefs is adopted, by which a given note will retain the same relative position upon the staves for all instruments and clefs; and, instead of using only five lines in a stave, he employs a greater number, having one called a "union line," differing from the others in size or color, to render it conspicuous, to enable a person to distinguish the position of the notes more readily.

Registering Music.—Composers and extemporizers of pianoforte music have long been in want of some contrivance that should register the notes of a musical composition as fast as they were struck upon the instrument. Many attempts have been made to produce such an apparatus, but never, we believe, with real practical success. Their parts have generally been too complicated and uncertain for utility. An invention, by Joseph C. Day, of Hackettstown, N. J., seems to effectually overcome all difficulties. It consists in placing across the top of the piano a frame, in which an endless apron of paper or other substance is made to revolve by means of a weight or spring. A series of light perpendicular rods extend down from the frame, the lower ends of which rest, one upon each key. The upper ends of the rods are furnished with markers; whenever a key is pressed the rod which rests upon it also falls, and its marker touches the revolving paper, leaving a mark indicative of the note touched. When the finger is removed, the key rises and carries up the marker away from the apron. If the paper is lined off laterally and longitudinally, the composition may be easily read and copied by the operator. The length of the notes will be shown by the length of the mark.

Portfolio for Binding Sheet Music.—In an invention for the above purpose, patented by James Shaw, of Providence, R. I., a roller, constructed of wood, is permanently attached to the back of the portfolio, on the inner side of the covers. The roller is equal in length to the covers, and has a longitudinal groove cut in it its entire length; it also has grooves cut in it circumferentially at equal distances apart. Metallic rings are fitted loosely into the grooves. The music sheets, maps, engravings, or other articles, are secured to the rings within the portfolio, by means of a needle and thread.

Improvement in Melodeons.—In ordinary melodeons the keys are quite short; they do not extend back like piano keys, but terminate just at the fulcrum. Attached to the under side of each key, in a melodeon, is a wire projecting downwards, known as a "push-down pin;" when a key is pressed, this pin comes in contact with a pair of corresponding reed valves, opens the same, and musical sounds result. In the best melodeons each push-down pin opens two valves, so that for each pressure of a key, two different sounds are produced. An invention, by T. F. Thornton of Buffalo, N. Y., consists in elongating the rear end of the key, and placing upon the upper surface of the extended part a "push-up pin," arranged in connection with an additional set of reeds and valves. The result is that whenever a key is touched, four musical sounds, forming a chord, are produced, instead of two, as heretofore.

SEROPYAN'S PROTECTIVE PROCESS AGAINST COUNTERFEITING.

In the plan proposed by Mr. Seropyan, the paper, before the printing, is tinted over the whole surface by means of an oil color, excepting that in certain parts of each bill, five or more, the denomination is indicated in large letters or figures, which are left white like the uncolored paper. After this comes the printing of the engraved plate. To alter such a bill, it is necessary to color up, precisely to the general tint, the white letters and figures, expressing the denomination, so as completely to obliterate them, and, at the same time, not obscure the engraving over them.

The new plan prevents photographic copying by means of the peculiar color and nature of the ink, and also of the color of the paper; and from the results of trials with Seropyan's bills which have been examined, as well as from known principles with regard to the impossibility of obtaining distinctness in a photograph when the object copied has certain shades of color, it is believed that the method is a complete protection.

In copying a print by any anastatic process, the ink of the letters, or of the engraved lines, does not absorb the corrosive liquid with which the paper is moistened, and upon this difference between the clean paper and the ink lines, the possibility of anastatic copying depends. Now in the Seropyan mode of printing bills, the general face of the bill being covered with oil color, there is no such distinction as is here required; whatever means may be used to remove the oil will obliterate the printing. Hence the anastatic method cannot possibly be used in copying such bills.

POWERS' SYSTEM OF MODELLING.

The following is a description of the new method of modelling recently introduced by Powers, the American sculptor:—The original block is constructed in a masonry of small bricks of "gesso," laid in plaster, and of dimensions varying from three to four inches long by two to two and a half inches wide, and about three quarters to one inch thick. These, piled together, become a homogeneous mass of sulphate of lime, and an easily workable artificial stone. The block so made is next chipped down to the required size, the component limbs and trunk being hewn out of the solid, principally by the aid of small and light chisels and hammers. Upon the scaly chipped surface of the figure in this state (when it resembles a lepidodendron more than anything else) the modelling of the muscles and features is effected in a paste of plaster, dabbed on with trowels, floats, and finally spuds of various sizes. The finished surface of the nude is lastly worked up by hollow files, pierced at one end, like a colander, with holes, half round which a tooth is raised. These files are extremely effective; they are made by the artist himself, of every shape, size, and curvature, and rasp the dry plaster away beautifully, leaving a pleasant texture of surface.

In the fingers and extremities of the plaster model copper wires are inserted, being the only representatives of the unwieldy mass of iron framework necessary for the setting up and support of a clay model; these wires, by their ductility, afford sufficient liberty for changing the pose and attitude of members, if, as the work proceeds, occasion arises for so doing. A finger, for instance, requires to be more bent; it is sawn through to the wire at the joint, the wire is twisted into the required position, and a fresh modelling of the joint muscles is alone required. The wires, in fact, take the place of bones.

For finishing the limbs of his figures with that extreme nicety which he does, Mr. Powers adopts a bold and novel mode. He has invented a vice, which is set upon a ball and socket joint, and has, by virtue of raising and depressing screws, every possible variety of motion. This instrument is the perfection of ingenuity. The sculptor cuts off from his figure an arm, a head, a leg, when modelled sufficiently for his purpose, and, fixing it in the vice, turns, twists, scrapes and polishes it at his ease, to the most detailed finish. In cutting off, a dowel is inserted into one side of the cut, and a mortice hole left in the other, and these are so arranged, with regard to a groove which is first made on the outside of the limb, as to insure an absolute accuracy in refitting. By arrangements of this kind the working of the torso is rendered much less difficult than when covered in part by limbs stretching before it, and the finishing of the nude to that exactness which Mr. Powers always adopts before touching the drapery, becomes a less tedious operation.

The several advantages obtained by this system are, the saving of one whole operation, viz. casting, the model itself being used for the points; the convenience of being able at any time to put aside or resume a study without that intervening watchfulness, and care in moistening and covering up, which a clay model requires; the more absolutely sculpturesque nature of the designing itself; the facility of bending the extremities when modelled by means of their central wiry bones, which would only cut through instead of moving the clayey limbs; the saving of time and labor, by remodelling a portion only, instead of a whole limb, when slightly altered in position; and, lastly, the better anatomical exactitude with which members detached from the body may, as members, be worked.

SUBMARINE AND SUBSOIL MAPS.

As far back as the year 1852, Professor Forchhammer, of the University of Kiel, suggested in a speech to the assembled *savans* of Germany at their annual gathering at Wiesbaden, the possibility of constructing submarine charts on the same principle as the common geographical maps, with a shading of greater or less strength to denote the mountains and other inequalities of the bed of the sea. That gentleman has just now had a map on this principle engraved. It is intended to illustrate a work of his now in the press on the Ruins of Troy, and represents the sea between the Island of Tenedos and the opposite coast of Asia Minor, including therefore the classic spot where the Greek fleet lay at anchor, the rendezvous of the different naval contingents to the memorable expedition to Troy. This submarine map is partly based on the soundings taken by H. B. M. surveying ship Beacon, and published in the Admiralty charts, and partly from the observations made on the spot by the learned professor himself, who spent a long time in those classical parts for the purpose of studying their topography. He proposes to call the charts constructed on his new system, "Bentheographical Maps."

Subsoil Map.—M. Dumon, of Paris, has recently constructed, by order of government, a map, exhibiting the nature and character of the subsoil for the whole of France. It is designed to be used with, and to accompany another map descriptive of the geographical and geological features of the surface. The one map exhibits with the greatest accuracy all information pertaining to the surface, while the other reveals what lies immediately below the surface, thus affording indications of great value to the agriculturist, and to those engaged in searching for minerals or building materials.

COOKING WITHOUT FIRE.

Mr. W. W. Albro, of Binghamton, N. Y., has invented a contrivance for this purpose, which consists in a combination of tin cooking dishes placed above each other, the bottom of one vessel fitting into the top part of the dish below, &c. In the lower dish of all, the inventor places a small quantity of quicklime, and then by means of a tube introduces a little cold water; a strong chemical action ensues, and intense heat is instantly generated, whereby articles of food, such as meat, vegetables, &c., placed in the other dishes, will be cooked in a very short time. The inventor states, that a tin contrivance of this kind, not occupying greater space than an ordinary bandbox, will do the cooking of a family of five persons. It is also adaptable for working men's dinner pails, enabling them to enjoy freshly cooked and warm meals.

GAS AND ATMOSPHERIC AIR COOKING.

There is probably no greater popular error than the idea that the *brighter the light is the greater the heat,* since it is a well known fact that many substances which give scarcely any light, are remarkable for their heating properties. Thus alcohol and pure hydrogen gas give but little light, while their heat is very much greater than that of the bright, shining flame of a candle or lamp. It is evident, then, that the production of light and heat involves principles which require entirely different contrivances when we desire to obtain the best effects.

When carbureted hydrogen gas is used for illumination, the light is due to the combustion of the carbon with the hydrogen of the gas, and the oxygen of the atmosphere. As the action of the oxygen is confined to the exterior surface of the gas, the greater the surface exposed, in proportion to the bulk or volume of the gas, the more brilliant will be the light; to attain this object, the gas is usually thrown from the jet in the form of a thin sheet, as in the "bat wing," or in a thin ring, as in the "argand" burner. There is, however, a limit to the tenuity of this sheet or ring, from the necessity of having a sufficient volume of gas, to allow a large number of particles of carbon to become ignited at the same time, because it is from their ignition that the light proceeds.

Under these circumstances, more gas generally passes through the jet than is consumed, and the proportion which is thus wasted depends upon the purity of the gas, and the construction of the jet from which it is burned. It is a natural inference, therefore, that the most wasteful method of using gas, either for light or fuel, would be to burn it from separate, round-hole jets, because in this form there is less of the gas exposed to the action of the oxygen than in any other.

Having thus explained the process of illuminating by gas, let us now examine how these principles should be modified so that the gas may be used to the best advantage for fuel. In this case, heat is the sole object, and the *perfection* of any process would be to consume *all* the gas, and be able to control all the heat which it evolves. To obtain this result, as far as possible, it is essential, 1st. That not the surface only, but all the *particles* of the gas, should be brought in contact with the oxygen. 2d. A due regard to economy requires that no draft should be created around the jet by heat or otherwise, by which the gas will issue irregularly, causing a greater consumption of gas at one time than another. 3d. The products of consumption should be made to add to the heat, or be so disposed of as to prevent any unpleasant or noxious effluvia from passing off.

IMPROVEMENTS IN GAS APPARATUS.

Shades for Lamps and Gas Lights.—H. Gillen, of London, has taken out a patent for making globes and shades composed of prisms of glass. They are strung together, and made to assume the proper form on a frame. By varying the shape of these prisms, very beautiful and novel effects are produced.

Improved Gas Apparatus.—Mr. A. Longbottom, of London, has obtained a patent for constructing retorts for making gas from oil, with an interior cone in each, and convex on the outside, to contain the fire. Each retort has also a false perforated bottom, under which is placed a mixture of charcoal and lime. The oil is permitted to enter the retort and drop on the red hot apex of the cone, when it is converted into gas. The gas cannot get out without passing through the perforated bottom and amongst the heated mixture of charcoal and lime, which tend to purify it. From the retort it passes to the cooler, where it is washed with water, and from thence into a receptacle for use.

Improvement in Gas Retorts.—The object of an invention by J. G. Hock, of Newark, N. J., is to enable the heads of the retorts to be more handily and quickly attached and detached than the mode of fastening them at present in general use admits. Another object is, to enable the fastening to be readily detached from a worn out retort and applied to a new one. The neck of the retort is cast with a strong lug on each side, close to the mouth, said lugs having a square hole through them to receive the square shanks of two hook headed bolts, which, with a bail and an inclined projecting rib, on the outside of the retort, constitute the fastening.

Improved Gas Burner.—An improvement has been recently brought forward designed to be used in connection with burners where the flame is produced by the combustion of two jets of gas issuing simultaneously from the top of the burner. The improvement consists in placing a small blade of metal on top of the burners, between the gas orifices, so as to more fully separate and spread the two jets, and cause the flame to be broader; the metallic blade is also alleged to act as a receiver, and by becoming itself highly heated, to impart additional caloric to the gas, and thus produce better combustion. The blade is quite small, and the two jets unite above it in one common flame, in the usual manner, excepting that it is broader and larger than it would otherwise be. The invention is said to be applicable to nearly all burners now in use, and it is claimed for it that it effects an important purpose,—that of increasing the illuminating power of the gas without augmenting the consumption.

KNIGHT'S SAFETY ENVELOPES.

Mr. R. T. Knight, of Philadelphia, has recently patented an improvement in envelopes for valuable and important letters, with the double purpose of making the envelope, post-mark, &c., a part of the letter, and of preventing any clandestine opening of the same. It is, for some purposes, quite a defect in the present envelope that the gum may be moistened and the letter opened without discovery. Wafers may be soaked nearly as easily, and wax is liable to melt in hot climates. In Mr. Knight's invention a little more paper is used, and the flaps being locked together by a species of dovetailing in addition to the gum, a metallic clasp or eyelet is put through the lower portion near the edge, which effectually secures the whole package. An eyelet through a letter folded in the ordinary manner would not only prevent its removal from the envelope, but would interfere with its unfolding when properly opened. To avoid this difficulty the paper is to be folded with its edge projecting, and this edge, rather than the folded portion, is allowed to receive the eyelet. By this arrangement the soaking or tearing open of the usual flap of the envelope does not release the letter, and the process required is a tearing or cutting around on three sides of the envelope, after which it may be opened like the cover of a book, and the contents unfolded. The letter thus goes on file carrying the envelope with it, as a testimony of the time and place of mailing, and also of any misdirection, returning, &c., which often might render such a matter of importance.

INDIA RUBBER BUTTONS.

A style of button for overcoats and general business clothing has been introduced within the last two years, which grows more shiny with age and wear, and in its every quality seems to be an admirable button. It is made from one of the Goodyear varieties of prepared rubber, and a manufactory is now in operation in New Brunswick, which gives employment to some two hundred hands, male and female. The buttons have until this season been held at so high a price as to a great extent to prohibit their introduction, but a material reduction has, we learn, been lately made, which bids fair to render them the standard style for the class of clothing described.

IMPROVED TOILET GLASS.

An improved toilet glass exhibited at a recent exhibition of the London Society of Arts, presents the peculiarity of reflecting the back of the head as perfectly as it does the face, on one surface at the same time, thereby enabling a lady to arrange her back hair with the greatest ease and precision. A brass telescopic rod with a circular mirror suspended from it, is attached to the top of an ordinary toilet glass by means of a thumb screw, and when the rod is drawn out, the back of the head is at once reflected in the glass; when not required for use, the circular mirror can easily be placed back at the top of the glass out of the way, so as not in the least to interfere with the ordinary use of the glass.

NEW WAY TO CLEAR A HOUSE OF RATS.

A correspondent communicates a novel plan adopted by him to free his house from rats, and which proved perfectly successful. His house had been completely overrun by them, and he had tried every means to get rid of the vermin but without success, until he hit upon the following expedient:—Raising a small board in the garret floor, he opened a communication between the floor and ceiling beneath, which interior communicated with the spaces between the side walls and the laths and plaster over the whole house. Into this opening he placed a dish containing finely pulverized black oxide of manganese, and poured over it a suitable quantity of strong hydrochloric (muriatic) acid. The floor-board was then replaced. The effect of the chemical mixture of black oxide of manganese and hydrochloric acid is to disengage slowly in the cold that most powerful, deodorizing, fumigating gas, chlorine. In common with all gases, it gradually diffuses itself through the air, but having a greater weight than atmospheric air, it accumulates at the lowest levels. The tendency of the gas liberated, therefore, was to penetrate every vacant space between the walls and ceilings, and at last found exit in the cellar.

It may be here stated that the quantity of gas so liberated can exert no injurious effect upon the house or its inmates—indeed the result is rather beneficial than otherwise upon the general health. In the case in question, the odor was not noticed to any extent in the body of the house, but after a while was very perceptible in the cellars. In a concentrated condition, chlorine, it is well known, is most offensive, irrespirable, and destructive of animal life. It, at the same time, neutralizes and destroys all other odors and infectious matters.—EDITOR.

PATENT DRESS FASTENING.

An English patent has just been issued for a style of fastening very similar to the studs often employed in shirt bosoms, but much easier to operate. One head is smaller than the other, and is rounded, so that it may be easily thrust through round holes or metallic eyelets in the cloth, and hold until it is pulled with considerable force to remove it. To facilitate both the applying and removing—as also to insure the staying in its place until the hole becomes worn considerably too large—the smaller head and also the shank which connects it with the other is split into four parts, which spring slightly by their elasticity, so that it contracts on entering or leaving the holes, but extends to its full size when fairly in place. It would seem a very desirable improvement for shirt bosoms, as it would dispense with much of the crumpling and soiling now unavoidable in fixing the ordinary studs.

IMPROVED FISH HOOK.

Mr. J. T. Buel, of Whitehall, N. Y., has invented a new fish hook, the improvement in which consists in having the upper part of the shank of the hook, which is made solid or in two parts, terminate in a small barb, whereby a "minnie" can be secured upon the hook more permanently, and in a position to insure the capture of the fish as surely as he bites. Also in having the hook thus constructed, made in two parts, so as to allow of the lower barb being turned out of line with the upper one, and so constructing the upper barb that an elastic eye shall be formed by it and the shank, whereby an artificial minnie may be conveniently placed on or removed from the shank, and a natural minnie substituted for it and twisted spirally, and thus caused to spin similar to an artificial bait when in the water. Also combining with the lower barb of the improved hook, one or more minnie barbs, in a manner to form a "minnie gang," and having one of the minnie barbs turn free of the lower barb of the improved hook, so that, when desirable, a spiral twist may be given to the natural minnie.

IMPROVED SUGAR PAN.

A new sugar pan has been invented in England of which the improvement consists in introducing into the body of the vacuum pan a series of vertical tubes, through which steam is admitted to facilitate the operation of evaporation and crystallization. The tubes are inclosed within a cylindrical casing, and between the sides of the pan a vacant space is left. This arrangement causes an upward current of the solution in the pan at the centre of the series of tubes, whilst a gentle descending current is produced between the cylinder and pan, by which compound motion the contents in the pan are prevented from burning.

NEW INSTRUMENT FOR THE ADMINISTRATION OF CHLOROFORM.

M. Duroy, of France, has invented what he calls the Anasthesimeter, an instrument to be used in the application of chloroform. It is a circular stand of wood bearing a close cylindrical vase, into which descends a tapering stem from a bottle-like reservoir fixed above it. This reservoir is graduated with a scale, each division corresponding to one gramme of chloroform; so that the quantity of chloroform poured in can be accurately measured. Then, by turning a tap, according to the indications of another scale, the chloroform descends through the tapering stem at the rate of four, ten, twenty-five, or more drops a minute, into the vase beneath, from whence it is breathed, mingled with air, by a flexible tube leading to the patient's mouth. Thus, the quantity to be inspired can be determined beforehand according to the nature of the case.

BLANC'S PROCESS FOR EXTRACTING THE FIBRES OF PLANTS.

The following is M. Blanc's (of New Orleans) recently patented process for extracting the fibres of various endogenous plants: "I cut the plants in August or September, close to the ground, and sink a pit *in the field where the plants grow*, from six inches to two feet deep, throwing the earth outside, forming an embankment around the pit. I then commence in the centre of the pit, and set the plants in a perpendicular position with their butts downwards (*as soon as the plants are cut*, before they have time to die, and while they are still green and alive), and continue to set up around the same, keeping them as near perpendicular as I can, and pressing them closely together until I have filled the pit with the plants or the sprouts of the trees, which I cut when young and tender.

I then commence covering the sides of the same with leaves or straw, so as to surround it perfectly; I then throw the earth against the sides on the leaves or straw, making it several inches thick, until the whole is encased in a wall of earth as high as the tops of the plants, leaving the top of the stack or pile uncovered. My reason for doing so is, that by excluding the surrounding current of the atmosphere and the heat of the sun from the plants, I cause the gas contained in the natural state of the plants to be evolved by degrees, or slowly, and as it is carried off at the top of the plants, the moisture of the earth rises up and through the plants, and destroys the glutinous particles thereof, and causes the fibre to separate from the woody substance, preserving its strength and elasticity, and changing the color to a light yellow. After I have prepared my pit or stack, which may be of any size that the quantity to preserve may indicate, I let it remain in this state from eight to fifteen days, when the process will generally be sufficient; this may be known by taking from the stack at different points and trying it,—if the bark will separate easily from the woody substance, and a light mouldy appearance is visible, then it is time to break up the pit and spread it on the ground to dry.

When the plant is dry, which will be in from five to ten days, the woody portion is separated by passing the plants through any ordinary rollers or beaters, or by horses treading on them. By this process I get the fibre from the wood, and have all its strength and elasticity preserved, and am now able to manage it without having such great quantities to handle. Several of the fibres of the finest qualities will be perfectly prepared by this process for manufacturing. The coarser fibres can be water-rotted for a few days, say six to eight, when they can be fitted for market or manufacturing by the common process of breaking, scutching and hackling flax or hemp.

PLASTER CASTS OF LEAVES AND FLOWERS.

The following process is recommended by an eminent English engraver, for obtaining accurate and beautiful casts from the leaves and other parts of plants. The leaf, as early as convenient after being gathered, is to be laid on a fine-grained, moist sand, in a perfectly natural position, with that surface uppermost which is to form the cast, and being banked up by sand in order that it may be perfectly supported. It is then, by means of a broad camel-hair brush, to be covered over with a thin coating of wax and burgundy pitch, rendered fluid by heat. The leaf is now to be removed from the sand and dipped in cold water; the wax becomes hard, and likewise tough, to allow the leaf to be ripped off without altering its form. This being done, the wax mould is placed in moist sand, and banked up as the leaf itself was previously; it is then covered with plaster of Paris, made thin, due care being taken that the plaster be nicely pressed in all the interstices of the mould, by means of a camel hair brush. As soon as the plaster has set, the warmth thus produced softens the wax, which, in consequence of the moisture of the plaster, is prevented from adhering to it, and, with a little dexterity, it may be rolled up, parting completely from the cast, without injuring it in the least. Casts obtained in the manner thus described are very perfect, possessing a high relief, and form excellent models, either for the draughtsman or for the moulder for architectural ornaments.

MARINER'S TIME COMPASS.

This new instrument, invented by Mr. Reeder, of Cincinnati, consists of a chronometer, and a horizontal dial, with a style on its face, and a stationary equatorial brass ring laid out in degrees, minutes, and seconds. These are supported on a movable axis, forming the focus of a vertical quadrant laid out in angles at each side, so that the angle of dial and ring can be changed by a thumb screw. Below the dial is the common mariner's compass, with a spirit-level on its table or standard top. The instrument is designed to be used with the compass in steering ships, and its object is to indicate the position of the ship at any hour of the day when the sun shines, thus operating as a corrector of the compass, which is liable to be affected by local attraction in iron ships, and by masses of metal, such as a cargo of wrought or pig iron.

PURIFYING COTTON SEED FOR THE MANUFACTURE OF OIL AND OIL CAKE.

Heretofore the efforts made to render the seed of the cotton plant available for the production of oil, or for the purpose of feeding man or domestic animals, have not been productive of perfect results, owing to the nature of the shell by which the kernel of the seed is inclosed, as some fibres of the cotton adhere to it, and both the shell and the fibres of cotton absorb a considerable portion of the oil, and also render the cake unsuitable for feeding purposes.

A patent has recently been taken out by Daniel W. Messer, of Boston, Mass., for an improvement in preparing cotton seed, having for its object the removal of the above evils. The nature of this improvement consists in the separation of the shell of the seed from the kernel, previous to expressing the oil, by which a greater quantity of oil is obtained from the same amount of seed, whilst the residuum, or oil cake, is left free from shell and cotton fibre, and is therefore rendered much superior for feeding cattle. This he accomplishes as follows:—

The shell of the cotton seed is first softened by soaking it in water, or by subjecting it to the action of low steam. When boiling water is employed, about five minutes' immersion of the seed in it is sufficient; when cold water is employed, a much longer time is necessary; and the time required to soften different varieties of seed, varies with the amount of moisture in the seed. After the seed is thus softened, it is passed through proper rollers, or subjected to gentle pressure in a press in small quantities. By this means the shell is broken, and the kernel is forced out. Both the kernels and shells of the seed are then dried in the sun, or by very low artificial heat. If the oil is to be used for culinary purposes, great care must be taken not to dry the kernels under a high heat. When dry, the kernels and seeds are separated from one another by sieves, and the oil is then expressed from the clear kernels by passing them between revolving pressure rollers, or any suitable oil pressing mill. The residuum, or skin, of the pure kernels forms beautiful oil cakes for feeding cattle.

Oil from Cotton Seeds.—The following is the claim of a patent recently granted to Dr. A. A. Hayes, of Boston, for extracting oil from the cotton seed:—"I do not claim any mode of crushing the matured seed or expressing the oil from the kernels. I claim the maturing of the cotton seed, after it has been separated from the cotton by heat, artificially applied so as to render the husk brittle and easily separable from the kernel."

NEW DRAWING AND SURVEYING INSTRUMENTS.

New Drawing Instrument.—A new instrument has been invented by Mr. W. J. Kammerhueber, of Washington, for facilitating the draughtsman in the construction of linear perspectives. It consists in providing the sides of the drawing board with raised edges of circular form, the sweep of the circle corresponding with the distance of the vanishing point. The lines are drawn with a common T-square, the base or cross piece of which is provided with a couple of pins. The pins rest against one of the circular edges above named, and on being moved around against the circle, the blade of the square will always indicate the direct line of perspective.

Crandall's Surveying Instrument.—Mr. E. A. Crandall, of Friendship, Alleghany Co., N. Y., has invented an instrument for indicating distances by inspection, which will, if completely successful, be of great value to surveyors everywhere, and particularly in rough districts, where it is desirable to measure across rocks and chasms, creeks and lakes. The principle is that of triangulation—a method always adopted in extensive and accurate measurements, as in the Coast Survey, but which requires too much figuring for ordinary field-work, and especially for the mass of excellent practical but rather unlettered backwoods surveyors. Triangulation consists in taking two observations of an object, either at the same instant or successively, from stations a short distance apart, so that the lines in which the object is viewed shall taper in a proportion corresponding according to a certain law with the distance of the object. Mr. Crandall's instrument carries two small telescopes, each provided with the usual cross wires for very accurate pointing. One of these is firmly fixed to the instrument, but the other is free to swivel horizontally, and is ingeniously provided with very delicate and accurate verniers for reading off the angle. The distance apart of the two telescopes is only one foot, but even with this narrow base the triangulation may be made to indicate distances as great as a mile with a degree of accuracy depending of course on the correctness of the instrument and the keen observation of the operator. To facilitate the measurement of considerable distances, the extremely slight motion of the telescope is magnified as the distance increases, by employing levers which voluntarily and successively come into play, and make the very slight change of position for every ten or one hundred feet very sensibly readable. The base of the triangle being uniformly one foot, it follows that the instrument may be graduated not with degrees, minutes, and seconds, but with the distances themselves, in plain figures. The value of such an instrument, in denoting at once the distance of any inaccessible as well as familiar object, can hardly be overrated.

Proportional Dividers.—An invention, by H. M. Parkhurst, of Perth Amboy, N. J., consists in providing each of the legs of common dividers with a short adjustable secondary leg, jointed at right angles to the middle of the primary legs, and so arranged as to open and close parallel with the latter. When the dividers are opened or closed, the secondary legs will move, more or less, proportionate to the distance of their points from the joint of the original legs. If the points of the secondary legs are set at precise right angles to the other legs, the secondary pointers will move just one half the distance of the other points. The secondary legs can be set so as to exhibit any desired proportion with the utmost exactness. There is a scale, set screw, &c., for adjusting the angle of the secondary legs, which facilitate accuracy.

IMPROVEMENTS IN SAWS AND SAWMILLS.

Barlow's Improved Saw.—Mr. Nelson Barlow is the inventor of a saw for either cross cutting, splitting, or bevel cutting any kind of wood, with all the rapidity and ease of the ordinary saws, and yet leaving a nearly perfect planed surface. It is a trifle thinner, requires little "set," and consequently makes a thinner "kerf," or takes away less of the wood in cutting, than the ordinary varieties.

Saws are usually set by bending the alternate teeth laterally in opposite directions; no such set is put in this saw. The general outline of the teeth is that known as the "gullet," or "brier," and the peculiarity consists in hollowing out or grooving the cutting face of every tooth, or of every alternate one, in a line extending from the point inward. This form enables the tooth to act as a gouge so as to cut smoothly rather than to tear away the material, and by slightly spreading the acute edges at each side, a sufficient width of kerf is attained to relieve the body of the saw. The grooves are formed and renewed by clamping a small steel cutter-wheel upon the tooth and turning it by a crank attached. The edges are spread by a blow or two transmitted through a steel set or punch of suitable shape, and the sides are "erased" or smoothed in the usual manner by touching lightly with a stone while running.

Previous attempts to widen the points of saw teeth have generally failed, we think, from the teeth anchoring in the wood. The gouging propensity, or rather the clean cutting action due to the peculiar form, seems to prevent any such evil, and if the thin edges can be made to endure, the improvement will probably come into great favor.

Allen's Variable Feed for Sawmills.—Soft wood may be fed up to a saw much faster than hard, and there are in most logs inequalities which call for different rates of feed every few seconds. Common sawmills can only be adjusted so that the feed shall be moderate enough for the hardest knots, and consequently too slow for the clear portions of the wood. Mr. Z. G. Allen, of Buffalo, has lately invented a variable feed, of which the variation in the rate is produced by allowing one wheel to turn by the friction alone or "rolling contact" with the face or side of another, and letting the first move endwise on its shaft at the will of the sawyer. By this means (the face-wheel being on the end of its shaft, and supposed to revolve with any uniform velocity), the number of turns per minute of the driven shaft varies with every new position of the movable wheel. If its periphery is allowed to press against the centre only of the face-wheel, no motion results; but when moved ever so little from that position, a degree of speed is obtained which increases with every successive removal of the wheel from the centre, until, at its periphery, the fastest rate of speed is attained. By means of a suitable lever held in the hand of the sawyer, the rate at which the log is fed up may be varied with every indication (by sound or otherwise) of a changing character in the wood. The periphery of the driven wheel in this feed is made of hard wood, placed in such manner that the end of the grain is always presented to rub against the face-wheel.

Barlow's Patent Circular Saw.—This improvement consists in grooving the faces of the saw teeth from their points inwardly, forming thereby acute cutting edges or double fleams at their sides. Thus constructed the teeth act upon the wood like so many gouges, cutting their way through, not tearing it, as do the common saws. The result is that the stuff comes from the saw with its surface planed off about as smooth as can be done with a smoothing plane. Saws thus made are adapted for all kinds of work, splitting, cross-cutting, &c., no change at all in the set being required.

Improvements in the Manufacture of Saws.—The usual method of tempering saws is to heat and then dip them in oil. This process is slow, laborious, and costly; it is also disadvantageous, because the saws become warped, and require to be hammered up straight again by hand. An improvement recently introduced by Henry Waterman of Williamsburg, N. Y., consists in tempering and straightening the saws at one operation. This is done by heating the saws to the proper degree, and then pressing them with a sudden and powerful stroke between two surfaces of cold iron. Drop presses are employed for the purpose. The mechanism required in this process, it will have been observed, is quite simple, and not expensive. Its use effects an important economy in the manufacture of nearly all kinds of saws, and also improves their quality.

HORSE BRAKES.

When the animal muscles are employed in overcoming resistance, or, in other words, in developing power, certain effects are observed, among which are a quickened pulse, improved health and spirits, and (if severe or long continued) exhaustion or fatigue. This is the case in ascending a hill, drawing a load on a level, giving motion to machinery, and generally wherever work of any kind is performed; but in descending a ladder, or holding back a load in descending a hill, there is a reverse action of the muscles, a kind of *absorption of power*, the effect of which has never, we presume, been investigated, as the phenomenon is comparatively rare, and is seldom prolonged beyond a very few minutes. Carriages have recently been constructed in a peculiar manner for the turnpike road over the summit of Mount Washington. They are made to stand at different angles, so that the floors are always nearly level, and they are provided with brakes operated at will by the hand of the driver, or by the backward strain of the horses. The last feature seems particularly worthy of attention, as it may prove advantageous in general use. The brakes referred to are operated by a strap passing around a pulley or ring in the forward extremity of the pole or tongue. At every declivity the carriage, in crowding forward upon the horses, tightens the strap and brings the brakes in contact with the wheels. When it becomes necessary to back the carriage, a bolt is dropped by the driver which renders the brakes inoperative.

IMPROVEMENT IN GLASSES FOR HOTBEDS, &C.

The following is a recent French invention for economizing space and expense. Glass plates united by India rubber cloth, are made to fold up so as to occupy but little space in transportation, but what is of more importance, the cost is not a fourth that of bell glasses of the same capacity.

COMBINED LOG AND SOUNDING LINE.

This instrument, recently patented in the United States by Adolphe Percoul, of Marseilles, France, and which is designated as a "sounding log," serves both the purpose of the common log, viz. that of ascertaining the speed of the ship, and also to take soundings without "heaving the vessel to." It consists of a buoy and a lead line, with some other simple appendages. When used as a log, the line is fastened to the bottom of the buoy with the lead hanging some distance below it, the other end of the line being wound on a reel like the common log reel. When the lead and buoy are thrown overboard, the log remains stationary on the surface of the water, where it is held upright by the weight of the lead, which is held suspended from it, and the line is unwound by the motion of the vessel, the same as the common log line. The only difference between this line and that of the common log is, that it has colored marks in place of knots, as knots would interfere with the operation of sounding. When the instrument is to be used for taking soundings, the line is allowed to run over a pulley at the bottom of the buoy, the freedom of its movement being only very slightly checked by the friction of a spring. The lead is drawn by the line close up to the buoy, and both are thrown overboard; the vessel still continues on its course, while the reel is held for the line to run out. The buoy remains on the surface of the water where it was thrown in, and the weight of the lead keeps the buoy upright, and throws the line over the pulley of the buoy until the lead touches the bottom, which is known by the buoy turning over on one side, in consequence of the weight no longer acting upon it. When the buoy falls over, the friction of the spring on the line is so much increased that the buoy remains fast on the line while line and lead are drawn on board the vessel. The distance from the buoy to the lead is of course the depth of water.

MIXING WHEAT FLOUR WITH PAINTS.

Mr. J. Gattman, of Philadelphia, has discovered a method of manufacturing paints by grinding crude colors in a composition of water, flour, or its equivalent, rosin, or its equivalent, fish oil, or any drying or undrying oil, in a proper proportion and manner, and by which the paint thus manufactured may be produced at a cheap rate, and afterwards thinned with water to the required consistency.

UTILIZATION OF WASTE STEAM.

What may be done by economizing the waste water and steam of engines, is shown by an experiment recently made in Wales, by Mr. D. Llewellyn. From a small 8-inch cylinder engine employed by him for agricultural purposes, he conducted a jet of steam for twenty minutes daily, through an inch iron pipe, into a bed of rough stones, covered by a glazed frame; a journal of the temperature was kept, from which it appeared, first, that although steam was introduced among the stones for only twenty minutes a day, the thermometer was raised from 51° to 68° in the first twenty-four hours; second, that the temperature continued to rise for many hours after the second application of steam, until the thermometer reached 108°; third, that at the end of nineteen hours the heat of the frame diminished; yet, fourth, that at the end of *seventy hours* the temperature was 69° still. This is a conclusive answer to those who think that masses of heated water, or heated porous materials, like rough stones, will become so reduced in temperature by a few hours' withdrawal of the prime heating power, as to endanger the plants cultivated in houses thus warmed. The experiment continued to be successful, and enabled pineapples of the most perfect quality to ripen.

ALLEN'S GRIST MILL.

Mr. Z. G. Allen, of Buffalo, has recently constructed a superior mill, which differs in many important respects from those now in use. The spindle, or the upright shaft through the centre of the stone is continuous, being, by the peculiar construction of the mill, made in one piece, instead of being divided as usual in the middle: and the same being made adjustable laterally, both at top and bottom, allows of much more perfect "tram" than is generally attained. The method of connecting the stone with the spindle is far more perfect than any with which we are familiar—being in fact a perfect universal joint without possible slack. This is attained by slotting through the spindle and inserting a flat, thin "driver," or bar of iron, edge uppermost, and connecting it by a tapering pin in the centre, and by suitable boxes at each extremity. Each box being secured to the stone by a single bolt, the whole is as conveniently removed, when necessary, as are the more primitive arrangements. But the most conspicuous innovation is in the holding down of the stone—which is done by a lever and weight resembling those attachments to a safety valve. In all rapid grinding with light stones, it is common to hold the grinding surfaces together by applying a screw to a lever pressing upon the spindle, and, in the best device of this kind, this screw is so connected that it is always worked to correspond with the elevations of the stone by the ordinary "lighter screw." By that construction the upper centre is depressed in proportion as the lower centre (and consequently the stone) is lowered by the miller in the course of the work, and provided the adjustment of all the parts is perfect, the operation of the mill is, in this respect, precisely similar to the one under notice. But such perfection is rarely attainable in practice, and the spindle is liable in some positions to be either loose or so tightly held as to become heated. Another obvious advantage of the new arrangement is the liberty allowed to the stone to rise in case of dropping any hard mass, as a nail, into the mill. In brief, the device under notice appears to be a successful attempt to apply the most perfect of mechanism to the hanging of mill stones, with the addition of a self-acting means of holding down the stone without a possibility of ever exceeding the required degree of force. The stone is as readily removed for picking as under the ordinary arrangements.

TOBACCO PULP CIGARS.

A patent has been taken out in England for reducing those parts of tobacco leaves left—after the finest portions are stripped off for cigars—into pulp, by cutting them up in a machine, then submitting them to the action of steam in a close vessel. After this the pulp is made into sheets, by passing it through rollers from the pulp engine, or else through fine hair sieves, in the same manner that paper is made. The sheets of tobacco thus made from pulp are formed into cigars and cheroots.

COMPOSITION FOR RENDERING FABRICS WATERPROOF.

Payen, the eminent French chemist, has prepared the following composition to be used in rendering clothing for the French army waterproof:— Dissolve two pounds and a half of alum in four gallons of water; dissolve also, in a separate vessel, the same weight of acetate of lead in the same quantity of water. When both are thoroughly dissolved, mix the solutions together, and when the sulphate of lead resulting from this mixture has been precipitated to the bottom of the vessel in the form of a powder, pour off the solution, and plunge into it the tissue to be rendered waterproof. Wash and rub it well during a few minutes, and hang it in the air to dry.

VENTILATION OF MINES.

The London *Mining Journal* describes a new method devised for ventilating mines. It consists of a reservoir, or hydro-pneumatic box, placed on one side the adit level, supplied with water from a cistern on the surface. A metallic tube descends from the cistern to the vessel in the adit, and the supply is regulated by a self-acting valve. At the top of the metallic tube is a glass case, nicely regulated by a slide, which being suspended at a certain point admits no more water than is necessary. To draw in the largest possible quantity of air, a vortex is formed, and a continuous stream of air and water, varying in proportion according to the distance between the reservoir and the hydro-pneumatic box, is conveyed from the former into the latter. Here the water and the air are separated, the former escaping at the self-acting valve, and the latter being forced through a main tube, which branches off to any part of the mine.

CHIMNEY REGISTER AND WEATHERCOCK.

Mr. J. A. Royce, Lee, Mass., has made an improvement in the above by which to avoid a greater consumption of fuel during windy weather than there is in fair weather. On the top of the chimney is placed a device similar to an ordinary slatted hot air register. This register has a vane and rudder, and is turned to the proper position by the action of the wind against the rudder, and its slats, after it is thus moved, are closed more or less by the action of the wind against a sail, which is on a mast projecting up from the slats. When the wind blows hard, the slats are operated so as to almost entirely close up the flue of the chimney and thus diminish the draught, and when it is calm they open the flue and thus increase the draught.

IMPROVED LITHOGRAPHIC PRINTING PRESSES.

In order to give a uniform and forcible impression to all parts of the stone in lithographing, with the expenditure of but a very small amount of power, a press with the following improved arrangement has been devised: A wood or metallic air-tight chamber or tub, containing water or other fluid, with its bottom or one side composed of india rubber, or some other waterproof, elastic or pliable material, is used to give the impression; said chamber being furnished with a tube and plunger, and the pliable bottom or side of the chamber serving as a tympan. By applying pressure to the plunger, an equal amount of pressure is transmitted by the water or fluid to every part of the tympan, and by using a small plunger an immense pressure may be obtained with a small expenditure of power.

Lithographic Printing Press.—In an improved French lithographic printing press the following novelties are embraced. A sliding carriage, which travels over the stone or other engraving, and carries along the printing scraper, to take off the impression, and which is moved to and fro by a crank on a shaft; a loose tilting frame which carries a plate and sheet to lie down upon the paper that has been put upon the plate to be printed, from the printing scraper passing over the sheet with the necessary pressure, and the loose tilting-frame being raised or tilted up by the said carriage at the end of each backward and forward stroke, so as to allow of putting a fresh sheet of paper on the stone or plate engraved upon.

BURT'S SOLAR COMPASS.

An invention presented to the Franklin Institute in 1835, improved and again reported on in 1840, receiving a medal at the London Fair in 1851, and used in public surveys for fifteen years, can but with extreme difficulty be termed a new invention. The solar compass seems, however, to have but recently been prepared to attract the attention it deserves, and a very brief notice may not be inappropriate.

The compass is the invention of Mr. Wm. A. Burt of Mount Vernon, Michigan, and seems to occupy a kind of intermediate place between the old Rittenhouse compass and the Theodolite of the present day. It is designed for extensive land surveys, and is greatly superior to the theodolite in the facility with which it is used. As compared with the more ordinary compass, in all mineral regions and in localities where the aberrations of the needle are a source of frequent difficulty, it appears almost indispensable.

It may be described as a magnetic compass, with every facility for levelling and adjustment, and provided additionally with movable arcs and simple mechanism by which whenever the sun is visible, and its declination known (which may be found in any nautical almanac), the time of day, the latitude of the place, the angle made by any point with the true meridian, and consequently the correct bearing thereof, may be determined by inspection with the minutest accuracy. Its easy adjustment and entire reliability, enable it to supply the want long felt by the practical surveyor.

DUMÉRY'S METHOD OF CONSUMING SMOKE.

Among the prizes awarded during the last year by the French Academy, was one to M. Duméry for a contrivance for consuming the smoke of chimneys, which has worked with complete success in a series of comparative experiments under the inspection of a commission of the academy.

M. Duméry, in place of throwing in the fresh coal by the door of the furnace upon the burning combustible, as in ordinary fires, causes it to enter below by means of stoking bars worked with the hand in a kind of recurved funnel, with open sides, and extending to the grating on that side. This method was long ago suggested by Franklin; but the arrangements here adopted are peculiar to this inventor and attain perfectly the end proposed.

IMPROVEMENT IN STEREOTYPING.

One of the persons employed in the State printing office of Vienna has made the discovery that plates of plaster of Paris will uniformly contract by a repeated washing with water, and still more if with spirits of wine. On this is based a process to produce both print (*drucksachen*) and woodcuts in various gradations of type and size, by a calculated diminution of the plaster of Paris plate. Already print and drawings have been made of a twelfth-part size, reduced from three inches to one inch in diameter, and yet even the reduction to the smallest size does not encroach on the perfect correctness of the impression.

HYDRO-STEAM ENGINE.

A very peculiar and apparently effective combination of the steam engine and Turbine water wheel called the "Hydro-Steam Engine," has recently been invented by Mr. William Baxter, of Paterson, N. J. The invention, which is especially adapted for the driving of propellers, is constructed as follows:—

Two steam cylinders are placed vertically and parallel to each other, united at the top by a valve chamber and the steam and exhaust passages, and at the bottom by the Turbine wheel chamber and valve cases for the induction and eduction of the water. There is a short stem or rod through the stuffing-box of each cylinder head, answering to the piston rod of the ordinary steam engine, intended for the operation of the slide valve, which lies horizontally on its seat, its stem running through a stuffing-box at each end of the valve chest. Two quadrant pieces or right angled levers jointed on the outside of the chest and immediately over the steam cylinders, one at each end, communicate an alternate motion to the valve, they being struck by the upward motion of the short stems or rods which pierce the cylinder heads: these rods again are operated by the upward motion of the pistons, which work without rods or any outward connexion whatever. Steam is admitted only to *one* side of the pistons, the other being in contact each with a column of water; which water is continually forced through the Turbine wheel and thus producing a rotatory motion, proportioned in velocity to the pressure of the steam in the cylinders, and to the size of the Turbine water wheel.

The steam acts upon the pistons in the manner of a direct action pump, one end of the cylinder being used for steam and the other for water. The same water is used all the time, it being forced alternately through suitable valves,—easily understood by those acquainted with such matters—the curvature of the blades of the deflecting guide wheel directing the water on to the curves of the wheel buckets. Water being nearly an incompressible body, an air chamber is necessary, as in all forcing pumps, to maintain a uniform current, and also to secure a certain degree of elasticity, without which there would be some danger of rupturing the parts. The primary object to be gained by this new motor is the doing away with a multiplicity of parts.

RECENT IMPROVEMENTS IN AGRICULTURAL MACHINERY AND PROCESSES.

Mr. Denison, the well known agricultural writer of England, thus answers the question, "What progress has been recently made in agricultural machinery in Great Britain?" He says:—

"A reply may confidently be given that progress has been made on every side—in machinery, in scientific acquirements, in field practice; and to such an extent, that beyond all question, the productive powers of these kingdoms have been more largely increased within the last four years than within an equal space of time at any former period.

"In machine making, though some interesting novelties have appeared, the characteristic feature has been the constant improvement, tending to perfection, of our established implements, and a great extension of their use through the body of the farming community, a fact significant of the superior intelligence which is now brought to bear on farming affairs, promising a sure and continued progression.

"First on the list in point of interest, first in its remarkable increase, stands steam machinery.

"No farmer who has ever had a steam engine on his farm will ever again be without one; no farmer who has ever threshed his corn with steam power could bear again to see his horses toiling in the wearisome circle, now jerking onwards when the whip sounds, now brought almost to a stand-still when the machine is clogged by a careless feeder. The regular stroke of the untiring steam engine gives excellence to the work, keeps everybody in his place, and introduces among men, even the most careless, something of its own exactness and precision."

The Royal Agricultural Society of England held their annual meeting and exhibition at Chelmsford in July. This meeting of the society will be memorable, not only on account of the liberal prize which was offered for the best steam cultivator, but also from the improvement which was made in selecting a few classes of implements for the ordinary prizes, instead of distributing them throughout the whole collection—thus allowing of a much more careful series of trials being made than was possible under the former arrangement. The prizes given on the present occasion were confined to those machines used in preparing the land for crops, together with reapers and some tile machines and draining tools. Next year's list will embrace other classes of implements, and, in the succeeding year, the list will include all such as shall not have been included in the previous lists.

Mr. Boydell's steam plough, which was noticed in our previous volume, was a subject of special interest, from the peculiarity of its construction in having an endless railway attached to the wheels, which enables it to traverse over ordinary rough ground; which without such a contrivance as the portable railway would be almost out of the question. To this engine was attached the ploughing machine of Mr. Coleman, which consisted of seven ploughs, arranged so as to advance in a triangular form, the foremost point being the apex. In the trial, however, owing to the complicated nature of the plough itself, it was found impossible to keep all the tools at work at once, or to regulate the depth according to the form of the ridge. In addition to the system upon which Mr. Boydell proposes to cultivate the soil, there is the system of steam ploughing, by means of a stationary engine and windlass; the wire ropes used in drawing the ordinary plough across the land being led through pulleys anchored in the ground, and which are shifted along the margin of the land as the work proceeds. Of this plan there are two rival schemes, viz. that of Mr. Fowler, and that of Mr. Smith. Mr. Fowler has a set of four common ploughs in a frame, and turns over as many furrows, evenly, well laid, and at a fair depth—the quality of the work being all that can be desired. By another arrangement Mr. Fowler makes two furrows at once, and by trench ploughs, two furrows deep. Mr. Smith does not employ the common plough, but it performs what is called "baulkploughing," combined with subsoil ploughing and grubbing—all these operations being performed by one passage of the implement.

The reaping machines were tried upon a piece of half-ripe rye, partially laid, but to no great extent. There was Crosskill's Bell's reaper, the same as exhibited last year, as also the same with an improved delivery, consisting of two endless straps with wooden cogs upon them, passing from side to side, in front of a sloping platform. A fly-wheel is added to this machine, which increases the regularity of the working of the parts. Dray's Hussey's reaper was also one of the competing ones exhibited, this machine having a tipping platform.

Chambers's water drop-drill received the approbation of the judges. This is a new invention; and a great improvement upon the ordinary liquid manure drill, as all the liquor is deposited with the seed where wanted, and so is not wasted by being poured out in a continuous line.

The show of agricultural implements, at the late Paris exhibition, is described by English visitors as presenting in many of the machines of French and continental construction much scientific ingenuity, but productive of little practical utility, and one of the visitors writes that he saw no foreign field implement which he should consider an advantageous addition to the husbandry of England. Among machines of a different class, he describes one in the following terms, which he recommends as a simple and useful instrument, viz. a straw-loom exhibited by M. Guyot, of the Chateau de Sillery, which sells at a cost of only 80 francs. So simple a machine may deserve the attention of gardeners in this country:—

"It forms mats with two threads of wire, No. 4, woven with straw, or reeds, or rushes, which will last four years. The machine is worked by a man like a common hand loom, and the thin web as it is formed passes through below the machine, and winds itself up behind the workman like a carpet. This straw web is used for the protection of young vines trained along the ground, and costs rather less than 1d. a yard. The inventor used 60,000 yards of it last year to protect his vines to the 15th of May against white frosts; till the 30th of June against cold rain; and till harvest against the otherwise slow maturity of a cold season. This invention might be very usefully employed in market gardens and nursery grounds, and the matting can also be set up in a frame perpendicularly for the protection of wall fruit."

The following are brief memoranda of new agricultural instruments brought out during the past year:

Iron Harrow.—This is in two parts, in the form of a horse shoe, and is expanding, and when going to a field it may be turned over forward and rides as though on a sled upon its own frame.

Improved Horse Rake.—The rake is on wheels, with wire teeth, discharging its load by uncatching a latch, and then the teeth are lifted by a strap around the breast of the horse, and held up until past the winnow, when they drop into place by their own weight on checking the horse, or giving the wheels a slight push forward.

An improvement in the straw carrier of threshing machines has been made by placing strips of iron on the slats, with edges turned up so as to hold the straw loose and allow the grain to fall, and by bringing some of the slats to fall down on the underside of the chain, by which rolls of straw drop through on the back motion.

Thompson's Corn Planter.—A corn planter recently invented by L. Thompson of New Haven, Conn., has the following peculiarities of construction. It is mounted on two light wheels, and is worked by a horse with the aid of one man or boy, who sits on the box, holding the reins. A great fault with corn planters generally—on which, by the way, there are some fifty or more patents—is that of leaving the earth loose instead of nicely covering and pressing it down like a farmer's hoe; another is, that the grains are planted too closely together: both these are avoided in the machine referred to, and the labor of planting which is always cool and less severe than most agricultural operations, is by this means rendered decidedly easy and pleasant. Two rows are planted at once, the earth for each being excavated by a light plough-like attachment, and replaced by nearly similar scrapers, standing in a reverse position, while behind the whole are dragged metallic rollers of suitable weight to press the earth together and form a smooth surface. The ploughs are dragged continuously along, and have no motion except the ability to yield in case of meeting too great an obstruction. There are no reciprocating parts to get out of order, except a single valve in each spout, which regulates the precise moment of depositing the grain in the shallow furrow. The proper amount for each hill is measured off by a continuous rotary motion, thrown down into a wide spout, and held near its mouth until the right moment, when it is dropped behind the forward plough, covered by the succeeding one, and pressed down by the roller. A stop in reach of the driver throws the small measuring wheel out of gear while the machine is turning round at the ends of the rows, and a strong lever in the hand serves to lift the forward or opening ploughs whenever any formidable obstruction is anticipated.

Improved Excavator.—In an improved excavator recently invented by J. F. Willey of Fredonia, N. Y., the scoop is formed of two parts connected by a joint, and the bottom of the two formed of slats which are allowed to turn. The scoop is suspended by chains to a cart, so that it may be raised bodily.

As the cart moves along, the scoop may be readily filled and as easily discharged. As the scoop is formed of two parts jointed together, each part is filled separately, therefore there is not such a large quantity of earth to be forced backward, at once, while filling the scoop. The power required to work common excavators is great, because of the great amount of earth to be forced back in the scoop.

Self-acting Barn Door Fastener.—An upright bar of strong wood, working free in staples, is attached inside of the door, in two parts, with a small rack upon each, working upon a pinion fast to the door. Lift up the lower part of the bar, from the outside or in, and it rolls the top down and catches. Shut the door and the catch is loosened—the weight of the lower part of the bar falls and rolls the pinion, turning the corresponding rack up, thus fastening the door top and bottom.

Machines for Husking Indian Corn.—The annual production of Indian corn is 600,000,000 bushels, nearly all of which is shelled by machinery; but the husking is done by hand. The expense of husking is estimated at 5 cents a bushel, or $3,000,000 a year! No less than 129 different patents have been granted for shellers; but for huskers, only *four* patents have ever been issued—two of which have long since expired. Not one of them is sufficiently practicable, we believe, to meet the wants of the community.

Corn huskers are very much needed on every farm throughout the land. Here is a splendid opportunity for inventors, and we hope they will not be slow to improve it.—*Scientific American.*

New Plough.—A correspondent of the N. Y. Tribune gives the following description of a new plough exhibited at the recent fair of the N. Y. State Agricultural Society:—It is what has been long sought for—*a perfect reversible plough;* that is, reversible by shifting the beam instead of the share, so as to obtain a side hill plough that works just as well one way as the other, and just as well as any plough made to work but one way, turning the furrow either right or left. Fifteen years ago, Barnaby & Moore, of Ithaca, made a plough that was intended for this purpose, but failed because the beam never stood in the exact right position with the point, except when it was set in the centre, and then it was simply a double mould-board plough. Consequently, the plough was a failure and went out of use, notwithstanding the flattering reception it met with at first. Every farmer felt how much such a plough was needed, and this helped him to believe it had been invented.

Where Moore left off, A. Barton, a plain, poor, but thinking man, of Onondaga county, commenced, and has perfectly succeeded. His beam is attached to the share by a strong but free joint on the underside, and the point of the plough is attached to the point of a strong coulter attached to the centre of the beam, so that whichever way the beam is turned, right or left, the point goes with it, and the beam sets exactly as though it was framed into the handle on that side. It may also be set in the middle, and then is a double mould-board plough, but its great value consists in its easy conversion from a right handed to a left handed plough, without any more labor than lifting and shutting the latch of a door while the team is turning. The point is of steel and selfsharpening. The whole is plain, simple, cheap, strong, and what is more, has been thoroughly tested.

Proposed Improvement in the Construction of the Plough.—The following proposal for an improvement in the construction of the plough, was lately made at an agricultural meeting in Great Britain. The object proposed to be effected was to change the present mode of action of the plough, which is in reality a *wedge* forcibly dragged through the soil, lifting up that portion which is above it, at the expense of hardening or making more compact that portion which is below it. This mode of action has a tendency to harden and glaze over the subsoil, or that part of the soil on which the sole of the plough rests in its passage. The remedy proposed consists in the adaptation of rollers to the sole shoe, or in adding a hind wheel, notched or teethed, so that when following in the track of the sole shoe the notches or teeth may break up the smooth track formed by its action. The proposer of these two modes of improving the plough seems to think most favorably of the idea of rollers (whose mode of action, however, he does not specify), as they would not only prevent the glazing and hardening, but would, in his opinion, lessen the draught.

Subsoil Plough.—This improved agricultural implement, invented by Mr. Wilson, of England, consists of an ordinary earth-fork to which is attached a long handle, bent to about ten inches to the foot out of the straight line, in the plane of the fork's prongs. A small transverse handle is attached to this main lever, at about the usual height of a spade handle, on the side opposite that to which the main lever is inclined. This enables the user to guide the implement into the earth. The prongs are straight, so that either the right or left foot may be used. When the prongs have been sunk up to the neck into the subsoil, the extreme end of the main lever is acted upon to bring a powerful lifting pressure upon the soil.

Self-Holding Plough.—A new self-holding plough, the invention of Mr. Binkerhoof, of Batavia, N. Y., has the following peculiarities. It differs but little from some other ploughs now in use, but with the addition of a guiding wheel about two and a half feet in diameter, which runs in the furrow, and guides the plough, gauging the width of the furrow, while another wheel of less diameter supports the plough on the opposite side. The grounds ploughed were a stiff sod with a heavy clay subsoil, and which would try the merits of the machine most effectually, yet it did its work perfectly, with no assistance from the driver except in turning at the ends.

Hunt's Horse Power.—Dr. Richard Hunt, of Freeport, Ill., lately patented a simple construction for making horse power available, which, though involving a large weight of timber, is advertised to cost but $50. From one to twelve animals may be employed walking in a circle upon the ground, and turning a heavy horizontal wheel to which they are directly attached, and which they in fact walk within. The wheel is geared at its periphery, and transmits a high velocity without further multiplication. The principal novelty consists in making this wheel of such weight that it requires no framing whatever, and supporting the load on small iron wheels which travel around on a raised track just within the horse path. The expedient is simple and admirable.

A New Theory of Churning.—Mr. E. Conkling, through the *Ohio Cultivator*, makes the following suggestions on the true philosophy of churning: "The plan is to inject the cream into itself or against a hard substance, with great force, by means of a sort of force pump, thereby producing concussion sufficient to rupture the globules, and produce speedy and perfect comminution of the butterine particles."

Implement for Cutting down Trees.—An implement recently invented by S. C. Ehrsam, of New York, consists in giving a rotating motion around the body or trunk of the tree, to a cutting blade; also, in giving to the blade a feed motion into the tree, by means of an annular rack or toothed rim, and a spiral thread. The rack or toothed rim is attached to a collar, which is fitted around the trunk of the tree, the screw thread being cut on the upper edge of the collar, and fitting in or between corresponding threads on the under side of the chisel or cutter. Power being applied, the cutter revolves around the tree, and cuts inward, until the trunk is severed.

NATURAL PHILOSOPHY.

THE FUTURE PROGRESS OF PHYSICAL SCIENCE.

THAT no further improvement is desirable in the means and methods of ascertaining the ship's place at sea, no one, I think, will from experience be disposed to assert. The last time I crossed the Atlantic, I walked the quarter-deck with the officer in charge of the noble vessel on one occasion when we were driving along before a leading breeze and under a head of steam, beneath a starless sky at midnight, at the rate certainly of ten or eleven miles an hour. There is something sublime, but approaching the terrible, in such a scene;—the rayless gloom, the midnight chill,—the awful swell of the deep,—the dismal moan of the wind through the rigging, the all but volcanic fires within the hold of the ship;—I scarce know an occasion in ordinary life in which a reflecting mind feels more keenly its hopeless dependence on irrational forces beyond its own control. I asked my companion how nearly he could determine his ship's place at sea under favorable circumstances;—theoretically, he answered, I think, within a mile;—practically and usually within three or four. My next question was, how near do you think we may be to Cape Race, that dangerous headland which pushes its iron-bound, unlighted bastions from the shore of Newfoundland far into the Atlantic,—the first land-fall to the homeward-bound American vessel. We must, said he, by our last observations and reckoning, be within three or four miles of Cape Race. A comparison of those two remarks, under the circumstances in which we were placed at the moment, brought my mind to the conclusion, that it is greatly to be wished that the means should be discovered of finding the ship's place more accurately, or that navigators would give Cape Race a little wider berth. But I do not remember that one of the steam packets between England and America was ever lost on that formidable point.

It appears to me by no means unlikely that, with the improvement of instrumental power and of the means of ascertaining the ship's time with exactness, as great an advance beyond the present state of art and science in finding a ship's place at sea may take place, as was effected by the invention of the reflecting quadrant, the calculation of lunar tables, and the improved construction of chronometers.

I have no doubt we live on the verge of discoveries and inventions in every department, as brilliant as any that have ever been made; that there are new truths, new facts, ready to start into recognition on every side; and it seems to me there never was an age, since the dawn of time, when men ought to be less disposed to rest satisfied with the progress already made, than the age in which we live; for there never was an age more distinguished for ingenious research, for novel result and bold generalization.

In the wonderful versatility of the human mind, the improvement, when made, will very probably be made by paths where it is least expected. The great inducement to Mr. Babbage to attempt the construction of an engine, by which astronomical tables could be calculated and even printed by mechanical means and with entire accuracy, was the errors in the requisite tables. Nineteen such errors, in point of fact, were discovered in an edition of Taylor's Logarithms printed in 1796; some of which might have led to the most dangerous results in calculating a ship's place. These nineteen errors (of which one only was an error of the press) were pointed out in the *Nautical Almanac* for 1832. In one of these *errata* the seat of the error was stated to be in cosine of 14° 18′ 3″. Subsequent examination showed that there was an error of one second in this correction, and accordingly in the *Nautical Almanac* of the next year, a new correction was necessary. But in making the new correction of one second, a new error was committed of ten degrees. Instead of cosine 14° 18′ 2″ the correction was printed cosine 4° 18′ 2″, making it still necessary, in some future edition of the *Nautical Almanac*, to insert an *erratum* in an *erratum* of the *errata* in Taylor's Logarithms. (*Edinburgh Review, Vol. LIX.* 282.)

In the hope of obviating the possibility of such errors, Mr. Babbage projected his calculating, or, as he prefers to call it, his difference machine. Although this extraordinary undertaking has been arrested, in consequence of the enormous expense attending its execution, enough has been achieved to show the mechanical possibility of constructing an engine of this kind, and even one of far higher powers, of which Mr. Babbage has matured the conception, devised the notation, and executed the drawings—themselves an imperishable monument of the genius of the author.—*Address at the Dedication of the Dudley Observatory, by Edward Everett.*

LAYING THE GUNS OF A BATTERY WITHOUT EXPOSING THE MEN.

Mr. Babbage has published the following method of laying the guns of a battery without exposing the men to the fire of the enemy:—

The numerous casualties, chiefly by rifle shot, which have occurred to those employed in pointing guns at the object of attack, and also in examining their effect after their discharge, induced me to recur to means which had previously been devised for reconnoitring with security. The highest skill is required in the man who points the gun; his safety is, therefore, to be considered first.

In pointing a gun at the object to be hit, the two sights of the gun and the distant object must be brought into the same line. To do this, a man stands behind the gun and looks along that line. But if, instead of a man in that position, we put a good common looking-glass inclined at an angle with the line of direction, the coincidence of the two sights and the distant object can then be made by an observer placed in other positions.

Suppose an officer is placed in the corner of a battery where neither rifle nor round shot can reach, he may either point the gun by his eye, may employ a common opera-glass, or he may use a small telescope, which, if required, might be fixed to a post.

In laying guns by means of a telescope some little difficulty may occur from the foci of the sights and the object not being the same. The difficulty can be much diminished by placing the looking-glass at a greater distance behind the gun. In fact, with a simple inverting telescope of very low power, or with a common opera-glass, a very moderate distance will render both objects sufficiently distinct.

The angular position and elevation of the gun must be adjusted by directions from the officer to the men attending the gun. These adjustments must be contrived by screws, or other means, so as to be made by the men when screened from direct fire.

When the officer is satisfied that all the guns are well laid, he must then turn to a telescope, attached vertically to the parapet. Fixed to the telescope by an arm reaching above the parapet must be another small looking-glass, having an angular motion on its horizontal axis. This telescope may consist of a single lens of from three to eight feet focus, and have attached to its eye-glass a small prism to turn the vertical rays into a horizontal direction.

The officer, having adjusted his telescope on the point he is battering, may then observe the united effect of all the guns; or he may cause them to be fired in succession, waiting between each shot until the smoke has cleared away, in order that he may judge of the precision with which each gun has been laid.

The plan of seeing round a corner by means of a small bit of looking-glass has been long known and described in books on the amusements of science. A repetition of the combination constitutes the toy by which children are surprised to find they can see through a deal board. In a different form, by means of an inclined mirror concealed within the tube, the frequenter of the theatre points his glass in one direction whilst he surveys the real object of his attraction in another. Such a telescope, when used behind a wall or a tree, becomes a safe reconnoitring telescope.

ON SOME OF THE PRINCIPAL CAUSES OF ATMOSPHERIC ELECTRICITY. BY M. BECQUEREL.

The causes which constantly furnish the air with an excess of positive and the earth with an excess of negative electricity—excesses which are capable of giving rise to storms and other phenomena under certain conditions—are still unknown. In studying this question some years ago, I observed the electrical effects produced in the tissues of plants, and at the contact of these plants with the soil; in this contact the soil is constantly positive, and the plant negative, whatever may be the part of the plant put in metallic communication with it. I then indicated this evolution of electricity as one of the causes of the electricity of the atmosphere. In repeating these experiments, a year ago, I was struck by the anomalies manifested, in operating on the margin of a river, or in the river itself, or at a certain distance, near the plant; and I was thus led to study the electrical effects produced at the contact of the soil with a fall or stream of water, of which I then understood all the importance. This question leads us to one of the principal sources of atmospheric electricity—a question of a most complicated nature, from the numerous causes which conduce to the general effect. The apparatus employed in these researches consists of—1. Diaphragms of porous porcelain, or little bags of sail-cloth, each containing a depolarized plate of gold or platinum, surrounded by charcoal of sugar-candy, with a view to render the electrical effects constant during a few moments in order to measure them—2. Tangent compasses of great delicacy, adapted for experiments of this nature—3. Atmospheric electrometers to collect the electricity of vapors formed above the soil or water; and various accessories, such as copper wires, gold and platinum covered with gutta percha, &c. The electrical effects produced by the contact of the soil and water are complex, for they vary in direction and intensity according to the substances which compose the soil, or which are dissolved in the water; for the production of electrical effects, it is necessary that there should be a heterogeneity between the water of the river and that by which the soil is moistened. When the waters are slightly alkaline, they are negative; when they are acid, as is the case with the earth of heaths, they are positive. The well waters of Paris often present effects of this kind, in consequence of the infiltration of drainage waters, which change in nature from time to time; thus in the course of a month the electrical effects are seen to change in intensity and sign, without any derangement of the apparatus. From this state of things it results that sometimes there are no electrical effects, as is also the case in experimenting with the water of a river and its sandy banks, or the adjacent lands which are washed during inundations. It is necessary to establish *permanent* observations to follow all the variations to which the actions of contact are subject, and to guard against the effects of polarization, which are always to be found in operating only for a few moments. Very commonly polarization is destroyed in the course of 24 hours, and the effects of which we are in search may then be observed. In some exceptional cases the electrical current has sufficient intensity to cause the action of a needle telegraph at a distance of several kilometres. When water evaporates, either from a stream or from the earth, it must necessarily carry off with it an excess of electricity of the same nature possessed by the one or other, and this becomes diffused in the atmosphere; this electricity may arise not only from the reaction of the water of the river upon that with which the soil is moistened, but also from the decomposition of organic matter. In the latter case the electricity is always positive, whether it arises from the river or from the soil; in the former the two vapors are of contrary signs; the effects are complex. From the foregoing it will be understood why storms generally take place in summer, at that period of the year when the decomposition of organic matters and evaporation are at their maximum, and also why they are so frequent and so violent under the tropics at the period when the sun approaches the zenith. This is so true, that in those regions there is always a storm bursting at each instant in a locality suitably placed in relation to the sun. The phenomena to which I have referred are so varied that it is indispensable, before formulating general principles, to multiply experiments in a place serving as a permanent observatory, then in flat countries and amongst mountains, on the margins of rivers and water courses, and on the sea shore, in countries like Holland, where there are large alluvial tracts, in salt marshes, &c. Then, and then only, shall we be able to judge of the importance of the subject with which I am occupied, and which is connected with one of the greatest questions in terrestrial physics.

ON THE FORM OF LIGHTNING.

Mr. Nasmyth, at the British Association, 1856, said that the form usually attributed to lightning by painters and in works of art was very different from that which he had observed as exhibited in nature, and from observing this he was induced to call attention to it. He believed the error of the artists originated in the form given to the thunderbolt in the hand of Jupiter as sculptured by the early Greeks. The form of lightning as exhibited in nature was simply an irregular curved line, shooting from the earth below to the cloud above, and often continued from the cloud downwards again to another distant part of the earth. This appearance, he conceived, was the result of the rapidly shooting point of light which constituted the true lightning, leaving on the eye the impression of the path it traced. In very intense lightning, he had also observed offshoots of an arborescent form to proceed, at several places, from the primary track of the flash.

This communication gave rise to an animated discussion, as to whether or not the flash of lightning was the effect of a rapidly moving point of light, and if so, whether the direction was, as stated by Mr. Nasmyth, in nine cases out of ten from the earth to the cloud, or the contrary. Mr. Nasmyth adduced the manner in which leaden pipes were burst, they being bad conductors of electricity, as proofs of his views—of which he instanced one which had been burst in several places, from the bottom to the top, in Edinburgh, during a thunderstorm, the pieces of which Sir J. Leslie had obtained and placed in his physical class room. On being questioned, however, by some members of the section, as to how these distant burstings outwards along the pipe gave any indication of the direction, it did not appear there were any decisive marks indicating this.

ON THE APPARENT CONVERSION OF ELECTRICITY INTO MECHANICAL FORCE.

The following is an abstract of a paper communicated to the *Philosophical Magazine* (London), by W. R. Grove, detailing a series of experiments, apparently showing the conversion of electricity into mechanical force:—

His object was to show, that when electricity performs any mechanical work which does not return to its source, electrical power is lost. The first experiment was made in the following manner:—A Leyden jar, of one square foot coated surface, has its interior connected with a Cuthbertson's electrometer, between which and the outer coating of the jar are a pair of discharging balls fixed at a certain distance (about half an inch apart). Between the Leyden jar and the prime conductor is inserted a small unit-jar of 9 square inches surface, the knobs of which are 0.2 inch apart. The balance of the electrometer is now fixed by a stiff wire inserted between the attracting knobs, and the Leyden jar charged by discharging from the unit-jar. After a certain number of these (twenty-two in the experiment performed in the theatre of the Institution), the discharge of the large jar takes place across the ½-inch interval; this may be viewed as the expression of the electrical power received from the unit-jar. The experiment is now repeated, the wire between the balls having been removed, and therefore the "tip" or the raising of the weight is performed by the electrical repulsion and attraction of the power of two pairs of balls; at twenty-two discharges of the unit-jar, the balance is subverted, and one knob drops upon the other, but *no discharge takes place,* showing that some electricity has been lost, or converted into mechanical power, which raises the balance.

By another mode of expression, the electricity may be supposed to be masked or analogous to latent heat, and would be restored if the ball were brought back, without discharge, by extraneous force.

The experiment is believed to be new, and to be suggestive of others of a similar character, which may be indefinitely varied.

Thus, two balls made to diverge by electricity should not give to an electrometer the same amount of electricity as if they were, whilst electrified, kept forcibly together: an experiment of this sort I have made since my lecture, in the following manner:

To a thick brass wire, 2 feet long, insulated and terminated by knobs, are suspended by fine platina wires, two pairs of discs of paper coated with tin-foil, and 4 inches in diameter. The apparatus is electrized in a dry atmosphere by sparks from a machine, and the discs of each pair respectively diverge.

To one of the pairs a silk thread is attached, by which the discs can be forcibly approximated. As often as this is done the divergence of the other pair increases.

Another mode of showing the same effect is the following:—

On the top of an ordinary gold-leaf electroscope place two brass plates, such as are commonly used for a condenser, connect them by a long fine wire, and electrify them by a rubbed rod of glass or sealing wax, so that the gold leaves diverge.

Now raise the upper plate by a glass handle: the leaves collapse in proportion as it is raised, and again diverge as it is depressed. It should be recollected that the plates are electrified by the same electricity, and are always metallically connected by the fine wire, in which respect this differs from ordinary induction experiments.

It may be said that here the mechanical force is given by the hand; but this is only in part, the repellent effect of electricity does part of the work and should be therefore expended; it is analogically as though a man were to add his force to the piston rod of a steam engine, which would not prevent the loss of heat by dilating steam.

ON THE USE OF ELECTRICITY AND GALVANISM FOR PRODUCING EXPLOSIONS.

M. Ebner has laid a report before the Austrian Academy of Sciences, which relates to the solving of the question, "Whether electricity or voltaism is preferable for the exploding of mines in quarries?" &c. The report gives preference to the former, because the amount of effect of the voltaic battery depends on the quality of the conductor through which it has to act; and whenever a great effect (force) is required, the alternative presents itself, either to use colossal batteries, or costly conductors of the usual large dimensions. Electricity, on the contrary, operates in consequence of a mechanic action, without the co-operation of the conductor; and as the resistance does not exist, conductors of cheap material and small power are sufficient. The apparatus adopted now by the Austrian Corps of Engineers, consists of two discs or plates, of 12 inches diameter, and the charge is made without the conductor being employed, by the mere placing of a point between the plates. A smaller apparatus can be carried on a strap on the back of a man. The conductor consists of soft brass wire, of half an inch thickness, and each apparatus is furnished with 2000 fathoms of plain wire, and 400 fathoms of wire coated with gutta percha, and also materials for constructing isolated conductors. The explosive substance, a mixture of sulphur, antimony, and chloride of potash, can be made with ease, and placed in the form of a cartridge at any part of the conducting line. With these apparatuses explosions have been effected at a distance of 1½ German leagues, and fifty mines exploded simultaneously, on a line of 100 fathoms. Under water explosions were effected at a distance of 400 fathoms, the conductor extending to the length of 500 fathoms. The effects of these machines are independent of seasons and weathers. At the explosions made under water in the Danube, near Grein, and the marble quarries near Neustadt, it has been used for two years without the loss of a single life. According to a signal, the explosion is made when the excavators and others are absent, and bore holes are mostly exploded simultaneously.—*Mechanics' Magazine*, No. 1688.

PRESENT STATE OF ORGANIC ELECTRICITY.

Professor Goodsir has communicated to the *Edinburgh New Philosophical Journal* "A Brief Review of the Present State of Organic Electricity."

The general theory of electricity, says the professor, has rapidly approached a consistent form through the labors of recent physicists, and particularly by the researches of Mr. Faraday. The hypotheses of one or of two electric fluids, however modified, have been found tenable only so far as they involved the idea of force. In the phenomena of statical, as in those of current electricity, there is constantly pressed upon the observer the necessity of admitting two forces, or two forms or directions of a force, inseparable from one another. And thus "the influence which is present in an electrical condition may best be conceived of as an axis of power having contrary forces, exactly equal in amount, in contrary directions."

This peculiar form of force manifests itself in different kinds of inorganic matter, under circumstances such as friction, change of temperature, magnetic influence, and chemical action.

It is also manifested in organized beings, not only under circumstances in which they stand related to it as masses of mere matter, but more particularly during the actions performed by their component textures and organs.

Electrical science has been hitherto chiefly prosecuted in the region of inorganic nature; and although Volta opened up a boundless field of discovery in the region of inorganic under the influence of organic electricity, the latter still remains comparatively uncultivated.

In the investigation of electrical force, as manifested in organic nature, the peculiar economy of the organized being must be taken into account. Each organized being, although dependent on certain external circumstances as the conditions of its existence, is, nevertheless, a system *per se.* Irrespective of those electrical conditions into which it may be thrown, through surrounding bodies, or through the medium in which it lives, it undoubtedly contains more or less numerous sources of electrical disturbance, in the numerous processes and arrangements productive of currents, in the structures which collectively constitute its organization. The organized being may be considered *electrically* as a system of electrical currents, excited by electrical arrangements in the disposition of its fluids, textures, and organs.

So far as has yet been ascertained, these electrical currents, with the exception of those produced by the special batteries in the electrical fishes, are not employed in the economy of the being. They are merely necessary consequences of the organic process carried on by the different structures; and effect, by their arrangement, the distribution of the resulting electricity, and the maintenance of the general electrical equilibrium of the organic system. The detection and investigation of these organic electrical phenomena are, however, important, not only for general electrical science, but also for the elucidation of the organic processes themselves. Residual phenomena, as such electrical disturbances must generally be considered in physiology, will, when investigated, indicate the probable nature of the actions from which they result.

EXISTENCE OF AN ELECTRICAL ÆTHER THROUGH SPACE.

Mr. G. J. Knox, in a letter to the editors of the London *Philosophical Magazine*, says: In a paper, entitled "On the Direction and Mode of Propagation of the Electrical Force traversing Interposed Media" (*Philosophical Magazine*, 1840), I endeavored to prove, from the experiments of Sir H. Davy, that an electric current consists in alternate states of induction and equilibrium of the particles of the medium conveying the current, the *intensity* of the current being proportional to the *rapidity of change* of induction and equilibrium, and consequently that the *mass* of oscillating æther surrounding the particles represents the *quantity*, while the *rapidity* of the oscillations represents the intensity of an electric current.

The *Philosophical Magazine*, No. 58, contains some very interesting experiments, which were made by Mr. L. Clark, on the transmission of currents of electricity of varying intensity through 768 miles of gutta percha wire, indicating a velocity of propagation of about 1,000 miles in a second, which velocity is sensibly *uniform* for *all intensities from* 31 *cells to* 500; which results, Dr. Faraday remarks, "afford a fine argument in favor of the opinion of those who suppose the electric current to be analogous to the vibrations of air under the action of sonorous bodies." The experiments of Professor Grove on the electro-chemical polarity of gases, where he obtains rings alternately bright and oxidated, showing effects of oxidation and reduction by the same current on the same plate, he considers as "analogous to the phenomena of interference in light; though doubtless, if this be a right view, the very different modes of action of light and electricity would present very numerous phenomenal distinctions." The idea has lately been presented to my mind, that the oscillations of the electrical æther in combination with the particles of the medium conveying a current, produce undulations, not only in the æthers of light and heat, but also in another æther, which Dr. Draper calls the tithonic æther, but which, if experiment proves to be the case, should be more correctly termed the electrical æther.

Dr. Draper, in the year 1847, undertook a series of experiments upon the rays of light emitted by incandescent bodies, from which he concluded that when a platinum wire is heated by the voltaic pile or otherwise, it emits rays of light, which increase in refrangibility proportionally to the increase of heat, which he explains thus:—"As the luminous effects are undoubtedly owing to a vibratory movement executed by the molecules of the platinum, it seems from the foregoing considerations to follow, that the frequency of those vibrations increases with the temperature." Sir David Brewster has observed, that in the spectra produced by the electric light, the chemical rays are more numerous than in those produced by the lime light. The problem then to be solved is—whether the chemical rays be produced *directly* by the oscillations of the electrical æther in the platinum wire, or *indirectly* by the heat produced.

This question might be resolved by observing the effect produced by voltaic piles of *different* intensities, the *heat* remaining *constant;* and if so, it would afford a strong argument in favor, not only of an oscillatory movement in the electrical æther in combination with the particles of bodies, but also of the existence of such an æther through space.

ON THE ORIGIN OF THE AURORA BOREALIS.

An important paper on the Aurora Borealis has recently been published by the Smithsonian Institution, entitled, "The Recent Secular Period of the Aurora Borealis," by Professor Olmstead, of Yale College. The following extract from this paper will sufficiently explain its nature:—

"It has appeared to me incumbent on some one devoted to the studies of nature, who has witnessed this exhibition of the Aurora Borealis, probably among the most remarkable that have ever occurred since the creation of the world, to write its history, to give an accurate history of its varieties, to present at one view a classification of the principal facts, in order, if possible, to ascertain the *laws* of the phenomenon; and finally to determine the *origin,* or primary cause to which it may be referred. I am the more encouraged to undertake this labor, from having enjoyed peculiarly favorable opportunities for observing these exhibitions from their commencement, and from having amassed from the accounts published in the periodicals of the day, and from an extensive correspondence, a greater amount of facts, than, so far as I know, any other person has taken the trouble to accumulate.

"I know of no other method of successfully investigating a subject of this kind, than first, to examine all the facts of the case; secondly, to bring together into one view, in separate groups, such as are similar, forming a full and accurate classification; thirdly, to inquire what general facts these truths reveal, since these deductions form the proximate laws of the phenomenon; and, finally, to make the laws the groundwork of a general *theory*, which shall assign the true cause of all."

The "Secular Period" embraces the exhibitions of the Aurora Borealis during the years 1827, '35, '36, '37, '48, '51, '52, and '53. Professor Olmstead classifies the Auroras by six different names; Aurora Twilight, the Arches, the Streamers, the Corona, the Waves, and the Auroral Clouds.

IMPROVED ELECTRICAL AND GALVANIC APPARATUS.

Breton's Galvanic Battery.—A battery arranged by M. Breton, of Paris, for medicinal purposes, is maintained in a constant moisture with chloride of calcium. For one of the poles there is a mixture of copper filings with sawdust, the latter designed to separate the metallic particles,—the filings are mixed with a solution of chloride of calcium. The other pole is a similar mixture, in which the copper is replaced by zinc filings. These two preparations placed in a vase, and separated by a porous cell, make a battery, which has always the same intensity of action, on account of its constant humidity, and the indefinite number of its elements.

Improved Electro-Medical Apparatus.—Mr. W. P. Piggott, of London, has patented some improvements in galvanic, electric, and electro-magnetic apparatus, and in the mode of their application as a curative and remedial agent. The inventor constructs a brush consisting of a mixture of bristles and metallic wires or plates, or coats a portion of the bristles forming the brush with metal by electric deposition, and these metallic wires, plates, or electrotyped or metallized bristles, communicate with and receive their electricity, galvanism, or electro-magnetism, from a battery or electrical apparatus, fixed in the back, or some other convenient part of the frame of the brush, or otherwise, as may be required, thus causing what is commonly known as positive or negative currents of electricity to pass from the ends of the wires, plates, or metallized bristles, when moved in contact with the hair or skin. Secondly, in the construction of a bath for the administration of galvanism, electricity, or electro-magnetism, one part of which bath will communicate positive, and the other negative electricity, and this is effected by forming the bath of a combination of elastic or flexible waterproof material and metal, in such a way that when a part of the waterproofing material is caused to envelope any required part of the body, two distinct currents of electricity, galvanism, or electro-magnetism, are created in the same bath.

Instrument for determining the Value of Intermittent, or Alternating, Electric Currents, for Telegraphic Purposes.—At the British Association Meeting for 1856, Mr. E. O. Whitehouse demonstrated that the effect of a weak electric current, say after it had traversed 100 miles of wire on an ordinary magnetic needle, was altogether inappreciable; and even the effect of strong currents at short intermitted periods, caused the needle so to vibrate as to render the observing of the arcs quite impossible; but by transmitting a very feeble current in such a way as to excite a powerful coil, and produce an electro-magnet by soft pieces of iron in the axes of the coils, he showed that, by a strongly framed and accurately constructed steelyard, he was able actually to weigh the feeblest currents, and to compare them with even the most powerful current transmitted through short distances. The exhibition of the apparatus, which worked admirably, and, as it were, weighed the force of each current as transmitted during the ordinary rapid working of the telegraph, seemed to afford much satisfaction to the section.

Substitute for the Copper Wire in the Construction of Helices.—The cost of helices of fine wire, and the limit of thickness to which the fine wire can be covered with silk for insulation, are two impediments which M. Bonelli has sought to set aside by very simple means. He takes a band of paper of the height of the helix of an electro-magnet, or of the corresponding part of the galvanometer; this band carries parallel to its edge, metallic lines $a\ a'$, $b\ b'$, etc., passing from one extremity to the other; these lines, placed in the circuit, will give passage to the current, while they are also insulated from one another by the paper that separates them; so that the current will pass uninterruptedly provided the lines of metal are unbroken. The number of these lines which may be put on a band of paper is almost indefinite. Leaving their extremities free, the current may be made to pass, either along the lines united, or in all of them at the same time and in the same direction.

Globotype Telegraph.—The London *Artizan* has recently published an illustrated description of a new and peculiar telegraph bearing the above name, invented by David McCallum, of Stonehouse, England. The leading characteristic of this invention consists in releasing small glass balls of three different colors—white, black, and blue—in such a manner as to fall over a series of inclined planes, and drop into their proper places, where, by their color and the way that they are made to arrange themselves, they form a message. These balls are thrown out one by one at the will of the operator, and as multiplied and intermixed they form the alphabet, like Professor Morse's dots, spaces, and dashes.

THE LAW OF THE SQUARES—IS IT APPLICABLE OR NOT TO THE TRANSMISSION OF SIGNALS IN SUBMARINE CIRCUITS?

The following is an abstract of a paper read before the British Association, by Mr. E. O. Whitehouse, the well known electrician and physicist. Mr. W., in commencing, stated that it was for the purpose of determining the force of either intermitting or alternating currents, whose duration was not sufficient to admit of the needle assuming a position of rest, that he proposed the use of the magneto-electrometer—an instrument rendering available the force of magnetic attraction instead of the deflection of the needle—as a means of measuring the amount of current circulating. This force was, he said, until we approach the point of magnetic saturation of the iron, strictly proportioned to the energy of the current under examination. The number of grains thus lifted on the arm of the lever the author proposes to call the practical "value" of the current for telegraphic purposes. The most striking features of this instrument are—1st. The facility of determining the value of currents which do not admit of being tried by the galvanometer. 2nd. The very great range which this instrument has (viz. from unity up to half a million), as well as the definiteness and accuracy of the results, even the extremes of the register being strictly comparable with each other. 3rd. Unlike the degrees upon the galvanometer, these grains of force are units of real "value" and of practical utility, as was shown by a telegraphic instrument in circuit being worked perfectly by a current of four grains. Referring to the proceedings of the association last year, the author showed that a wire six times the length of the Varna and Balaklava wire, if of the same lateral dimensions, would give thirty-six times the retardation, and thirty-six times the slowness of action. If the distinctness of utterance and rapidity of action practicable with the Varna and Balaklava wire are only such as not to be inconvenient, it would be necessary to have a wire of six times the diameter, or better, thirty-six wires of the same dimensions, or a larger number of small wires twisted together, under a gutta-percha covering, to give tolerably convenient action by a submarine cable of six times the length. Although the subject of submarine telegraphy had many points of the highest importance requiring investigation, and to the consideration of which he had been devoting himself recently, Mr. Whitehouse proposed to confine his remarks on this occasion to the one point indicated in the title, inasmuch as the decision of that one, either favorably or otherwise, would have, on the one hand, the effect of putting a very narrow limit to our progress in telegraphy, or, on the other, of leaving it the most ample scope. He drew a distinction between the mere transmission of a current across the Atlantic (the possibility of which he supposed everybody must admit) and the effectual working of a telegraph at a speed sufficient for "commercial success." The author then gave a description of the apparatus employed in his researches, of the manner in which the experiments were conducted, and, lastly, of the results obtained. The wires upon which the experiments were made were copper, of No. 16 gauge, very perfectly insulated with gutta-percha—spun into two cables, containing three wires of equal length (eighty-three miles), covered with iron wires and coiled in a large tank in full contact with moist earth, but not submerged. The two cables were subsequently joined together, making a length of 166 miles of cable, containing three wires. In addition to this, in some of the latest experiments he had also the advantage of another length of cable, giving, with the above, an aggregate of 1,020 miles. The instruments, one of which was exhibited, seemed to be of great delicacy, capable of the utmost nicety of adjustment and particularly free from sources of error. The records were all made automatically, by electro-chemical decomposition, on chemically-prepared paper. The observations of different distances recorded themselves upon the same slip of paper, —thus, 0·83 and 249 miles were imprinted upon one paper, 0·83, 498 miles upon another slip, 0·249, 498 upon another, and 0·535, 1,020 upon another. Thus, by the juxtaposition of the several simultaneous records on each slip, as well as by the comparison of one slip with another, the author has been enabled to show most convincingly that the law of the squares is not the law which governs the transmission of signals in submarine circuits. Mr. Whitehouse showed next, by reference to published experiments of Faraday's and Wheatstone's (*Philosophical Magazine*, July, 1855), that the effect of the iron covering with which the cable was surrounded was, electrically speaking, identical with that which would have resulted from submerging the wire, and that the results of the experiments could not on that point be deemed otherwise than reliable. The author then addressed himself to the objections raised against conclusions drawn from experiments in "Multiple" cables. Faraday had experimented, he said, upon wires laid in close juxtaposition, and with reliable results; but an appeal was made to direct experiment, and the amount of induction from wire to wire was weighed, and proved to be as one to ten thousand, and it was found impossible to vary the amount of retardation by any variation in the arrangement of the wires. Testimony, also, on this point was not wanting. The Director of the Black Sea Telegraph, Col. Biddulph, was in England, and present at many of the experiments. He confirmed our author's view, adding, "that there was quite as much induction and embarrassment of instruments in this cable as he had met with in the Black Sea line." The author considers it, therefore, proved "that experiments upon such a cable, fairly and cautiously conducted, may be regarded as real practical tests, and the results obtained as a fair sample of what will ultimately be found to hold good practically in lines laid out *in extenso.* At the head of each column in the annexed table is stated the number of observations upon which the result given was computed,—every observation being rejected on which there could fall a suspicion of carelessness, inaccuracy, or uncertainty as to the precise conditions; and, on the other hand, every one which was retained being carefully measured to the hundredth part of a second. This table is subject to correction, for variation in the state of the battery employed, just as the barometrical observations are subject to correction for temperature.

Amount of Retardation observed at various Distances. Voltaic Current. Time stated in Parts of a Second.

Mean of 550 observations.	Mean of 110 observations.	Mean of 1840 observations.	Mean of 1960 observations.	Mean of 120 simultaneous observations.	
83 miles ·08	166 miles ·14	249 miles ·36	498 miles ·79	535 miles ·74	1020 miles 1·42

—Now it needs no long examination of this table to find that we have the retardation following an increasing ratio,—that increase being very little beyond the simple arithmetical ratio. I am quite prepared to admit the possibility of an amount of error having crept into these figures, in spite of my precautions; indeed, I have on that account been anxious to multiply observations in order to obtain most trustworthy results. But I cannot admit the possibility of error having accumulated to such an extent as to entirely overlay and conceal the operation of the law of the squares, if in reality that law had any bearing on the results. Taking 83 miles as our unit of distance, we have a series of 1, 2, 3, 6, and 12. Taking 166 miles as our unit, we have then a series of 1, 3, and 6. Taking 249 miles, we have still a series of 1, 2, and 4, in very long distances. Yet even under these circumstances, and with these facilities, I cannot find a trace of the operation of that law." The author then examined the evidence of the law of the squares, as shown by the value of a current taken in submarine or subterranean wires at different distances from the generator thereof, which he showed were strongly corroborative of the previous results. He next examined the question of the size of the conducting wire; and he had the opportunity of testing the application of the law, as enunciated by Prof. Thomson last year. The results, far from confirming the law, are strikingly opposed to it. The fact of trebling the size of the conductor augmented the amount of retardation to nearly double that observed in the single wire. The author, however, looked for the *experimentum crucis* in the limit to the rapidity and distinctness of utterance attainable in the relative distances of 500 and 1,020 miles. 350 and 270 were the actual number of distinct signals recorded in equal times through these two lengths respectively. These figures have no relation to the squares of the distance. "Now, if the law of the squares be held to be good in its application to submarine circuits, and if the deductions as to the necessary size of the wire, based upon that law, can be proved to be valid also, we are driven to the inevitable conclusion that submarine cables of certain length, to be successful, must be constructed in accordance with these principles. And what does this involve? In the case of the Transatlantic line, whose estimated length will be no less than 2,500 miles, it would necessitate the use, for a single conductor only, of a cable so large and ponderous, as that probably no ship except Mr. Scott Russell's leviathan could carry it,—so unwieldy in the manufacture, that its perfect insulation would be a matter almost of practical impossibility,—and so expensive, from the amount of materials employed, and the very laborious and critical nature of the processes required in making and laying it out, that the thing would be abandoned as being practically and commercially impossible. If, on the other hand, the law of the squares be proved to be inapplicable to the transmission of signals by submarine wires, whether with reference to the amount of retardation observable in them, the rapidity of utterance to be obtained, or the size of conductor required for the purpose, then we may shortly expect to see a cable not much exceeding one ton per mile, containing three, four, or five conductors, stretched from shore to shore, and uniting us to our Transatlantic brethren, at an expense of less than one-fourth that of the large one above mentioned, able to carry four or five times the number of messages, and therefore yielding about twenty times as much return in proportion to the outlay. And what, I may be asked, is the general conclusion to be drawn as the result of this investigation of the law of the squares applied to submarine circuits? In all honesty, I am bound to answer, that I believe nature knows no such application of that law; and I can only regard it as a fiction of the schools, a forced and violent adaptation of a principle in physics, good and true under other circumstances, but misapplied here."

DR. SCORESBY'S OBSERVATIONS ON THE VARIATION OF THE COMPASS.

Dr. Scoresby, of England, has, it is well known, devoted much time and attention during the last few years to an examination of the phenomena of magnetism in relation to the compass, and published several able communications on the same subject. During the latter part of the year 1855, with a view of aiding research, the British and Australian Steam Company tendered to Dr. S. a free passage in an iron steamer, the Royal Charter, to Australia, and extraordinary facilities for conducting experimentation and research. The proposition so made was accepted, and the voyage having been successfully completed, Dr. Scoresby has recently published a report of the results of his magnetical researches during the voyage of the Royal Charter to Australia and round the world. The Royal Charter, it should be noted, is an iron ship, of the clipper class, with auxiliary steam power, belonging to the Liverpool and Australian Navigation Company. She is 324 feet in length on deck, and 42 in breadth, and 2,787 tons measurement. The compasses of the Royal Charter, observations on which were an important object of Dr. Scoresby's inquiries, were four in number; the steering compass, adjusted by magnets on Mr. Airy's principles, 68 feet from the stern; another adjusted compass (called the "companion compass") 89 feet; a standard compass on the deck house, unadjusted, 181 feet from the stern; and a compass aloft, 42 feet above the poop deck.

The leading objects contemplated by Dr. Scoresby in his recent undertaking were, to verify or test his theoretic views and results of inductive researches on the phenomena of magnetism with relation to the compass, especially as to the "retentive quality" so highly developed in iron ships in the process of construction, with the changes in such magnetism—views which he had first placed before the public at the meeting of the British Association at Oxford in 1847, and since then in his "Magnetical Investigations" published in 1852, and in various other forms; and to test also his plan of a compass aloft, first proposed in his account of discoveries on the eastern coast of Greenland in 1822, for the avoidance of the ship's attraction, and for obtaining correct compass guidance, so essential to safety in navigation. Four plans or processes were adopted by Dr. Scoresby for the determination of the facts, as to the nature and changes of the ship's magnetic condition, viz. comparisons, almost daily, of the four compasses described; experiments on the ship's external magnetism, as indicated by her deviating action on a compass placed first near the upper edge of the top plating, and then gradually let down towards the water's edge, such experiments being made in different parts of the ship's length on the poop and forecastle; the determination, from time to time, of the polarity of iron bars, standards, &c., having an upright position; and, finally, the ascertaining of the position taken by a Fox's dipping needle in different stations about the deck, and comparing the results with the known terrestrial dip.

By these several appliances, the whole of the objects contemplated in the voyage were satisfactorily and completely attained; and to Dr. Scoresby it was necessarily most gratifying to find that not one of the conclusions he had been led to by inductive research was in any measure contravened; but, on the contrary, all the leading propositions he had for years been urging on the attention of navigators and men of science were distinctly verified. Thus, just as he had predicted, the ship retained her original magnetic condition, and the adjusted compasses preserved very nearly their original state, so long as the ship was on courses not very remote from the direction of the ship's head when building; but when she came into a south-westerly direction, the reverse of that on the stocks, under a heavy sea, just as had been predicted, the compasses changed, and there was an error, temporarily, in the steering compass, of a point or more. On reaching a position of considerable southern dip, the adjusted compasses went wrong—one of them to the extent of a point and three quarters—a moderate change only in comparison with many ships, due, no doubt, to the favorable position of the Royal Charter's compasses in being removed so far from the stern, and entirely above the iron plating of the sides. On swinging the ship at Melbourne, the standard compass was found to have lost nearly one half of its original errors, and the two adjusted compasses to have attained considerable deviations; whilst the compass aloft was, to all practical ends, quite correct. But the most striking change exactly consistent with theoretic deductions was the complete inversion of the ship's magnetic polarity—the whole of the top sides having changed from southern to northern, externally; and every standard, stanchion, davit, or other mass of iron about the deck, including also four iron capstans, had attained at the upper parts northern polarity, which, northward of the equator, had been tested as having their southern poles upward. Approaching the magnetic equator, on the homeward passage, the two ends of the ship, as had also been predicted, attained polarities corresponding with the action of terrestrial induction, the stem aloft, as well as below, changing to southern polarity, and the head becoming more intensely magnetic with the contrary polarity. The gradual travelling of the southern polarity, from the stern forward, as the ship advanced northward towards the line, was a fact which Dr. Scoresby watched with great attention and interest, until, after reaching some distance within the northern tropic, the whole of the ship's sides had changed again their polarity, so that from stem to stern, as when the ship first set out, the upper plating had all acquired the southern polarity. Finally, as to these corroborating facts of previous deductions, it was mentioned that, though the upper polarity of the ship had changed, yet some general influence, derived from the previous inversion of polarity, or, more particularly, from the earth's inductive power, while the ship's head was continually directed northward from the passing of Cape Horn, had been received or retained.

Hence, on swinging the ship at Liverpool, immediately on her return to port, the adjusted compasses were found not merely to have retained their southern errors, but that the maximum of the steering compass had increased up to about two points; whilst correspondently, in a theoretic view, the standard compass had become still more correct than when at Melbourne, its errors on a large number of points being now trifling and unimportant.

The most important fact remains to be noticed—viz. that such was the general accuracy of the compass aloft in this case of the Royal Charter, and such the instruction derived from the repeated swinging of the ship, that the course actually made good on every occasion during the voyage was accurately known—that is, far within the limits of the defects of steering, and that numerous determinations by azimuths and amplitudes of the variation of the compass in the Pacific and North and South Atlantic, were obtained with perhaps as much accuracy as had ever been had even in ships built of timber.

CORRECTION OF COMPASSES.

A late Glasgow invention seems to promise something of importance in enabling the compass to work with certainty on iron vessels, although it is difficult to understand the principle. It consists solely in covering the ordinary box with cork or the pith of elder wood, with several coats of resinous varnish or sealing wax. The bowl in which the compass is suspended is also lined with the same, and the result is not a complete annihilation, but a very great diminution of the effect of all local attractions.

ON THE HEAT PRODUCED BY THE INFLUENCE OF THE MAGNET ON BOILERS IN MOTION, BY M. FOUCAULT.

In 1824, M. Arago observed the remarkable fact of the attraction of the magnetic needle by conducting bodies in motion. The phenomenon appeared singular; it remained unaccounted for until Faraday announced the important discovery of induced currents. From that time it was proved that, in Arago's experiment, motion gave rise to currents, which, reacting on the magnet, tended to associate with it the mobile body and to attract it in the same direction. It may be said, generally, that the magnet and the conducting body tend, by mutual influence, towards relative repose.

If, notwithstanding this influence, it be desired that the motion should continue, a certain amount of labor must be bestowed upon it, the movable part seems to be restrained, and this work necessarily produces a dynamic effect, which I have thought, according to the new doctrines, must be attributed to heat.

We arrive at the same conclusion by observing the induced currents which follow in the interior of the body in motion; but this mode of considering things could give only, with great trouble, an idea of the quantity of heat produced, whilst by considering this character as due to a transformation of work, it appeared to me certain that we should easily produce, in a decisive experiment, a considerable elevation of temperature.

Having at hand everything necessary for a prompt verification, I proceeded as follows:—

Between the poles of a powerful electro-magnet I partially engaged the solid of revolution belonging to the rotatory apparatus which I have called a *gyroscope*, and which I had previously used in experiments of quite another nature. This solid was a torse of bronze, connected by means of a toothed pinion to a moving wheelwork, and which, turned by means of a handle, may attain the speed of 150 to 200 turns per second. To render the action of the magnet more efficacious, two pieces of soft iron superadded to the bobbins prolong the metallic poles and concentrate them in the vicinity of the turning body.

When the apparatus is at full speed the current of six Bunsen elements directed into the electro-magnet, arrests the motion in a few seconds, as if an invisible bridle had been applied to the motive power; this is Arago's experiment developed by Faraday. But if we then strain at the handle, in order to restore to the apparatus the motion which it had lost, the resistance experienced, compels us to exert a certain degree of force, the equivalent of which reappears and is effectively accumulated in heat in the interior of the turning body.

By means of a thermometer buried in the mass we follow, step by step, the progress in elevation of temperature.

Having taken, for example, the apparatus at the surrounding temperature of 16° C. (60° 8′ F.), I saw the thermometer rise gradually to 20° C. (68° F.), 25° C. (77° F.), 30° C. (86° F.), and 34° C. (93° 2′ F.); but the phenomenon was so much developed as not to require the employment of thermometrical instruments; the heat produced had become sensible to the hand.

A few days afterwards the battery being reduced to two elements, a flat disc formed of red copper was raised in two minutes' action to the temperature of 60° C. (140° F.).

If this experiment appears interesting it will be easy to arrange an apparatus for fully developing the phenomenon which I have noticed. Undoubtedly, by a suitably constructed machine composed only of permanent magnets, we may produce elevated temperatures and exhibit to the public assembled in lecture theatres a curious example of the conversion of labor into heat.

TERRESTRIAL MAGNETISM.

As early as 1825, Col. Sabine had inferred, that an influence was exerted by the sun and moon on terrestrial magnetism. In a set of observations taken at the winter station of one of the polar expeditions, where the declination was about 90°, and discussed by him, it was remarked that when the sun and moon were on the meridian at the same time, the diurnal variation reached 5°, but when they were at right angles to each other, this quantity fell as low as 20°. The sagacity Col. Sabine exhibited in his inference from this isolated set of observations has been sustained by the laborious and patient observations and investigations of fifteen years. Some quantities so minute are developed in the researches, that a less time would hardly have served to separate them from the larger quantities in which they are involved. The results set forth by Col. Sabine to the British Association are as follows:—

1. The diurnal variation following in all places the order of solar time, and being at its maximum about two hours after noon, changes its sign at the time of the two equinoxes. Thus, while the maximum diurnal deflection from the magnetic meridian is eastward in all places up to the 21st of March, a change in the amount of deviation begins on the 22d, and is completed in about ten days, after which the maximum daily variation is to the westward, and at a mean equal to the eastern variation of the preceding six months.

2. There is an annual variation in the intensity of terrestrial magnetism, of small amount indeed, but affecting both the northern and southern hemisphere in the same manner, the intensity being greatest when the sun is in perigee and least when it is in apogee.

3. It is well known that all the instruments used in magnetic observation are from time to time affected by disturbances, or storms as they are often called; these storms have been found to be subject to a periodic fluctuation, and this period has been discovered to correspond with that assigned by Schabe to the spots on the solar disc.

4. It has been clearly shown that there is a variation in magnetic declination, dependent on the change of the moon's position in relation to the meridian of the place of observation, and having therefore for its period, the lunar day. This, although first inferred by Sabine from a single set of observations, has been since fully proved by Kriel. Finally, the hypothesis which ascribes the variations in the phenomena of terrestrial magnetism to local variations of temperature is completely refuted.

May we not hope that the relations of the magnetism of the earth with the heavenly bodies, which exert the greatest influence in other respects upon our planet, having been thus conclusively shown, a basis is now provided upon which to erect a science, that will be as simple in its laws and as fertile in its results as the theory of universal gravitation? Up to the present time terrestrial magnetism as a science has had no other foundation than vague or unsupported hypotheses, or empiric propositions, which, although true, have been founded on no general law. Henceforth it would appear to be as closely within the reach of mathematical methods as the tides.—*Proc. British Association.*

ON THE CONSTRUCTION AND OPERATION OF THE SUBMARINE ATLANTIC TELEGRAPH.

A recent writer in the London *Times*, reviewing the proposed construction of the Submarine Atlantic Telegraph, sketches out the details and prospects of the enterprise as follows:—

"The cable, to allow for the inequalities of the ground and other exigencies of the case, will be 3,000 miles long. The wires will be isolated in gutta-percha coatings; and all the improvements which science can afford will be applied to give durability, strength, and efficacy to the cable. To lay so enormous an amount of coil, two ships will proceed to the mid-ocean, each carrying half the line. They will then separate, and continue to lay out the cable until they shall have reached their respective destinations. The wires will enable them during the entire process to telegraph each to the other at will, so that their combined movements will be, as it were, at the direction of one mind. Hitherto, almost all the cables which have been lost have been sacrificed from being placed in sailing vessels towed by steamboats. These have become unmanageable in bad weather, and, to save themselves, have been obliged to throw the coil overboard. This could not occur, if the countries most interested, England and the United States, were to contribute first-rate steam men-of-war. At all events, it is well to think, that in this instance, as there will be two vessels, the line can scarcely be lost, for, even if one were obliged to sacrifice her freight, the other could wind it up from the deep. The number of wires to be used is not determined upon, and here again modern science has achieved a great triumph. Of course, in a line of such length the amount of copper used in the wire becomes an object of the gravest consideration in determining its expense. Now, in telegraphs above ground, it has been found that the facility of transmitting a current has increased with the enlarged size of the wire. The electricity has, as it were, a broader path to move on. Thus an imperfect conductor can compensate for its defective state of conduction, by increase of volume. Take, for instance, the two metals, copper and iron. Iron offers seven times the resistance of copper to the passage of an electric current, but by proportionally increasing the size of the iron wire, electricity will be as readily transmitted through it as through the better conducting metal; and consequently iron wires, one-sixth of an inch in diameter, are used in the telegraphs of this country. It was dreaded, from such a course of reasoning, that so enormous a line should not only be of the best conducting material, but that it should also be of great thickness, which would vastly enhance the expense, but Dr. Whitehouse has, in a series of over 4,000 experiments, demonstrated that not the same, but rather an opposite condition operates in submarine lines. It is to be remarked that the wires here are thoroughly isolated, so that the charge sent into one resembles the charging of a Leyden jar, and, consequently, the smaller, within certain limits, the wire which is to be charged, the more effective the operation of the electricity will be. This is a result of the most important character, for otherwise the company would have been put to enormous cost in employing larger wires, which would, in fact, have been only operative to retard the telegraphic action."

"So far, indeed, as regards the wire connection between the two countries, there seems no doubt that it can be made; but that mechanical difficulty overcome, there will remain the question whether telegraphic signals can be transmitted through a submerged wire, of that length, however carefully it may be insulated. On this point electricians and mathematicians are at variance. It is not a simple question whether an electric current can be transmitted, but whether the wire can be discharged, after transmission, quickly enough for the repetition of telegraphic signals.

"This difficulty first presented itself in the telegraph from Harwich to the Hague. It was found that the water surrounding the wires prevented them transmitting distinctive signals, the action of each one being prolonged so as to interfere and blend with the signal preceding. The difficulty was quite unexpected. Faraday brought his wonderful power of investigation to bear on the subject, and ascertained that the conducting property of sea water on the outside of the gutta-percha has the effect of converting the coated wire into an elongated Leyden jar, and causes it to retain a portion of the charge, in the same manner as an ordinary Leyden jar retains a part of the electricity after it has been discharged. This difficulty, which seemed to present an effectual bar to the use of Professor Morse's instruments—in which the electric current traverses continuously in the same direction—was overcome by reversing the direction of the current after each signal, by which process the wire was prepared to transmit another. That plan has answered from London to the Hague, but doubt is entertained whether the remedy will apply across the Atlantic. Experiments, so far as they can be made, show that the obstacle may be overcome; but theoretical philosophers are not wanting, who, armed with arrays of figures, contend that the thing is impossible."

During the past summer, the U. S. steamer Arctic, was sent out to run a line of soundings from Newfoundland to the nearest point on the Irish coast, with a view of affording information relative to the laying of the proposed telegraph. The result of the expedition has been stated by one of the party as follows:—

"Not a single rock had been met with, not a particle of gravel or sand had been brought up, but it appears as if nature had provided a bed 'soft as a snow bank,' to use Maury's own words, for the express purpose of receiving a telegraph cable.

"Lieut. Berryman says that he is satisfied that the lead, with the sounding apparatus, has frequently buried itself ten or fifteen feet deep in this soft material, and he doubts not that the cable will likewise sink and imbed itself in a similar manner. The greatest depth attained has been two thousand and seventy fathoms (about two and a third miles); but perhaps the most remarkable, and at the same time the most satisfactory result, is the perfect confirmation which these soundings give of the opinion expressed by Lieut. Maury as to the existence of a great flat or level at the bottom of the ocean, unparalleled by anything on the surface of the earth, and which he proposes to name the 'Telegraph Plateau.' For more than thirteen hundred miles the body of the Atlantic, in the direct line of our track, is found by these soundings to present an almost unbroken level plain. Nature has thus placed no obstacle in the way of this great undertaking, which may not, by cautious perseverance, be overcome; nay, rather (if we except the enormous length of the cable which will be required) it would seem that the line to be followed by the Atlantic cable presents absolutely fewer engineering difficulties than the shorter route (though more complex, from the nature of the bottom) on which the Mediterranean cable must be laid."

During the last few weeks of the year, the enterprise of constructing the Transatlantic telegraph has been pushed forward with vigor. The whole amount necessary for the construction of the work has been subscribed in England and the United States, and contracts for the manufacture of the cable have been made. By the terms of the contracts, the cable is to be completed and deposited on board a vessel by the 31st May next, in order that it may be laid down during the succeeding months of June and July. The English Government has acted with the utmost liberality. It has directed a vessel to be sent out at its own expense, to make further and thorough soundings, and to examine the coasts of Ireland and Newfoundland, with a view to select the best places for landing the cable. It has also agreed to guarantee an interest of four per cent. per annum on the entire amount of capital required to manufacture and lay down the cable.

It is proposed to construct the cable of seven copper wires, covered with three separate layers of gutta-percha, over which is to be bound hemp saturated with tar and other materials, the whole being inclosed in 126 iron wires.

ON THE EXTERNAL TEMPERATURE OF THE EARTH AND OTHER PLANETS OF THE SOLAR SYSTEM.

We obtain the following paper by Mr. Hopkins, on the above subject, from the Proceedings of the Cambridge (England) Philosophical Society:—

We have not sufficient data to determine the superficial temperature of any planet except our own. We know, however, that it must mainly depend on the temperature of the planetary space, and on the heat which the nearer planets at least receive directly from the sun, but modified, and possibly in a far greater degree than has been generally supposed, by the particular circumstances by which each planet may be characterized. No astronomer, judging from the appearances which Mars and Jupiter present to us, would entertain any serious doubt as to the existence of atmospheres surrounding those planets, and the probability would seem to be almost equally strong of Saturn being likewise enveloped in a similar manner. The obliquity of the axis of rotation is known with considerable accuracy in the case of Mars and Jupiter, and also in that of Saturn, if it coincide with the axis of rotation of his ring. Venus presents great difficulties to the observer, but it appears now pretty satisfactorily determined that the period of rotation about her own axis is nearly the same as that of the earth, and that the obliquity of her axis is large, amounting to as much as about 75°. This must produce an extraordinary difference between the changes of annual temperature in that planet and those which we experience. The author has endeavored, in this paper, to estimate numerically the effect of this anomalous obliquity. Practical astronomers have entertained the opinion that Venus likewise has an atmosphere. Of Mercury we know too little by direct observation to form any opinion on those points founded on observed facts, and the same remark will apply to the remoter planets beyond Saturn; but most astronomers probably feel much the same conviction that Mercury, Uranus, and Neptune, have atmospheres of greater or less extent, as that they revolve round their own axes with greater or less angular velocity. The earth's atmosphere is known to be almost completely diathermanous for heat radiating directly from the sun; and it is assumed to be equally so for the heat which proceeds directly from the fixed stars, and to which the general temperature of space is due.

This radiating heat, therefore, has little or no effect in heating the atmosphere during its transmission to the earth's surface; but after falling upon, and heating terrestrial objects, it loses the power of radiating completely through the atmosphere, and is transmitted back into space through the atmosphere by conduction, conversion, and partial radiation to limited distances. But for any of these modes of transmission, it is essential that the temperature of the atmosphere should be greater in its lower than in its upper portions, and in a degree greater as the quantity of heat to be transmitted is greater. The temperature (τ_2) of the upper portion must be determined by the condition, that in a given time a quantity of heat must radiate from it into surrounding space equal to that which falls upon it from external sources in the same time, and is transmitted back after reaching the surface of the earth or objects near to it. Consequently τ_2 must be independent of the height of the earth's atmosphere. At lower points the temperature will increase till we reach the surface of the Earth; and if we denote the temperature there by τ_1, it is manifest that τ_1 will be greater, the greater the height of the earth's atmosphere.

It must here be particularly observed, that τ_2 is the proper temperature of the component particles of the atmosphere, and is probably widely different from the temperature which would be indicated by a thermometer placed at the upper extremity of the atmosphere, since the instrument would not only be affected by the exchange of heat between its bulb and the atmospheric particles, but also by the heat radiating upon its bulb from every source of heat in surrounding space; while the atmosphere, on account of its diathermancy, would remain unaffected by this radiating heat.

Conceive now a thermometer to be placed at a point sufficiently above the earth's atmosphere. If the bulb were sheltered from the direct influence of the solar rays, the thermometer would indicate the temperature of that point of space, independent of the effect of radiation from the central luminary of the solar system, but dependent on the radiation from all other sources of heat in the universe. If the instrument thus sheltered were sufficiently remote from the sun and every planet, it would indicate very nearly the same temperature at every point within the solar system, assuming the absence of all unknown centres of heat within that system or near to it.

This is what may be understood by the general temperature of planetary space. Let it be denoted by T. We shall then have T greater than τ_2; and therefore if we now conceive the thermometer to be transported to the upper limit of the atmosphere, it will be affected by the lower temperature there, and will indicate a temperature intermediate to T and τ_2. If the instrument be brought still lower within the atmosphere, it will indicate a still lower temperature, from its being entirely surrounded by a portion of the atmosphere more dense than at the extreme boundary, till this tendency to lower the indications of the thermometer is counteracted by the greater temperature of the atmospheric particles as we descend towards the earth's surface. At some point, consequently, within the earth's atmosphere the indication of the thermometer would attain its *minimum;* after which, in descending continuously towards the earth, the temperature indicated would constantly increase, omitting variations due to temporary or local causes.

Thus it follows, that the existence of an atmosphere like that of the earth, enveloping a planet, may, according to its extent, either elevate the superficial temperature of the planet above, or depress it below that of surrounding space independently of the direct solar radiation. With respect to our own globe, we are entirely ignorant of the height to which the thermometer, in ascending, would continue to indicate a decreasing temperature, but we are sure that such height is great. This is important with reference to the ultimate object of this paper; for if the height of a planet's atmosphere were too small to allow a thermometer descending in it to attain its *minimum* indication, it is manifest that an increase of atmosphere would cause a decrease in the planet's superficial temperature; whereas, if the height of the atmosphere were great enough to allow the thermometer to attain the minimum, any increase of atmosphere would necessarily cause an increase in the superficial temperature of the planet.

In the earth's atmosphere, we are sure (as just remarked) that the indications of the thermometer would constantly increase in its descent from a very high point above the earth's surface; and therefore it follows, that if a planet be enveloped in an atmosphere similar to that of the earth, supposing both to exist in the planetary space unaffected by the heat which radiates from the sun, the superficial temperature of the planet would necessarily be less, under the same conditions, than that of the earth, if its atmosphere were smaller, unless it should be so small as not to allow a thermometer descending in it to reach its minimum indication. If the planet were entirely without atmosphere, its superficial temperature (in the assumed absence of solar radiation) would be that of surrounding space; but we have no means of determining what relation that temperature bears to existing terrestrial temperature, or what this latter temperature would become in the absence of solar radiation.

The author has calculated from Poisson's formulæ, the increase of temperature in the superficial crust of the earth, due to the amount of heat received by direct radiation from the sun, in different latitudes, above that temperature which would be common to all parts of the earth's surface in the absence of solar radiation, and with a uniformity of intensity of stellar radiation in all directions upon our globe.

But this increased temperature must produce an augmentation of temperature in the atmosphere, which must react on the terrestrial temperature till equilibrium of temperature be established. The author has endeavored to estimate the amount of this indirect effect of solar radiation by means of the data furnished by M. Dove's work on terrestrial temperatures, combined with calculations based on Poisson's formulæ. He concludes that the whole effect of solar heat at any proposed place is very nearly double that due to the immediate and direct effect of solar radiation.

Having thus ascertained this entire effect, he finds the temperature which would pervade the whole surface of the earth if solar heat were extinguished. He estimates this temperature at 39°.5 C. The annual variation of temperature in any latitude is found to be nearly the same in amount for the terrestrial surface and for the part of the atmosphere resting upon it. This must be understood as applying to those places at which the temperature is not materially affected by the horizontal transference of heat by marine or aërial currents, or any local causes, which disturb the dependence of temperature on latitude alone.

The author also points out the dependence of the annual inequalities of the terrestrial temperature (and consequently of those also of the atmosphere) on the conductivity and specific heat of the matter which constitutes the earth's crust.

If these were much greater, the annual changes of temperature would be much less. Before applying these results to other planets, the author states that he does not admit the notion, that the remoter planets may derive a considerable superficial temperature from the remains of that internal heat which they probably possessed in the earlier stages of their existence. It is a well established conclusion, that the superficial temperature of our own globe has arrived at that point below which it can never descend by more than the small fraction of a degree, so long as all external conditions remain the same as at present; and the superficial temperature of the remoter planets will in all probability be reduced to the corresponding limit. To these external conditions, therefore, and not to their primitive heat, must the existing temperatures on the surface of these planets be attributed, assuming always that they are not of less antiquity than our own globe. Hence the superficial temperature of the earth, with its present atmosphere, placed at the distance of Neptune, Uranus, or Saturn, would be very nearly 39°.5 C., since the effect of our solar radiation at those distances would be nearly insensible. But if the extent of the atmosphere were increased the superficial temperature would be augmented in a corresponding degree. Judging by the decrements of temperature observed by Mr. Welsh, the author concludes that an increase in the height of the earth's atmosphere of 35,000 or 40,000 feet, would elevate her superficial temperature, if placed in the remote planetary regions, to nearly the mean temperature of our present temperate zone. The same conclusion will hold with respect to the three planets above mentioned, if we suppose them to have atmospheres similar to that of the earth, and of sufficient extent. Their temperatures must be sensibly uniform over the whole of their surfaces, not being subject to any appreciable annual variation.

The same conclusions will apply to Jupiter, except that there will be a small augmentation of temperature arising from solar radiation, which the author calculates might amount to about 2½° C. at his equator. Hence, the author concludes, that those views which assign a necessarily low temperature to the above mentioned planets, in consequence of their distance from the sun, are altogether untenable.

The conditions under which Mars is placed approximate more nearly to those of the earth than for any other planet. The author calculates, that with an atmosphere similar to that of the earth, and exceeding it in height by about 15,000 or 20,000 feet, the equatorial temperature of Mars may be about 60° F., or 15° C., and his polar temperature about 10° C. The extent of the annual variations would be about half those on our own planet in corresponding latitudes, supposing the conductivity, specific heat, and radiatory power of the matter composing his superficial crust to be the same as for the earth.

Again, if the earth, with ner present atmosphere and obliquity, were placed in the orbit of Venus, the mean equatorial temperature would be upwards of 90° C., subject to the reduction, which would doubtless in this case be great, due to the horizontal transference of diminution in the atmosphere, which would reduce these temperatures in any assigned degree. But the obliquity of Venus, though not satisfactorily determined, is considered to be much greater than that of the earth, amounting, according to the estimate of some astronomers, to as much as 75°, as heretofore stated.

This would, of course, render the character of her seasons entirely different from those of the earth. The greatest mean annual temperature would be at the pole. Independently of the horizontal transference of heat by aërial currents or other causes taking the extreme obliquity of 75°, and supposing the atmosphere of Venus to be exactly like that of the earth, her mean temperature at the equator would be about 56° C., and at the pole 95° C.

This latter would probably be much lowered by currents; but if the height of the atmosphere of Venus be less than that of the earth's atmosphere by 25,000 feet, the author considers that the mean temperature of Venus in her equatorial regions would not exceed that of the temperate regions of the earth; while the mean polar temperature would probably be about 40° C., or about 12° or 13° C. higher than the earth's equatorial temperature.

The heat of sunshine may be moderated by an atmosphere more laden with vapor than that of the earth.

Supposing the atmosphere of Venus like that of the earth in its nature and magnitude, the temperature at her poles, with the supposed obliquity, must be subject to an enormous annual inequality, amounting to between 70° and 80° C. above or below the mean temperature, liable, however, to a great reduction by horizontal transference of heat. It may also be considerably reduced by the nature of the matter which constitutes her outer crust.

The moon is under the peculiar circumstances of the absence of a sensible atmosphere, and her long period of rotation about her axis. Assuming her to have no atmosphere at all, the mean temperature of her outer crust, in the absence of the sun, would be the general temperature of that portion of planetary space in which the solar system is situated. How much this might differ from the superficial temperature which the earth would have with the like absence of the sun, and which the author estimates at 39°.5 C., as above stated, it is impossible to determine; but whatever it may be, the influence of the sun's heat would be to increase by about 40° C. at the moon's equator, and by a small amount only at her poles. This must be attended by an enormous monthly inequality, amounting to nearly 60° C., supposing the matter of which her superficial crust is composed to have the same conductivity, specific heat, and radiating power as the crust of the earth.

If these be much greater for the moon, this inequality might be considerably diminished. At the poles it must be comparatively small.

The lunar temperatures here spoken of, are those which would be indicated by a thermometer placed in her immediate vicinity, and affected by the moon (in the assumed absence of an atmosphere) only by her direct radiation. We have not the means of determining what this temperature may be.

HEAT OF THE SUN'S RAYS.

At the Albany Meeting of the American Association, Judge Foot read a paper on the heat of the sun's rays, as determined by experiment. He commenced by a discussion of the proper mode of measuring the heating power of the ray. He had repeated some of the experiments of Cavendish, and had come to the conclusion that the true measure could be obtained by adding to the difference of temperature in the sunlight and in the shade a correction for increased temperature in the air. His first result was that the heating power of the sun's rays is not uniform, but varies constantly with the temperature of the place into which the rays fall. He then gave an account of experiments with a burning glass, which confirmed this result—the heating power of the focus not varying with the temperature of the glass, but of the place where the focus formed. Furthermore, he thought he had proved that the temperature of air is raised by sunshine passing through it. He found that of two jars of heated air, one placed in the sunlight would retain its heat the longest. Heat did not come from the sun, but light capable of exciting heat.

Prof. Henry then read a paper by Mrs. Eunice Foote, prefacing it with a few words, to the effect that science was of no country and of no sex. The sphere of woman embraces not only the beautiful and the useful, but the true. Mrs. Foote had determined, first, that the action of the rays increases with the density of the air. She has taken two glass cylinders of the same size, containing thermometers. Into one the air was condensed, and from the other it was exhausted. When they were of the same temperature the cylinders were placed side by side in the sun, and the thermometers in the condensed air rose more than twenty degrees higher than those in the rarefied air. This effect of rarefaction must contribute to produce the feebleness of heating power in the sun's rays on the summits of lofty mountains. Secondly, the effect of the sun's rays is greater in moist than in dry air. In one cylinder the air was saturated with moisture, in the other dried with chloride of lime; both were placed in the sun, and a difference of about twelve degrees was observed. This high temperature of sunshine in moist air is frequently noticed; for instance, in the intervals between summer showers. The isothermal lines on the earth's surface are doubtless affected by the moisture of the air giving power to the sun, as well as by the temperature of the ocean yielding the moisture. Thirdly, a high effect of the sun's rays is produced in carbonic acid gas. One receiver being filled with carbonic acid, the other with common air. the temperature of the gas in the sun was raised twenty degrees above that of the air. The receiver containing the gas became very sensibly hotter than the other, and was much longer in cooling. An atmosphere of that gas would give to our earth a much higher temperature; and if there once was, as some suppose, a larger proportion of that gas in the air, an increased temperature must have accompanied it, both from the nature of the gas and the increased density of the atmosphere. Mrs. Foote had also tried the heating effect of the sun's rays on hydrogen and oxygen, and found the former to be less, the latter more, susceptible to the heating action of sunlight.

SOURCE OF THE SUN'S HEAT.

The following is an abstract of Prof. Thompson's (of England) article, published some time since, and often referred to (see Annual of Sci. Dis., 1854, pp. 144–148), in which he advocates the hypothesis, "that meteors falling into the sun give rise to the heat which he emits."

All the theories that have yet been proposed to account for the heat of the sun, he remarks, as well as every conceivable theory, must be one or other, or a combination of the following three:—

1st. That the sun is a heating body, losing heat.

2d. That the heat emitted from the sun is due to chemical action among materials originally belonging to his mass, or that the sun is a great fire.

3d. That meteors falling into the sun give rise to the heat which he emits.

It is demonstrable, that unless the sun be of matter inconceivably more conductive of heat, and less volatile, than any terrestrial meteoric matter we know, he would become dark in two or three minutes, or days, or years, at his present rate of emission, if he had no source of energy to draw from but primitive heat.

The object of the communication is to consider the relative capabilities of the second and third hypotheses to account for the phenomena.

In the first place it is probable that there are always meteors falling to the sun, since the fact of meteors coming to the earth proves the existence of such bodies moving about in space. It is easy to prove that meteors falling to the sun, must enter his atmosphere or strike his surface, with immensely greater relative velocities, than those with which meteors falling to the earth, enter the earth's atmosphere, or strike the earth's surface. Now, Joule has shown that immense quantities of heat must be generated from this relative motion in case of meteors falling to the earth,—and it is all but certain that, in a vast majority of cases, this generation of heat is so intense as to raise the body in temperature gradually up to an intense white heat, and cause it to burst ultimately into sparks in the air, and burn, if it be of metallic iron, before it reaches the surface. Such effects must be experienced to an enormously greater degree before reaching his surface, by meteors falling to the sun, if, as is highly probable, he has a dense atmosphere. Hence, it is certain that *some* light and heat radiating from the sun is due to meteors.

It is estimated that the quantity of matter that would be required to strike, is about a pound to the square foot every five hours. At this rate, the surface would be covered to a depth of thirty feet in the year, if the density of the deposit is the same as that of water. We find the source of meteors principally within the earth's orbit; and we actually see them there as the "zodiacal light," according to Herschel, an illuminated shower, or rather tornado of stones. The inner parts of this tornado are always getting caught in the sun's atmosphere, and drawn to his mass by gravitation. The outer edge of the zodiacal light appears to reach nearly to the earth at present; and in past time it may be that the earth has been in a dense enough part of it to be kept hot, as the sun is now, by drawing in meteors to its surface. This calculation is according to Mr. Waterson's form of the theory, but, according to Prof. Thompson's, the fall of meteors must be twice that determined above. Then the whole surface would be covered annually to the depth of sixty feet, and the sun would grow in diameter a mile in eighty-eight years. Even at this rate, it would take 4,000 years to grow sufficiently to make the change apparent to the most refined observations.

A body of such dimensions as the sun might, by entering a cloud of meteors, become incandescent intensely in a few seconds, and on again getting to a position comparatively free from meteors, as suddenly become dark again.

If the sun is burning, and its conditions are similar to those of the earth, the fire would be choked, and by no conceivable adaptation of air and fuel, could keep a light for more than a few minutes. If it contains within itself all the elements of combustion, to give the amount of light and heat required would by demonstration cause it to burn away in 8,000 years. If the sun has been burning at that rate, he must have been of double diameter, quadruple heating-power, and eight fold mass, only 8,000 years ago.

ON A THERMOMETER FOR MEASURING FLUCTUATIONS IN TEMPERATURE.

The following description of a new thermometer invented by Mr. Stewart, was described by Mr. Welsh at the last Meeting of the British Association:— If a bulb be blown between two thermometric glass tubes of unequal bores, and the instrument be filled with mercury in the same manner as an ordinary thermometer, and laid horizontal or nearly so, it will be found that contractions from cold take place only in the narrow bore, and expansions from heat only in the wide one. The reason of this seems to be, that while the temperature remains the same the mercury is kept at rest, and prevented from retreating from the small bore into the bulb by friction; but, when a motive force is supplied by a change of temperature, the motion of the mercury takes place in that direction in which it is most aided by capillary action. It was suggested by Mr. Welsh to the author, that such an instrument might be used to measure fluctuations of temperature. And the author thinks it might be applied to measure with exactness the power of a source of radiant heat; for by alternately interposing a screen between this instrument and the source of heat, and withdrawing the same screen, the effect of the source on the mercury would be multiplied by the number of times this operation was performed. In constructing such an instrument care must be taken that the tubes used are quite free from dirt or moisture, and that they are not bent, but form one straight line, the bulb being in the middle, and swelling out symmetrically from both its extremities. The best proportion between the capacities of the bores is perhaps about 1 to 4, and the best arrangement of bores seems to be one suggested by Mr. Welsh, viz. a round bore for the wide tube, and a flat or elliptical bore for the narrow one, the greatest diameter of which equals the diameter of the wide bore. In graduating, if, when the instrument is vertical, the narrow bore being beneath, the mercury fills the bulb and rises in the wide bore, then the wide bore may be pointed off at different temperatures like an ordinary thermometer; but if under these circumstances the mercury does not rise in the wide bore, then, in order to point off the wide bore, the instrument must be laid horizontally in a dish of water, and compared with a standard thermometer at different temperatures; the extremity of the mercury in the narrow bore being always kept at a fixed point. When the wide bore has been pointed off we may, by running the mercury along, find what length of the narrow bore corresponds to a certain length of the wide one, and thus be enabled to point off the narrow bore. In using the instrument it should be kept nearly horizontal, and there is probably for each instrument a small range of inclination, for every position within which its peculiar action holds, but beyond which it is interfered with by gravity. Before graduating such an instrument it should be ascertained whether it is likely to answer, and the best test seems to be to lay it horizontally, exposing it to changes of temperature of the same nature with those which it is intended afterwards to measure;—if its action be perfect, the mercury will eventually be found to have retreated into the bulb from the narrow bore; but, should it have stopped at any point, the action will only be perfect up to that point. If this demands too much time, it may be tested by repeatedly applying to the bulb of an instrument so placed a few drops of slightly warmed water.

RESEARCHES RESPECTING HEAT, LIGHT, ETC.

The recent investigations of Mr. Joule of Manchester, and Professors Thomson and Rankine of Glasgow, relative to the mechanical equivalent of heat, have already illustrated in a remarkable manner many of the most obscure points of physical science, and promise to be productive of results not inferior to any which have been reached since the days of Newton. About twelve years ago, Mr. Joule demonstrated that the mechanical power expended in overcoming the friction of any machine produces an amount of heat of equivalent value to the power expended, so that, if this heat could be employed again in an engine which worked without waste or loss, it would exactly reproduce the power which had been expended in generating it. It is obvious that as heat is producible by a machine without any waste of its own substance, or is producible in water by agitation without the quantity of water being diminished, heat cannot be a material substance, and both heat and light are produced by vibrations similar to those which produce sound. The steam generated in a boiler, when condensed by cold water, as is done in a condensing engine, produces a certain quantity of warm water; but a given quantity of steam thus condensed will not produce the same temperature in the water which has accomplished the condensation, if such steam has been employed to work an engine, as it will produce if it has not been employed to generate power. For, as power is equivalent to heat, the steam which is employed to generate power would, unless there were a reduced temperature in the water which has accomplished the condensation, exhibit, when the power was turned into heat, a larger amount of heat than the steam contains, or the engine would be a heat-generating engine, which is impossible. The amount of power produced in a steam engine, therefore, is measurable by the amount of heat which has disappeared from the hot well, or, in other words, which cannot be discovered in the water by which the condensation of the steam has been accomplished; and in a perfect engine, in which the whole heat was turned into power, there would be no rise in the temperature of the hot well at all over the temperature of the water admitted to perform the condensation. The greater the difference of temperature between the boiler and condenser, the more effectual will any given quantity of coals be in generating power; and it is because air admits of the use of a far higher temperature than is possible in the case of steam, that it realizes a very superior economy. There are constructive impediments to the employment of air engines which, however, are not very difficult of supersession; and they will be surmounted speedily, so soon as practical engineers are thoroughly satisfied of the superior performance attainable by air engines, and which, therefore, it is important widely to announce. Mechanical power being convertible into heat, electricity, and also into light, it becomes easy to estimate the mechanical value of those agents; and a key is thus afforded whereby these heretofore inscrutable departments of science may be brought under the dominion of mechanical laws. Professor Rankine ascribes the elasticity of gases to a centrifugal action of their particles; and Professor Thomson, by a very ingenious process, makes an estimate of the density of the ether, or atmosphere, filling the interstellar spaces, by determining first the mechanical value of a cubic mile of sunlight and the velocity of the vibrations by which light is caused, and he knows then, by the usual laws of mechanics, that with the given velocity of motion, the density must be such as to produce the specified amount of mechanical power.

ON THE PRACTICABILITY OF CONSTRUCTING CANNON OF GREAT CALIBRE CAPABLE OF ENDURING LONG CONTINUED USE UNDER FULL CHARGES.

The following communication on the above subject was presented to the American Academy, by Professor Treadwell of Cambridge:

The importance of constructing cannon of a size larger than any now in use, to every nation that may be called upon to encounter the trials of war, is one of those facts acknowledged alike by the soldier and the civilian; and to obtain such instruments, capable of throwing projectiles larger and heavier, and to greater distances, than has hitherto been attained, is now occupying the attention of the scientific engineers and projectors of Europe more than any other question open to them. The present age has witnessed a remarkable increase in the size of all the great instruments of human industry. Ships within twenty years have been doubled in their dimensions, and steam engines are now constructed which compare with those of the last age as giants compare with common men. But although the want is fully acknowledged, and attempts have been made in hundreds of forms, no one has succeeded in producing a cannon essentially more powerful than those used in the days of Napoleon and Wellington.

I propose, in this paper, to search for the causes of these failures, to examine the action of the forces, both active and passive, which are called into operation in throwing shot and shells by gunpowder, and, at last, shall endeavor to show that our present cannon do not approach the size and power of those that may be constructed.

I have said that no essential improvement has been made during the present age in the size of cannon. It is true that they have been increased in calibre from seven up to eight and ten inches, and a few bomb-cannon have been made of twelve inches. But in the use of these the charges are so diminished, to be brought within the limits of safety, that the initial velocities, as inferred from their short ranges, are not so great as those of the old forty-two pounders; while with mortars, those of thirteen inches were used in the time of Vauban, and this remains, stereotyped, as the limit at the present day.

But to my examination. The properties or qualities of hardness and of tenacity or strength are the qualities indispensable to all cannon, and the superiority of one cannon over another is measured by the excess in which it possesses them. Inertia* is likewise required in a certain amount, to prevent excessive recoil. Now these properties of strength and hardness are possessed in an eminent degree by bronze and cast iron, and these bodies alone constitute in practice the materials for cannon; for although various attempts have been made to introduce steel and wrought iron, it is enough for my present purpose to say, that there are not twenty cannon in use in the world that are not made of bronze or cast iron. For strength, bronze is generally taken at 30,000 pounds to the square inch; that is, it will require a weight of 30,000 pounds to tear asunder a bar of good gun-metal bronze of one inch area. Following the mean of many experiments, cast iron has generally been taken at 20,000 pounds. But that I may be sure not to under-estimate the strength of this material, and as it has been considerably improved by gun-makers within a few years, I shall estimate it at 30,000 pounds, or as equal to bronze, although it is not to be relied upon as so constant in its strength as the latter material. For hardness cast iron greatly exceeds bronze. This renders it more suitable for very large guns, and it has, in truth, become so exclusively the material for everything above the size of field pieces, that I shall deal with it alone in the examination proposed in this paper.

Before examining the force of gunpowder it may be well enough to say a word upon the time of its explosion. Is the firing of gunpowder instantaneous? If it be instantaneous, then it must be evident that no other substance can be fired with a greater rapidity. For instantaneousness, bearing the same relation to time that a point does to space, can admit of no degrees. Both are existences without extension, and we cannot say of any two events

* This word is used throughout this paper in its strictly technical sense, as the force, or power of resisting all change of state, whether it be from rest to motion or from motion to rest; and I use, without a doubt of its accuracy, the square of the velocity by the mass, as the measure of this force.

that one is more instantaneous than the other, without implying duration to one at least, which also implies that it is not instantaneous. Now, many of the fulminating powders, and even gun cotton, are, as is well known, fired much more rapidly than gunpowder. The firing of this last cannot, therefore, be instantaneous, and we might rest with this logical solution of the question; but, like many other logical solutions, it adds but little to our wisdom, and the amazing rapidity with which a large mass of powder is inflamed, when in a close cavity, awakens our attention to the course of the events causing, or at least accompanying, this inflammation, and I shall notice two experimental results which seem to me to indicate the state of things during that whole course.

First, Count Rumford has proved that the burning of the grains is slow, or that a sensible time is required with each grain before it is wholly converted into the gaseous state; and secondly, various experiments made in England and in Prussia have shown that there is no sensible difference produced in the velocity of the shot by communicating the fire to the centre rather than to one end of the charge, which ought evidently to take place if the fire is communicated from one grain to another in succession, as this communication, being in both directions, when proceeding from the middle, would require but half the time that is required when proceeding from one end, and ought to produce a sensible increase in the velocity of the shot. I think, therefore, that these two facts warrant the following inference as to the course of the action during the production of the force. When the fire reaches the charge from the touchhole, the nearest grains become kindled; the hot fluid evolved is thrown further into the charge, and the burning succeeds successively until the pressure becomes so great as to condense the air contained between the grains sufficiently to produce the heat required for firing those grains, which are then consumed more or less rapidly, as they are fine or coarse. We have, then, first the burning in succession of a small part of the charge; then the immensely rapid, though not instantaneous, kindling of every grain composing it; and then the consumption of those grains, which is not accomplished without time. It is a task for the conception to grasp these events, following one another in distinct succession; each having its beginning, middle, and end, and all being comprised in the period of $\frac{1}{200}$th of a second (gun 4 feet long, *formula* $t = \frac{2s}{v}$). When we have mastered the imagination of these, we may go further and combine with them the connected and contemporaneous action of the ball, which passes from rest to motion, and through every gradation of velocity up to 1,600 feet a second, and leaves the gun as our historical period of $\frac{1}{200}$th of a second expires.

The expansive force of gunpowder, which must be resisted by the strength of the cannon, depends almost entirely upon the circumstances under which it is fired. Count Rumford has shown, by his experiments made about sixty years ago, that if the powder be placed in a closed cavity, and the cavity be two thirds filled, the force will exceed 10,000 atmospheres, or 150,000 pounds upon the square inch; and he estimates that if the cavity be entirely filled with the grained powder, and restrained to those dimensions, the force will rise to 50,000 atmospheres. My own experience, made in bursting wrought iron cannon the strength of which was known to me, leads me to believe that he has not over-estimated its power, although I am aware that it is generally considered as excessive. If, following an opposite course to that herein described, the powder be at liberty to expand upon any side the force thrown in the other directions is very small. Thus, if a charge be placed loose in a gun, without shot or wad, the force upon the walls of the gun is very trifling;—no more than is produced by the restraint of the inertia of the charge itself, or the fluid formed from it. If we would divest a charge of this property of inertia, and fire it in a constantly maintained vacuum, it would not rend walls made of cartridge paper, if a single end were left open for its escape. From the preceding statement it will be seen that gunpowder will take any force, from perhaps 50,000 atmospheres, when confined to a close cavity, down to zero, if it be deprived of inertia and fired in a vacuum constantly maintained.

In artillery practice, the restraining power which causes the powder to act against the walls of the cannon, is derived principally from the inertia of the shot. This is so much greater than the inertia of the powder itself, that the latter may be neglected in the considerations that are to follow. Now, bearing in mind what has been already said, let us compare the difference of the force of powder as exerted upon a small and large gun respectively. It is perfectly well known, that, if we have a pipe or hollow cylinder of say two inches in diameter, with walls an inch thick, and if this cylinder will bear a pressure from within of 1,000 pounds per inch, another cylinder, of the same material, of ten inches in diameter, will bear the same number of pounds to the inch if we increase the walls in the same proportion, or make them five inches thick. A cross-section of these cylinders will present an area proportional to the squares of their diameters, and if the pressure be produced by the weight of plungers or pistons, as in the hydrostatic press, the weight required in the pistons will be as the squares of the diameters, or as 4 to 100.

Now carry this to two cannon of different calibres, and take an extreme case. Suppose the calibre of one to be 2 inches in diameter and the other 10 inches, and that the sides of each gun equal, in thickness, the diameter of its calibre. Then to develope the same force, per inch, from the powder of each gun, the inertia of the balls should be as the squares of the diameters of the calibres, respectively; that is, one should be 25 times as great as the other But the balls being, one 2 and the other 10 inches in diameter, will weigh 1 pound and 125 pounds respectively; the weights being as the cubes of the calibres. Hence each inch of powder in the large gun will be opposed by 5 times as much inertia as is found in the small gun. This produces a state of things precisely similar to that of loading the small gun with 5 balls instead of 1; and although the strain thrown upon the gun by 5 balls is by no means 5 times as great as that by 1 ball, there can be, I think, no doubt that the strain produced by different rates of ball is in a ratio as high as that of the cube roots of the respective weights. This would give, in the example before us, an increase from 1 to 1.71, or the stress upon the walls of the 10-inch gun would be 71 per cent. greater than upon those of the 2-inch gun.

The foregoing statement and comparison, however, do not present the whole case; for they are made upon the supposition that the charge of powder, in each instance, is as the square of the diameter of the shot, or that the cartridges of the 2 and 10 inch guns are of the same length. This, if we take the charge of the small gun at $\frac{1}{3}$ of a pound, would give but $8\frac{1}{3}$ pounds for the large, or $\frac{1}{15}$ of the weight of the shot. The velocity obtained from this charge would produce neither range nor practical effect, and to obtain these results, that is, 1,600 feet a second, we must either increase the force through the whole length of the gun to 5 times that required for the small gun, or, the force remaining the same, we must provide for its acting through 5 times the space. Neither of these conditions can be practically accomplished. However, by an increase of both the charge and the length of the bore, the result may, in the limits under consideration, be attained. Thus, taking the large bore, if we double its length and make the cartridge 5 times as long, increasing the weight from $8\frac{1}{3}$ to $41\frac{2}{3}$ pounds,—or perhaps, having an advantage from the comparative diminution of windage and the better preservation of the heat, with a charge of from 30 to 35 pounds—we may obtain the full velocity of 1,600 feet a second. But this again increases enormously the strain upon the gun.

It does not appear obvious, at a first view, how an increase in the charge should increase the tension of the fluid produced from it, if the cavity inclosing it be proportionably enlarged. If a steam pipe a foot long will sustain the pressure of a given quantity of steam, of a given temperature, a pipe two feet long, of the same thickness and diameter, will sustain the pressure produced by a double weight of steam from the same boiler. Why then should the pressure upon a cannon be increased by a double length of cartridge? The difference seems to be this: With the steam, the pressure is as in a closed cavity; with the powder, the tension depends upon the movement of the shot while the fluid is forming. Now, whether the charge be large or small, the motion of the shot commences while the pressure is the same in both cases, and before the charge is fully burned, and with the same velocity in both cases; but with the large charge the fluid is formed faster than with the small, while the enlargement of the cavity by the movement of the shot is nearly the same in both cases. This destroys the proportion between the sizes of the two cavities, and the tension must increase faster, and become greater, from the larger charge. The law of this increase cannot, from the complicated nature of the problem, be stated with any reliable exactness, but we may, I think, conclude, from the increased velocity of the shot, and many other effects, that the stress thrown upon the gun by different charges of powder, within ordinary limits, will not vary essentially from the square roots of those charges. If then we increase, in the example under consideration, from a charge of $8\frac{1}{3}$ pounds to one of 32 pounds, the stress upon the gun, being as the square roots of these numbers, is raised from 2.88 to 5.65, or from 1 to 1.96. Having already increased the stress upon the gun, by the shot, from 1 to 1.71, if we multiply these together, we have a total increase of from 1 to 3.35. That is to say, if, under the conditions here stated, we load a gun of 2 inches calibre with 1 shot and $\frac{1}{3}$ of a pound of powder, and a gun of 10 inches calibre with 1 shot and 32 pounds of powder, the stress upon each square inch of the bores will be 3.35 times greater with the large than with the small gun; when at the same time, if the walls of both have a thickness proportional to the diameters of the calibres in each, the large gun will be incapable of sustaining a greater pressure per inch than the small one. Even with a charge of 12 pounds of powder, the stress upon the large gun must be more than double that upon the small gun when charged with one-third the weight of its ball.

The preceding examination does not, I think, present the difficulties to be overcome in increasing the size of cannon as greater than they really are, and although the results that I have arrived at are from extreme cases, and may be said to be mere deductions, yet they are deductions legitimately drawn from the most reliable experiments that have been made. How then can the necessary strength be obtained? Will it be answered, by an increased thickness? It is not necessary to examine the obvious objections of the great increase of size and weight that this implies, because no increase that can be given to the thickness will increase the strength to a sufficient degree to resist the force required. To prove this, I must ask attention to a further and somewhat elaborate examination.

About thirty years ago, Mr. Peter Barlow, of Woolwich, published a paper in the Transactions of the Society of Civil Engineers, on the hydrostatic press, in which he showed that hollow cylinders of the same materials do not increase in strength in the ratio of increase in thickness, but that the ratio of increase of strength is such, that, where they become of considerable thickness, the strength falls enormously below that given by the ratio of thickness.

Now, to obviate the great cause of weakness arising from the conditions before recited, and to obtain, as far as may be, the strength of wrought iron instead of that of cast iron, for cannon, I propose the following mode of construction. I propose to form a body for the gun, containing the calibre and breech as now formed of cast iron, but with walls of only about half the thickness of the diameter of the bore. Upon this body I place rings or hoops of wrought iron, in one, two, or more layers. Every hoop is formed with a screw or thread upon its inside, to fit to a corresponding screw or thread formed upon the body of the gun first, and afterwards upon each layer that is embraced by another layer. These hoops are made a little, say $\frac{1}{1000}$th part of their diameters, less upon their insides than the parts that they inclose. They are then expanded by heat, and being turned on to their places, suffered to cool, when they shrink and compress, first the body of the gun, and, afterwards, each successive layer all that it incloses. This compression must be made such, that, when the gun is subjected to the greatest force, the body of the gun and the several layers of rings will be distended to the fracturing point at the same time, and thus all take a portion of the strain up to its bearing capacity.

There may, at the first view, seem to be a great practical difficulty in making the hoops of the exact size required to produce the necessary compression. This would be true if the hoops were made of cast iron, or any body which fractures when extended in the least degree beyond the limit of its elasticity. But wrought iron and all malleable bodies are capable of being extended without fracture much beyond their power of elasticity. They may, therefore, be greatly elongated without being weakened. Hence we have only to form the hoops *small in excess*, and they will accommodate themselves under the strain without the least injury. It will be found best in practice, therefore, to make the difference between the diameters of the hoops and the parts which they surround, considerably more than $\frac{1}{1000}$th part of a diameter. The fixing the hoops in their places by the screw, or some equivalent, is absolutely necessary, not merely to reinforce the body against cross fracture, but to prevent them from starting with every shock of the recoil. I know, by experiment, that the screw thread will fix them effectually. The trunnions must, of course, be welded upon one of the hoops, and this hoop must be *splined*, to prevent its turning by the recoil. Small *splines* should likewise be inserted under every hoop. It will, moreover, be advantageous to make the threads of the female screws sensibly finer than those of the male, to draw, by the shrink, the inner rings together endwise.

It will be seen that with a gun made in this way, we must depend upon the cast iron body to resist the strain tending to produce cross fracture, though this resistance will be in some degree supported by the outer rings breaking joint over the inner rings. But if the body be made to constitute half the thickness of the walls, it will be found sufficient for the purpose without any reinforcement from the rings. This results from a principle or law, which, so far as I know, was first published by me in the year 1845, in a pamphlet on wrought iron and steel cannon. As I cannot put this matter in a better form than that in which I have there given it, I will here quote the statement as then made.

"Let us suppose we have a hollow cylinder, say twelve inches long, the calibre being one inch in diameter, and the walls one inch thick, giving an external diameter of three inches. Suppose this cylinder to be perfectly and firmly closed, at its ends, by screw plugs or any other sufficient means. Let this be filled with gunpowder and fired. The fluid will exert an equal pressure in every direction, upon equal surfaces of the sides and ends of the hollow cylinder. Let us next examine the resisting power of a portion of this cylinder, say one inch long, situate in the middle, or equally distant from the ends, so that it shall not be strengthened by the iron which is beyond the action of the powder. The fluid inclosed by this ring of one inch long contains an area of one square inch, if a section be made through it in the direction of its axis; and the section of the ring itself, made in the same direction, will measure two square inches. We have then the tenacity or cohesive force of two square inches of iron in opposition to an area of the fluid measuring one square inch; and if we take the tenacity of the iron at 65,000 pounds, the cylinder will not be burst, in the direction of its length, unless the expansive force of the fluid exceed 130,000 pounds to each inch. Next, let us suppose a section made through the cylinder and fluid, transversely. The area of the fluid equal to the square of the diameter of the hollow cylinder, is one circular inch, and the area of the whole section, the diameter being three inches, is nine inches. Deduct from this the area of the calibre, and we have eight circular inches. That is, the section of the iron is eight times greater than that of the fluid; whereas, in the former case of longitudinal section, the iron gave but twice as much surface as the fluid; and if we take, as before, the iron at 65,000 pounds per inch cohesive force, it will not be broken unless the force of the fluid exceed 520,000 pounds. It will be found, upon a further examination, that the relations of these sections to each other may be varied, as we take the diameter of the calibre to be greater or less, as compared with the thickness of the sides, but their difference can never be made less than as two to one. Here then is a principle, or rather a fact, of the utmost importance in forming cannon of any material, the strength of which is different in different directions; for as a cannon made in the proportions above specified, if the materials be in all directions of equal strength, will possess four times as much power to resist a cross fracture as it does to resist a longitudinal fracture, it follows, that a fibrous material which possesses four times the strength in one direction that it does in another, will form a cannon of equal strength, if the fibres be directed round the axis of the calibre. It is this fact which gives the great superiority to the various kinds of twist gun-barrels. For in these, although the fibres do not inclose the calibre in circles, yet they pass around it in spirals, thus giving their resisting force a diagonal direction, which is vastly superior to the longitudinal direction in which the fibres are arranged in a common musket-barrel."

The foregoing example supposes the cavity immovably closed at its ends, and gives to the powder more force than it actually exerts, in gun-practice, to produce cross fracture, compared with its force to produce lengthwise fracture, even at the part nearest to the breech of the gun; and as the recoil is resisted by the whole gun, the stress upon any part will diminish as the inertia, or weight, diminishes from the breech to the muzzle.

With these facts, principles, and laws, thus stated, I proceed to give some calculations to show the strength of a cannon constructed in the way that I have pointed out, as compared with one made in the usual manner. Take a cannon of 14 inches calibre, which will carry a spherical solid ball of 374 pounds, with sides 14 inches thick, made up of 7 inches of cast iron, and two hoops or rings, $3\frac{1}{2}$ inches each, of wrought iron. The external layer of cast iron will, from its position, as before explained, possess but one fourth of the strength of the inner layer, or whole strength of the iron, and the mean strength of the whole will be reduced one half. Take cast iron at 30,000 pounds to the inch area, and we have $30{,}000 \times \frac{1}{2} = 15{,}000$ pounds to the inch. The thickness of both sides is 14 inches, and $15{,}000 \times 14 = 210{,}000$ pounds for the strength of the casting, to each inch of its length. The first hoop has its strength reduced from 1 to a mean of .8. Take the strength of wrought iron at 60,000 pounds to the inch, and we have $60{,}000 \times .8 = 48{,}000$ pounds to the inch. The thickness of both sides is 7 inches, and $48{,}000 \times 7 = 336{,}000$ pounds. The outside ring must be reduced in strength by the same rule, for its mean from 1 to .832, which gives it 49,920 pounds per inch, and for the 7 inches 349,440 pounds. We have then, for each inch in length,

Cast iron body of the gun	210,000	pounds.
Inner wrought iron hoop	336,000	"
Outer wrought iron hoop	349,440	"
	895,440	pounds.

The diameter of the bore being 14 inches, we have $\frac{895440}{14} = 63{,}960$ pounds, as the resistance to oppose to each square inch of the fluid from the powder. The gun will bear, then, a pressure of 4,264 atmospheres.

The resistance to cross fracture at the part nearest to the breech will be, from the cast iron $28^2 - 14^2 = 784 - 196$ circular inches, equal to 460 square inches. Cohesive force, unreduced, 30,000 pounds, and $30{,}000 \times 460 = 13{,}800{,}000$ pounds, the whole strength. The bore contains 153 square inches, and $\frac{13800000}{153} = 90{,}196$ pounds to resist each square inch of the fluid, or 26,236 pounds to each square inch more than is provided to resist the longitudinal fracture, and this excess will be further reinforced by the wrought iron rings, which being screwed upon the casting, and the outer layer breaking joint over the inner, will add to the resistance to a great amount, which however need not be computed.

Let us now examine a gun made of a single casting of the dimensions that are given above; that is, of 14 inches bore, and sides 14 inches thick. Taking the normal strength of cast iron as before at 30,000 pounds per inch, we must reduce it, according to the laws before explained, to one third, or a mean of 10,000 pounds per inch; and the thickness of both sides being 28 inches, we have $10{,}000 \times 28 = 280{,}000$ pounds for the whole strength, and $\frac{280000}{14} = 20{,}000$ pounds to each inch of the fluid pressure, or 1,333 atmospheres, or $\frac{20000}{63960}$, or less than one third of the first example. Against a cross fracture the cast gun will possess a great excess of strength, which I do not like to call useless, although I do not perceive how it can be of any essential practical advantage.

Let us next inquire what force is required to give a ball of 14 inches diameter a velocity of 1,600 feet a second? We shall obtain a better conception of this force by estimating it in the height required by a fluid column to produce it. Suppose the ball impelled by the pressure of a column of the same substance, which would be in this case a column of fluid iron. Then (from the formula $v = \sqrt{2gh}$) we obtain $\frac{1600^2}{64} = \frac{2560000}{64} = 40{,}000$ feet, for the height of the column. But this would produce a jet forming a continuous stream. Suppose this stream to be 14 inches in diameter, and divided into a series of short cylinders, each of which, to equal a ball of 14 inches diameter, must be $9\frac{1}{3}$ inches long. Now in giving 1,600 feet velocity to this series of cylinders by a superincumbent column, the force will act upon each cylinder only through a space equal to its length. But in a cannon the powder acts, though with a variable force, through the whole bore of the gun. The variation of this force must depend, in every case, upon the quickness of the powder, arising from its composition, fineness of grain, dryness, and the heat received from the gun from previous firings; and most essentially from the amount of the charge; and we do not know the exact law of the variation for any one case or condition. Our best judgment, therefore, must be but an approximation to the truth, entirely empirical. But if we cannot determine the truth with exactness, we can at least assign limits within which it must be contained, and upon a comparison of the velocities produced by different lengths of bore, the effect upon the gun itself at different parts of its length, and various other grounds of comparison, I think that we may take the effect of the charge through the whole bore, supposing it to be 112 inches from the ball to the muzzle, and the charge 80 pounds, as equal to the action of the maximum force through a space of not less than one half, nor more than two thirds of its length. But that I may be sure to assign the maximum so great as to cover all anomalous or accidental conditions, I will take it as sufficient to produce a velocity of 1,600 feet a second, if acting constantly through one third the length of the bore. This will give $37\frac{1}{3}$ inches, or exactly 4 times the length of the cylinder which forms the equivalent of the shot. Then (from the formula $v = \sqrt{fs}$) the 40,000 feet above given for the height of the column, becomes $\frac{40000}{4} = 10{,}000$ feet; and if we take the whole force of the powder as equal to its maximum force, acting through two thirds the length of the bore, or $74\frac{2}{3}$ inches, our column will become 5,000 feet high. In all cases of providing strength, we must take the force to be resisted at its maximum.

Now a bar of cast iron 1 inch square weighs 3·2 pounds to the foot in length: we have then $10{,}000 \times 3{\cdot}2 = 32{,}000$ pounds pressure to each square inch of surface, or $\frac{32000}{15} = 2{,}133$ atmospheres, on the supposition that the whole action of the powder is equal to its maximum force through one third the bore of the gun. If we take the whole action as equal to its maximum through two thirds of the bore, the column, 5,000 feet high, gives 16,000 pounds, or 1,066 atmospheres. It cannot be less than this, and although it may never come up to the greater number, or 2,133 atmospheres, it would not be safe to estimate it at less when providing the means to resist it. We require, then, a pressure of 32,000 pounds to the inch, to obtain for a 14-inch shot an initial velocity of 1,600 feet a second. We have seen that a gun formed as I have proposed will be capable of resisting a pressure of 63,960 pounds to the inch, or very nearly twice the pressure required to produce the velocity sought, while with a gun made in the usual way, of one piece of cast iron, the power of resistance is limited to 20,000 pounds to the inch, or less than two thirds that which may be required to obtain the velocity.

We have seen that a cannon constructed in the manner recommended, of whatever size, having its walls equal in thickness to the diameter of its bore, will sustain a pressure of 63,960 pounds, equal to a column of fluid iron 20,000 feet high, very nearly. This is half the strength required to support a column capable of keeping up a continued stream with a velocity of 1,600 feet a second. Suppose that we construct such a cannon with a bore of 30 inches, and of such length that the ball shall receive the force of the powder while it moves through a space of 10 feet, and that this force be equal to a constant action of 4,266 atmospheres through 40 inches: it will be at once perceived that it will impress the above velocity upon a cylinder $\frac{40}{20} = 20$ inches long, or upon its equivalent, a sphere 30 inches in diameter. Such a sphere of solid iron will weigh 3,670 pounds, and at this point the *calculated* power of the gun meets the force required to give a velocity of 1,600 feet a second.

Although this size may be beyond practical reach, the contemplation of it as a theoretical perfection may stimulate us to attempt an approximation to it. A ball of a ton weight, with a range of, say six miles, would, as a mere display of mechanical force, be worthy of a great effort.

The following columns show the stress that the several kinds of guns, as mentioned, will bear, by calculation, and the pressure required to give the velocity of 1,600 feet a second. The third column shows the proportion between the required and the actual strength.

	Atmospheres.		Atmospheres.	
Hooped cannon for 14-inch shot will bear	4,266;	required	2,133	100 : 200
Cast iron gun, 14-inch shot, will bear .	1,333;	"	2,133	100 : 62
Cast iron 32-pounder cannon, 6¼ inches thick, will bear	1,333;	"	920	100 : 142
Hooped cannon 30 in. diam. 3,670 lb. shot,	4,266;	"	4,266	100 : 100

By this it appears that a common cast iron 32-pounder, having but 42 per cent. more strength than is required, is less reliable than a hooped gun of 14 inches. It will be recollected that the numbers given above in the second column, as showing the required strength, represent the utmost force ever exerted by a charge intended to produce a velocity of 1,600 feet a second.

In this paper, my principal object has been to show a mode of construction by which, with our present materials and knowledge, it will be perfectly practicable to make guns of great size capable of standing the requirements of the service. It follows almost of course, that the same form of construction must be the best possible for guns of smaller calibre, and that by adopting it, not only will the use of guns of enormous size be rendered practicable, but, if applied to cannon of smaller size, their bursting will be rendered almost impossible. If it be necessary to use the word *cost* in connexion with the object to be attained, I *know* that when the manufacture is mastered, with a good machine shop, the difference between the last of these and common cast iron guns will be altogether insignificant to the nation.

I abstain from opening the subject of different forms of bore and of shot, although I believe that in the end some cylindrico-conical form, lightened with cavities in the rear portion, and perhaps with some form of spiral grooves to produce rotation from the air, will be substituted for the solid spheres now used.

I should, however, leave the subject of this paper but very imperfectly treated, if I neglected to mention one most important effect of the force of the explosion, which is not indicated *à priori* by any theory, and which is so inconstant and uncertain in amount, that it can be appreciated only by a careful observation of its practical effects upon the gun, but which, unless guarded against, must essentially disturb the conclusions which I have herein deduced. I allude to what is known to artillerists as the lodgment or indentation of the ball. This first shows itself at the point immediately under the ball, where it rests at the moment of the discharge. It is best observed in a soft bronze or wrought iron gun, and from the first instant of its appearance, as a slight impression of the under surface of the ball, it goes on increasing at every discharge, until it becomes so deep as to deflect the ball upwards at the instant of its flight, to strike the upper surface of the bore, where a second indentation is made, considerably in advance of the first, and from this a third, still more advanced, upon the under side. These indentations go on increasing in number and size, and at length bulges appear upon the outside of the gun, which becomes oval near the muzzle, and is at last destroyed.

The lodgment here described has been attributed wholly to the downward pressure of the fluid when escaping through the opening of the windage, which is all upon the upper side of the ball, the under side resting by its weight in contact with the bore. There must undoubtedly be a great escape, not only of the fluid, but of burning powder in grains, through this passage, and the downward pressure from these causes may present an excess over the opposite pressure of the powder upon the under side of the ball, capable of producing some impression upon the under surface of the bore. I am inclined, however, to attribute the indentation mostly, if not entirely, to the compression of the back hemisphere of the ball under the enormous blow of the explosion, producing a corresponding enlargement of the ball in its diameter transverse to the axis of the bore. The smith produces such a change of form in his bar of iron, at pleasure, by the blows of a sledge applied to its end. The operation is called *upsetting*. This enlargement must impress itself upon the part of the bore upon the under side upon which the shot rests, and is alone sufficient, in my mind, to account for the whole mischief.

This view of the subject is confirmed by the form of the lodgment, which consists, at first, of a single narrow impression, exactly corresponding to a very small segment of the ball, and not in the least in advance of the spot on which the ball rests before the discharge. Now this would be the exact form and place of an impression produced by a sudden enlargement of the ball, and an equally rapid recovery of its true figure, which it would derive from its elasticity. But if the lodgment were produced by the pressure of the fluid upon its upper surface, it ought to form a long groove or channel, ceasing only with the diminished pressure of the fluid near the muzzle. Furthermore, the lodgment is greatest when a hard oakum wad is used behind the ball. Now such a wad must prevent, in some degree at least, the escape of the fluid, and therefore diminish the downward pressure. But such a wad driven hardest against the middle of the ball, in its rear, would act most advantageously to produce the lateral enlargement by *upsetting* it as before described.

Hard cast-iron guns do not exhibit this indentation in so great a degree, because, being unmalleable, they are incapable of a permanent change of form without fracture. With them, therefore, this pounding of the ball, being repeated a few hundred times, shatters the walls of the gun, which at length gives way at once and goes to pieces.

It must be obvious, that, if the lodgment be attributed to either or both of the causes which I have recited, it may be prevented by a most simple and easy means. This is nothing more than providing that the ball shall, at the moment of the explosion of the powder, have no part in contact with the bore of the gun, but that the windage space shall be equally distributed about the whole circumference. This may be entirely secured by enveloping the ball in a bag made of felt, or of hard woollen cloth, having an additional patch upon its under side to compensate for the weight of the ball. It would seem impossible that in this condition the ball, receiving the pressure of the powder equally distributed in the direction of the axis of the calibre, should touch the gun more than by a slight graze during its flight.*

Unless this or some equally efficient remedy is adopted, any considerable increase in the size of cannon must be hopeless; for a surface as hard as a smith's anvil would give way under the long-continued pounding of naked twelve-inch shot; and whenever hooped cannon may be made and used, it will be essential that the means of preventing the lodgment herein given be always and at all times carefully applied.

Pressure of Fired Gunpowder.—It is well understood that the pressure of the explosion in a gun is greatest at the beginning, and gradually dies away as the ball moves forward; but this depends much on the combustibility of the powder. With good quick powder the pressure at the instant the powder is fired is immense; but until recently no one has been able to measure it. Dr. W. F. Woodbridge and Major Alfred Mordecai have been recently making some experiments at the expense of the U. S. Ordnance Department, for testing this point, at the Arsenal in Washington. With a ball weighing about $6\frac{1}{2}$ lbs. and a charge of $1\frac{1}{2}$ lb. of Dupont's cannon powder, the greatest

* My observations upon the lodgment have been made upon wrought iron cannon. Between the years 1841 and 1845, I made upwards of twenty cannon of this material. They were all made up of rings, or short hollow cylinders, welded together endwise. Each ring was made of bars wound upon an arbor spirally, like winding a ribbon upon a block, and being welded and shaped in dies, were joined endwise, when in the furnace and at a welding heat, and afterwards pressed together in a mould by a hydrostatic press of 1,000 tons' force. Finding in the early stage of the manufacture that the softness of the wrought iron was a serious defect, I formed those made afterwards with a lining of steel, the wrought iron bars being wound upon a previously formed steel ring. Eight of these guns were 6-pounders of the common United States bronze pattern, and eleven were 32-pounders of about 80 inches length of bore, and 1,800 pounds weight. Six of the 6-pounders, and four of the 32-pounders, were made for the United States. They have all been subjected to the most severe tests. One of the 6-pounders has borne 1,560 discharges, beginning with service charges and ending with 10 charges of 6 pounds of powder and 7 shot, without essential injury. It required to destroy one of the 32-poun ers a succession of charges ending with 14 pounds of powder and 5 shot, although the weight of the gun was but 60 times the weight of the proper shot. If any of these guns are ever destroyed by firing them, the destruction will commence in the lodgment.

It was during a course of experimental firing with the soft wrought iron gun, that I had an opportunity of observing the formation and increase of the lodgment; and here I was led to the experiment of placing the shot in a bag, as recommended in the text. My experiments were not sufficiently extended and varied to lead me to an assured conviction that the evil may be entirely prevented by this practice; but they were enough to lead me to a confident expectation of that result, as I could never detect the formation of any lodgment or any increase in one previously formed when the bag was used.

I cannot leave this subject without observing that I regard the late, and still continued, attempts to make wrought iron cannon in Europe by the process of *fagoting* or *piling* as a strange engineering delusion. It may not surprise us that *amateur* engineers, whose whole knowledge of the character of iron is derived from a printed page, should expect useful results from this attempt, but that men practically acquainted with working iron should expect to forge a serviceable gun of wrought iron by the same process that is used to produce a shaft of that material, seems to me not very creditable to the *iron* knowledge of the age.

pressure at any instant on the interior of the gun at one inch from the breech varied between 19,000 and 21,000 lbs. per square inch. At one foot from the breech the greatest pressure was only about 8,000 lbs.; at two feet about the same; at three feet about 6,000, and at four feet about 5,900 lbs. The pressure of a small quantity of Hazzard's rifle powder, fired in a cavity from which there was absolutely no escape, was not sufficient to burst the box, the strength of which was estimated sufficient to sustain an internal pressure of about 93,000 lbs. per square inch. These facts are interesting, as they serve to show how the metal should be distributed in casting cannon, and also to remove the belief which exists among practical men that one grain of powder absolutely confined would exert an infinite force.

EXPERIMENTS ON THE STRENGTH OF METALS.

During the last year an elaborate and comprehensive work on the above subject has been published by the authority of the War Department,—made up of reports of experiments by officers of the Engineers and Ordnance, and more especially those conducted by Major Wade, U.S.A. The experiments were extended over a series of years, and were made to test the strength and other properties of metals employed in the manufacture of cannon. One new fact developed by them is, that iron fused a number of times up to a certain point, is thereby greatly improved in strength. In trials with some iron, it was found that its transverse strength was nearly doubled by being melted and cast four times. At the South Boston Foundry, experiments were made to test the strength of cast iron which had been submitted to fusion during different periods of time. Eleven thousand pounds of iron were cast into four six-pounder guns; one, after the metal had been under fusion or melted half an hour; the second, under fusion an hour and a half; the third, under fusion three hours; and the fourth, under fusion three hours and three quarters. The gun first cast burst at the thirty-first fire; the second, at the thirty-fourth; the third was fired thirty-eight times, and remained unbroken. Thus the strength of the metal seemed to increase in a ratio corresponding to the period of fusion, or under which it was kept in a highly molten state, and it might have been inferred from this that the fourth gun would have been the strongest of all. Instead of this being so, however, it proved to be the weakest, for it burst at the twenty-fifth discharge. In view of these experiments, Major Wade, in this report, says, "these results appear to establish satisfactorily the fact, that a prolonged exposure of liquid iron to an intense heat, does augment its cohesive power, and this power increases as the time of the exposure up to some (not well ascertained) limit, beyond which the strength of the iron is diminished." Experiments were also made to test the transverse strength of cast iron bars, two inches square and twenty-four inches long, the metal of which was kept under fusion during different periods of time. These bars were set on supports twenty inches apart, and the breaking force was applied at the middle. The results obtained from four castings were in favor of that which was kept fused longest—three hours. On this head the report says, "from this it appears that the cohesive power of the iron, so far as it can be shown by its capacity to resist transverse strains, is increased sixty per cent. by its continued exposure in fusion."

In most of the books which treat of the strength of cast iron, the resistance which it opposes to certain strains, is given; but little useful information can be obtained in them respecting the difference of strength in different kinds of cast iron. But as the density between the lower and higher grades of this metal differs as 6.9 to 7.4—a difference of thirty-one pounds per cubic foot, and as the tenacity of the metal has a relationship to its density, it was found by these experiments that cast iron, having a density of 6.900, had only a tenacity of 9000; while that having a density of 7.400, had a tenacity of 45,970.

Castings of the greatest weight, according to their size, are by far the strongest, and weighing them is a ready means of judging comparatively of their strength.

Some important facts were also developed in relation to the cooling of heavy castings. At the Fort Pitt Iron Works, two eight-inch and two ten-inch guns were cast, one of each in the common way, solid, and one of each with a core on a tube of iron, through which water was made to circulate after casting, to cool it from the interior, according to an invention of Lieutenant Rodman. The solid eight-inch gun burst at the 73d discharge; the hollow cast one stood 1,500 discharges, and did not burst; the solid ten-inch cast gun stood only 20 fires, while the hollow ten-inch gun stood 249. These guns were cast of the same material, and at the same time; the difference in favor of the hollow cast guns is astonishing. This is attributed to the method of cooling, it being supposed that in cooling, the solid guns contract entirely from the outside, and that a strain is exerted upon the arrangement of the particles of the metal in the same direction as the strain of the discharges. In addition to these facts, Major Wade gives some additional information in relation to *the effect of time*, after the castings are made, and before they are used Eight-inch guns proved 30 days after being cast solid, stood but 72 charges; a gun of the same bore, proved 34 days after being cast, stood 84 charges; while one which was proved 100 days after being cast, stood 731 charges, and another, proved after being cast six years, stood 2,582 charges. Major Wade accounts for this phenomenon in cast iron, by supposing that the particles strained in the cooling re-adjust themselves in the course of time to their new position, and become free or nearly so. In regard to the necessity of care in the selection of iron, Major Wade says, "What most demands attention at present, is the ascertaining and prescribing the conditions to be exacted of the raw material, and of its treatment up to, and exclusive of the casting; for if we do not make sure of obtaining a good quality of iron at the time of its casting into the mould all else is useless, and worse than useless."

So much for the experiments on cast iron. Those in relation to brass and bronze castings, made at the works of the Ames Manufacturing Company, near Springfield, Mass., are no less valuable and interesting.

Brass founders have often noticed a remarkable difference in the color and quality of castings made from the same molten mass of brass, and have been puzzled to account for this. It is believed by many persons that in forming alloys, the metals unite in definite proportions at different temperatures, and that in the cooling of brass castings the particles arrange themselves in a manner not yet well understood. A number of small bronze guns were cast, and bars were cut from different parts of them and tested. The material was the same in all cases, eight parts of copper and one of tin; they were all treated alike, and cast from the same molten mass. The samples of bars tested gave an extraordinary variety of results. A bar cut from one part of a gun exhibited a tenacity of 100, while a bar cut from another part of it exhibited a tenacity of 236; and the difference in the density of different parts of the same casting was also remarkable, being equal to 34 lbs. in a cubic foot, thus showing, we conceive, that the metals of alloys do unite in different proportions at different degrees of temperature. Three howitzers were cast from the same molten mass, poured at different temperatures into separate moulds. The first was poured at a very high heat into its mould; the metal of the second was kept fifteen minutes in the ladle before it was poured in, and the third kept fifteen minutes longer still. All the attending circumstances, excepting the temperature of the alloy when poured into the mould, were equal. The liquid metal of the first and greatest heat sank gradually down into the mould for a few minutes after casting, and receded about an inch and a half below its original height; soon after this it boiled at the surface as if gas were escaping, and fluid portions of the alloy arose and overflowed the top of the mould. The exuded metal congealed like lava, was of a dirty white appearance, and contained more tin than the mass of the casting. When cold, the casting was found to be an inch longer than the mould, and it was filled with minute vesicular cavities. The bars cut from it and tested, were very low in density and inferior in tenacity. The second howitzer cast fifteen minutes later at a lower temperature was shorter, when cold, than the mould, by nearly two inches. The third, cast at a still lower temperature, was, when cold, three inches shorter than the mould. The density of the bars cut from these three howitzers was greatest in the one cast at the lowest temperature, and as the tenacity follows the same law, it appears that casting brass at a high temperature is injurious to the quality of the casting—the difference in the tenacity of the three castings being as 3 to 1. In reference to this point the report of Major Wade says:—"The division of copper and tin into two or more separate alloys probably occurs at some definite temperatures; one division may occur in the liquid mass, and another after the temperature falls below the melting of copper, and the latter probably occurs in all large castings, for on a close examination of any gun casting, some traces of this whitish alloy will be found in some parts of it. That such a division may occur in the liquid mass, appears evident from the fact, that a portion of the liquid bronze will pass through a porous vessel as through a sieve, while another portion will remain within the vessel. The former is the more fusible alloy, the latter the less fusible, and forms the mass of gun castings. It thus appears that we may sift the more fusible alloy while both are liquid."

It was also discovered, in the course of these experiments with alloys, that small bars of bronze cast of the same metal as the cannon, were vastly stronger than the cannon. This is attributed to the rapidity with which they were cooled, thus preventing the particles changing position in the act of cooling.

In 1849 a chemical laboratory was established at the United States Arsenal at Pikesville, Md., for the purpose of analysing the cast iron employed in the manufacture of guns, and the charge of the experiments was committed to Campbell Morfitt, Esq., as analytic chemist, with Professor Booth, of Philadelphia, as consulting chemist. The final report of these experiments was made last year. The average specific gravity of the cold blast iron tested was 7.218, and the tensile strength was 29.219. The specific gravity of the hot blast iron was 7.065; the tensile strength 19.640. The extraneous substances combined with the iron were found to be allotropic carbon, combined carbon, silicium, slag, &c. It would appear that the iron having the greatest amount of combined carbon, with the least slag, was the best, and was found to be made by the cold blast. The hot blast appears to drive off some of the combining carbon, at the same time leaving a greater quantity of allotropic carbon, existing in a form analogous to graphite, or black lead, which is injurious.

The Report says: "The slag and allotropic carbon, being of a brittle nature, and not united with the iron, coat the crystalline plates of metal, and diminish their surface of contact, consequently it follows that the tensile strength of the metal must decrease in proportion to the increase of slag and allotropic (uncombined) carbon."

DOES THE MISSISSIPPI RUN UP HILL, OR DOWN HILL?

At a recent meeting of the American Academy, Prof. Lovering presented the following communication, which originated in a discussion, partially carried on in the *Common School Journal*, as to the propriety of the question in schools: "Does the Mississippi run up hill, or down hill?" The article commented on from the *School Journal* reads as follows:—

"The following egregious blunder, with the captivating title, '*Water running up Hill*,' is going the round of the public papers. '*Dr. Smith, in a recent lecture on Geology, in New York, mentioned a curious circumstance connected with the Mississippi River. It runs from north to south, and its mouth is actually four miles higher than its source: a result due to the centrifugal motion of the earth. Thirteen miles is the difference between the equatorial and polar radius; and the river, in two thousand miles, has to rise one third of this distance, it being the height of the equator above the pole. If this centrifugal force were not continued, the rivers would flow back, and the ocean would overflow the land.*'"

This statement of Dr. Smith, said Prof. Lovering, is wholly correct, except in the numerical details, in which Dr. Smith evidently did not aim at great precision. But the writer in the Journal (who is understood to be President Horace Mann) not only attacks the accuracy of these details, but assails the mechanical principle which lies at the foundation of Dr. Smith's statement; saying, that "it would be difficult to compact a greater number of errors of fact and of principle into one short paragraph, than are found in the above quotation." The precise numbers involved in this question are of secondary importance. I am willing, and Dr. Smith no doubt is willing, that Mr. Mann should have the numbers as he states them. Suppose then that the length of the Mississippi River, *measured on a meridian*, is only fourteen hundred miles, and that the mouth is only about two and a half miles more distant from the earth's centre than the source. The question arises whether the flow of the river from the north to south is caused by the centrifugal force, or whether the criticism of Mr. Mann upon this mechanical solution of the problem is sound. The critic asks: "Why then does not the mighty force which sends the Mississippi *up hill* four miles send the Nile back to the Mountains of the Moon?" And again he asks: "Why does not the centrifugal motion of the earth drive the waters of the Atlantic and Pacific Oceans towards the equator, at the rate of ninety-six miles a day?"

Let us attend next to Mr. Mann's own explanation of the flow of the Mississippi. After enlarging upon the protuberant matter at the earth's equator, he continues: "Now water, like every other material thing, is attracted towards the centre of gravity. The centre of gravity is that point about which all the parts are *in equilibrio*. Or, in popular language, water, like everything else, being attracted by matter, is most attracted, other things being equal, by the greatest quantity. The only philosophical idea we can have of *up* or *down* is *from* or *towards* the point of greatest attraction, that is, from or towards the centre of gravity." Elsewhere, this writer speaks of the earth "being an oblate spheroid, having the greatest quantity of matter, *and therefore the greatest attraction*, under the equator." Finally he says: "The whole truth is, that the waters of the Mississippi are constantly tending to the common centre of attraction; but, being prevented from approaching that centre *in a direct line*, they approach it indirectly, by moving forwards along the bed of the channel. They are constantly approaching the centre of gravity, that is, *they are constantly descending*."

One error into which Mr. Mann has fallen is that of supposing that the attraction which the earth exerts at any particular point of its surface is a local phenomenon, and not the resultant of the aggregate attractions of every particle of matter in the earth. This error leads him to a conclusion contradicted by the experiments and observations of the last two centuries; namely, that where there is the most matter, there is also the most attraction, and that consequently the attraction is stronger at the equator than it is at the poles. We might ask Mr. Mann why this mighty force of attraction does not send the Nile back to the Mountains of the Moon. My own answer is, that this excess of attraction at the equator does not exist, and therefore neither carries the Mississippi towards its mouth, nor tends to carry the Nile back from its mouth. To many the assumption will seem a plausible one, that the excess of *matter* at the equator should be accompanied with a redundancy of attraction there. They forget that the *whole earth* attracts everywhere. And calculation proves that the attraction of the whole earth upon a body at the surface is greater the nearer this body is to the poles; and for this obvious reason,—the excess of equatorial matter operates to the prejudice of equatorial gravity, by keeping the rest of the earth at an unusually large distance. Moreover, it is of no importance to the flow of the Mississippi whether the stronger attraction is at the equator or at the poles, since the flow of water is determined, not by the intensity of the gravity at the place where the water is, or anywhere else, but by the direction of this gravity in relation to the surface at that place.

Again, Mr. Mann speaks of the centre of gravity of the earth, and says that the waters of the Mississippi are constantly approaching this centre of gravity. But why is it that the Nile moves northward? Does that also approach constantly the same centre of gravity? The whole argument from the centre of gravity of the earth is fallacious, for the earth has no fixed centre of gravity. There is a new centre of gravity to the earth for every new spot of surface which an attracted body visits. Water could not flow in any direction without approaching some of these centres of gravity, and deserting others. And, in fact, the waters at the mouth of the Mississippi are further from the centre of gravity which belongs to the geographical situation of the mouth, than the waters of the sources of the river are from the centre of gravity which belongs to the position of these sources. In the case of the Nile, exactly the reverse of this is true.

What, then, is the true mechanical principle which is applicable to these cases? It is this: the mutual attraction of the particles of matter upon each other, which, if undisturbed, would mould a yielding earth into the form of a perfect sphere, has been so modified by the centrifugal force, resulting from the planet's rotation, as to make the figure of an ellipsoid, in which the largest radius exceeds the shortest by thirteen miles, the true figure of equilibrium. Cohesion enables the solid land to hold out to a limited extent against these moulding influences. But the free waters yield readily to their plastic touch, and are at rest only so long as the figure of equilibrum is unruffled, and always move in such a way as to restore it when it is disturbed. Water everywhere flows from places which are above the surface of equilibrium to places which are below it. The mouth of the Mississippi is two and a half miles more distant from the earth's centre of figure than the source. But it ought to be three miles. It is, therefore, below the surface of equilibrium, and the water flows south to fill up to the proper level. The source of the Nile ought to be about two and a half miles more distant from the earth's centre than the mouth of that river. But the excess of distance is more than two and a half miles. Hence the source is above the figure of equilibrium, and the waters flow as they do. The same mechanical causes, which originally swept the two oceans from the pole to the equator in order to build up that great equatorial embankment of water thirteen miles high, and thus give the earth a stable figure, are now carrying the Mississippi *to its mouth*, where the embankment is not yet high enough, and the Nile *from its source*, where the liquid embankment is too high. And here I may answer Mr. Mann's inquiry, 'Why does not the centrifugal motion of the earth drive the waters of the Atlantic and Pacific Oceans towards the equator?" It did once. But sufficient water has already gone to make the figure perfect now. Inasmuch as the earth's waters flow so as to restore the ideal figure of equilibrium wherever it is lost, and inasmuch as this figure of equilibrium is such that the resultant of gravity and the centrifugal force must be everywhere normal to its surface, the direction and the velocity of the flow are intimately connected with the centrifugal force. Without a rotation, and the centrifugal force which rotation produces, the earth's figure of equilibrium would be a sphere. In this event, the Mississippi would flow northward. Its southern direction, under existing circumstances, may therefore be fairly attributed to the centrifugal force. If the earth did not rotate, and the sphere were the figure of equilibrium, the Nile would flow in direction as it now does, but much more rapidly. Under existing circumstances, the same centrifugal force which accelerates the flow of the Mississippi retards the flow of the Nile.

If the inquiry be made whether the Mississippi runs *up hill* or down, I reply that this is simply a question of definition. If *down* means towards the earth's centre of figure, then the Mississippi runs up. If *down* means towards that part of the earth's surface where the attraction is greatest, then also the Mississippi runs up. We cannot say, with Mr. Mann, that *down* means towards the earth's centre of gravity, because the earth has no single centre of gravity. His definition of *up* and *down*, therefore, is without any meaning, and is not, as he says, based upon the only philosophical idea we can have of these terms. The only standard level of altitude is the surface of equilibrium. If we understand by *down* "below the surface of equilibrium," and by *up* "above the surface of equilibrium," then our definition will be as broad as nature's laws, and will lead to no paradoxes, all of which nature abhors more than a vacuum: then all the rivers will be found flowing downwards. On a small scale, and in local mechanics, an inclined plane is one which is inclined to the local plumb-line. But on a large scale, such as will take in the whole length of a great river, every plane surface is inclined to every plumb-line but one, and the surface which is not inclined, and on which, therefore, a body has no tendency to slide, is a surface which is everywhere perpendicular to the plumb-lines which intersect it; that is, it is the earth's surface of equilibrium. This is the only true, broad, and universal standard of level.

It may be concluded from what has been said, that the new hydrostatic paradox is of man's invention, and that nature is in no way responsible for it. Science abounds in such paradoxes; and men of science are too prone to array the merest truisms in paradoxical language which catches the popular ear, though at the sacrifice of making science itself vulgar. Moreover, if the explanation which I have given of the paradox under consideration is beyond the knowledge or above the comprehension of a child, then the question which involves it is unfit to be addressed to him.

ON THE ORIGIN AND TRANSFORMATION OF MOTIVE POWER.

The following paper, by Prof. Wm. Thompson, recently read before the Royal Institution of Great Britain, is one of the most valuable contributions to physical science made during the past year: The speaker commenced by referring to the term *work done*, as applied to the action of a force pressing against a body which yields, and to the term *mechanical effect produced*, which may be either applied to a resisting force overcome, or to matter set in motion. Often the mechanical effect of work done consists in a combination of those two classes of effects. It was pointed out that a careful study of nature leads to no firmer conviction than that work cannot be done without producing an indestructible equivalent of mechanical effect. Various familiar instances of an apparent loss of mechanical effect, as in the friction, impact, cutting, or bending of solids, were alluded to, but especially that which is presented by a fluid in motion. Although in hammering solids, or in forcing solids to slide against one another, it may have been supposed that the alterations which the solids experience from such processes, constitute the effects mechanically equivalent to the work spent, no such explanation can be contemplated for the case of work spent in agitating a fluid. If water in a basin be stirred round and left revolving, after a few minutes it may be observed to have lost all sensible or otherwise discernible signs of motion. Yet it has not communicated motion to other matter round it; and it appears as if it has retained no effect whatever from the state of motion in which it had been. It is not tolerable to suppose that its motion can have come to nothing; and until fourteen years ago confession of ignorance and expectation of light was all that philosophy taught regarding the vast class of natural phenomena of which the case alluded to is an example. Mayer, in 1842, and Joule, in 1843, asserted that heat is the equivalent obtained for work spent in agitating a fluid, and both gave good reasons in support of their assertion. Many observations have been cited to prove that heat is not generated by the friction of fluids; but that heat *is* generated by the friction of fluids has been established beyond all doubt by the powerful and refined tests applied by Joule in his experimental investigation of the subject.

An instrument was exhibited, by means of which the temperature of a small quantity of water contained in a shallow circular case provided with vanes in its top and bottom, and violently agitated by a circular disc provided with similar vanes, and made to turn rapidly round, could easily be raised in temperature several degrees in a few minutes by the power of a man, and by means of which steam power applied to turn the disc had raised the temperature of the water by 30 degrees in half an hour. The bearings of the shaft, to the end of which the disc was attached, were entirely external; so that there was no friction of solids under the water, and no way of accounting for the heat developed except by the friction in the fluid itself.

It was pointed out that the heat thus obtained is not *produced from a source*, but is *generated*; and that what is called into existence by the work of a man's arm cannot be matter.

Davy's experiment, in which two pieces of ice were melted by rubbing them together in an atmosphere below the freezing point, was referred to as the first completed experimental demonstration of the immateriality of heat, although not so simple a demonstration as Joule's, and although Davy himself gives only defective reasoning to establish the true conclusion which he draws from it. Rumford's inquiry concerning the "Source of the Heat which is excited by Friction" was referred to as only wanting an easy additional experiment—a comparison of the thermal effects of dissolving (in an acid, for instance), or of burning, the powder obtained by rubbing together solids, with the thermal effects obtained by dissolving or burning an equal weight of the same substance or substances in one mass or in large fragments—to prove that the heat developed by the friction is not *produced from the solids*, but is *called into existence between them.* An unfortunate use of the word "capacity for heat," which has been the occasion of much confusion ever since the discovery of latent heat, and has frequently obstructed the natural course of reasoning on thermal and thermo-dynamic phenomena, appears to have led both Rumford and Davy to give reasoning which no one could for a moment feel to be conclusive, and to have prevented each from giving a demonstration which would have established once and for ever the immateriality of heat.

Another case of apparent loss of work, well known to an audience in the Royal Institution—that in which a mass of copper is compelled to move in the neighborhood of a magnet—was adduced; and an experiment was made to demonstrate that in it also heat appears as an effect of the work which has been spent. A copper ball, about an inch in diameter, was forced to rotate rapidly between the poles of a powerful electro-magnet. After about a minute it was found by the thermometer to have risen by 15° Fahr. After the rotation was continued for a few minutes more, and again stopped, the ball was found to be so hot that a piece of phosphorus applied to any part of its surface immediately took fire. It is clear that in this experiment the electric currents discovered by Faraday to be induced in the copper by virtue of its motion in the neighborhood of the magnet, generated the heat, which became sensible. Joule first raised the question, Is any heat generated by an induced electric current in the locality of the inductive action? He not only made experiments which established an affirmative answer to that question, but he used the mode of generating heat by mechanical work established by those experiments, as a way of finding the numerical relation between units of heat and units of work, and so first arrived at a determination of the mechanical value of heat. At the same time (1843) he gave another determination founded on the friction of fluids in motion; and six years later he gave the best determination yet obtained, according to which it appears that 772 foot pounds of work (that is, 772 times the amount of work required to overcome a force equal to the weight of 1 lb. through a space of one foot) is required to generate as much heat as will raise the temperature of a pound of water by one degree.

The reverse transformation of heat into mechanical work was next considered, and the working of a steam engine was referred to as an illustration. An original model of Stirling's air engine was shown in operation, developing motive power from heat supplied to it by a spirit lamp, by means of the alternate contractions and expansions of one mass of air. Thermo-electric currents, and common mechanical action produced by them, were referred to as illustrating another very distinct class of means by which the same transformation may be effected. It was pointed out that in each case, while heat is taken in by the material arrangement or machine, from the source of heat, heat is always given out in another locality, which is at a lower temperature than the locality at which heat is taken in. But it was remarked that the quantity of heat given out is not (as Carnot pointed out it would be if heat were a substance) the same as the quantity of heat taken in, but, as Joule insisted, less than the quantity taken in by an amount mechanically equivalent to the motive power developed. The modification of Carnot's theory to adapt it to this truth was alluded to; and the great distinction which it leads to between reversible and not reversible transformations of motive power was only mentioned.

To facilitate further statements regarding transformations of motive power, certain terms, introduced to designate various forms under which it is manifested, were explained. Any piece of matter, or any group of bodies, however connected, which either is in motion, or can get into motion, without external assistance, has what is called mechanical energy. The energy of motion may be called either "dynamical energy," or "actual energy." The energy of the material system at rest, in virtue of which it can get into motion, is called "potential energy," or, generally, motive power possessed among different pieces of matter, in virtue of their relative positions, is called potential energy. To show the use of these terms, and explain the ideas of a *store of energy*, and of conversions and transformations of energy, various illustrations were adduced. A stone at a height, or an elevated reservoir of water, has potential energy. If the stone be let fall, its potential energy is converted into actual energy during its descent, exists entirely as the actual energy of its own motion at the instant before it strikes, and is transformed into heat at the moment of coming to rest on the ground. If the water flow down by a gradual channel, its potential energy is gradually converted into heat by fluid friction, and the fluid becomes warmer by a degree Fahr. for every 772 feet of the descent. There is potential, and there is dynamical energy, between the earth and the sun. There is most potential energy and least actual energy in July, when they are at their greatest distance asunder, and when their relative motion is slowest. There is least potential energy and most dynamical energy in January, when they are at their least distance, and when their relative motion is most rapid. The gain of dynamical energy from the one time to the other is equal to the loss of potential energy.

Potential energy of gravitation is possessed by every two pieces of matter at a distance from one another; but there is also potential energy in the mutual action of contiguous particles in a spring when bent, or in an elastic cord when stretched.

There is potential energy of electric force in any distribution of electricity, or among any group of electrified bodies. There is potential energy of magnetic force between the different parts of a steel magnet, or between different steel magnets, or between a magnet and a body of any substance of either paramagnetic or diamagnetic inductive capacity. There is potential energy of chemical force between any two substances which have what is called affinity for one another,—for instance, between fuel and oxygen, between food and oxygen, between zinc in a galvanic battery and oxygen. There is a potential energy of chemical force among the different ingredients of gunpowder or gun cotton. There is potential energy of what may be called chemical force, among the particles of soft phosphorus, which is spent in the allotropic transformation into red phosphorus; and among the particles of prismatically crystallized sulphur, which is spent when the substance assumes the octahedral crystallization.

To make chemical combination take place without generating its equivalent of heat, all that is necessary is to resist the chemical force operating in the combination, and take up its effect in some other form of energy than heat. In a series of admirable researches on the agency of electricity in transformations of energy,* Joule showed that the chemical combination taking place in a galvanic battery may be directed to produce a large, probably in some forms of battery an unlimited, proportion of their heat, not in the locality of combination, but in a metallic wire at any distance from that locality; or that they may be directed not to generate that part of their heat at all, but, instead, to raise weights, by means of a rotating engine driven by the current. Thus, if we allow zinc to combine with oxygen by the beautiful process which Grove has given in his battery, we find developed in a wire connecting the two poles the heat which would have appeared directly if the zinc had been burned in oxygen gas; or, if we make the current drive a galvanic engine, we have, in weights raised, an equivalent of potential energy for the potential energy between zinc and oxygen spent in the combination.

The economic relations between the electric and the thermodynamic method of transformation from chemical affinity to available motive power were indicated, in accordance with the limited capability of heat to be transformed into potential energy, which the modification of Carnot's principle, previously alluded to, shows, and the unlimited performance of a galvanic engine in raising weights to the full equivalent of chemical force used, which Joule has established.

The transformation of motive power into light, which takes place when work is spent in an extremely concentrated generation of heat, was referred to. It was illustrated by the ignition of platinum wire, by means of an electric current driven through it by the chemical force between zinc and oxygen in the galvanic battery; and by the ignition and volatilization of a silver wire by an electric current driven through it by the potential energy laid up in a Leyden battery, when charged by an electrical machine. The luminous heat generated in the last mentioned case was the complement to a

* On the Production of Heat by Voltaic Electricity, communicated to the Royal Society, December 17th, 1840 (*see* Proceedings of that date), and published *Phil. Mag.*, October, 1841.

"On the Heat evolved by Metallic Conductors of Electricity, and in the cells of a battery during Electrolysis."—*Phil. Mag.*, October, 1841.

"On the Electrical Origin of the Heat of Combustion"—*Phil. Mag.*, March, 1843.

"On the Heat evolved during the Electrolysis of Water," Proceedings of the Literary and Philosophical Society of Manchester, 1843, vol. vii. part 3. Second Series.

"On the Calorific Effects of Magneto-Electricity, and on the Mechanical Value of Heat," communicated to the British Association (Cork), August, 1843, and published *Phil. Mag.*, October, 1843.

"On the Intermittent Character of the Voltaic Current in certain cases of Electrolysis, and on the Intensity of various Voltaic Arrangements."—*Phil. Mag.*, February, 1844.

"On the Mechanical Powers of Electro-Magnetism, Steam, and Horses." By Joule and Scoresby.—*Phil. Mag.*, June, 1846.

"On the Heat disengaged in Chemical Combination."—*Phil. Mag.*, June, 1852.

"On the Economical Production of Mechanical Effect for Chemical Forces."—*Phil. Mag.*, January, 1853.

deficiency of heat of friction in the plate glass and rubber of the machine, which a perfect determination, and comparison with the amount of work spent in turning the machine, would certainly have detected.

The application of mechanical principles to the mechanical actions of living creatures was pointed out. It appears certain, from the most careful physiological researches, that a living animal has not the power of originating mechanical energy; and that all the work done by a living animal in the course of its life, and all the heat that has been emitted from it, together with the heat that would be obtained by burning the combustible matter which has been lost from its body during its life, and by burning its body after death, make up together an exact equivalent to the heat that would be obtained by burning as much food as it has used during its life, and an amount of fuel that would generate as much heat as its body if burned immediately after birth.

On the other hand, the dynamical energy of luminiferous vibrations was referred to as the mechanical power allotted to plants (not mushrooms or funguses, which can grow in the dark, are nourished by organic food like animals, and like animals absorb oxygen and exhale carbonic acid) to enable them to draw carbon from carbonic acid, and hydrogen from water.

In conclusion, the sources available to man for the production of mechanical effect were examined and traced to the sun's heat and the rotation of the earth round its axis.

Published speculations were referred to, by which it is shown to be possible that the motions of the earth and of the heavenly bodies, and the heat of the sun, may all be due to gravitation; or, *that the potential energy of gravitation may be in reality the ultimate created antecedent of all motion, heat, and light at present existing in the universe.*

ON THE ROTATORY MOVEMENTS OF THE CELESTIAL BODIES, AND THE SPIRAL FORMS OF NEBULÆ.

At a recent meeting of the Astronomical Society, England, Mr. Nasmyth read a paper entitled, "Suggestions respecting the Origin of the Rotatory Movements of the Celestial Bodies, and the Spiral Forms of the Nebulæ, as seen in Lord Rosse's Telescope." What first set me thinking on this subject, was the endeavor to get at a reason why water in a basin acquires a rotatory motion when a portion of it is allowed to escape through a hole in the bottom. Every well trained philosophical judgment is accustomed to observe illustrations of the most sublime phenomena of creation in the most minute and familiar operations of the Creator's laws, one of the most characteristic features of which consists in the absolute and wonderful integrity maintained in their action, whatsoever be the range as to magnitude or distance of the objects on which they operate. For instance, the minute particles of dew which whiten the grass blade in early morn are, in all probability, moulded into spheres by the identical law which gives to the mighty sun its globular form! Let us pass from the rotation of water in a basin, to the consideration of the particles of a nebulous mass just summoned into existence by the fiat of the Creator,—the law of gravitation co-existing. The first moment of the existence of such a nebulous mass would be inaugurated by the election of a centre of gravity, and, instantly after, every particle throughout the entire mass of such nebulæ would tend to and converge towards that centre of gravity. Let us now consider what would be the result of this. It appears to me that the inevitable consequence of the convergence of the particles towards the centre of gravity of such a nebulous mass would not only result in the formation of a nucleus, but by reason of the physical impossibility that all the converging particles should arrive at the focus of convergence in directions perfectly radial and diametrically opposite to each other, however slight the degree of deviation from the absolute diametrically opposite direction in which the converging particles coalesce at the focus of attraction, a twisting action would result, and rotation ensue, which, once engendered, be its intensity ever so slight, from that instant forward the nucleus would continue to revolve, and all the particles which its attraction would cause to coalesce with it, would do so in directions tangential to its surface, and not diametrically towards its centre. In due course of time the entire of the remaining nebulous mass would become affected with rotation from the more rapidly moving centre, and would assume what appears to me to be their inherent normal condition, namely, spirality, as the prevailing character of their structure: and as that is *actually* the aspect which may be said to characterize the majority of those marvellous nebulæ, as revealed to us by Lord Rosse's magnificent telescope, I am strongly impressed with the conviction that such reasons as I have assigned have been the cause of their spiral aspect and arrangement. And by following up the same train of reasoning, it appears to me that we may catch a glimpse of the primeval cause of the rotation of every body throughout the regions of space, whether they be nebulæ, stars, double stars, or planetary systems. The primary cause of rotation which I have endeavored to describe in the preceding remarks is essentially cosmical, and is the direct and immediate offspring of the action of gravitation on matter in a diffused, nebulous, and, as such, highly mobile condition. It will be obvious that in the case of a nebulous mass, whose matter is unequally distributed, that in such a case several sub-centres of gravity would be elected, that is to say, each patch of nebulous matter would have its own centre of gravity; but these in their turn subordinate to that of the common centre of gravity of the whole system, about which all such outlying parts would revolve. Each of the portions above alluded to would either be attracted by the superior mass, and pass in towards it as a *wisp* of nebulous matter, or else establish perfect individual and distinct rotation within itself, and finally revolve about the great common centre of gravity of the whole. Bearing this in mind, and referring to some of the figures of the marvellous spiral nebulæ which Lord Rosse's telescope has revealed to us, I shall now bring these suggestions to a conclusion. I have avoided expanding them to the extent I feel the subject to be worthy and capable of; but I trust such as I have offered will be sufficient to convey a pretty clear idea of my views on this sublime subject, which I trust may receive the careful consideration its nature entitles it to. Let any one carefully reflect on the reason why water assumes a rotary motion when a portion of it is permitted to escape from an aperture in the bottom of the circular vessel containing it; if they will do so in the right spirit, I am fain to think they will arrive at the same conclusion as the contemplation of this familiar phenomenon has brought me to.

ON THE ROTATION OF THE MOON.

One of the notable events connected with the progress of science during the past year has been a discussion which has prevailed in England respecting the question, "Does the moon revolve on her axis, or not?"

The question was first started by a London gentleman somewhat favorably known for his literary, though not for his scientific attainments, by a communication in the London *Times*, in which he assumed the negative in defiance of all astronomers. He charged them with designating that a rotation which is no rotation. The very fact which leads astronomers to impute to the moon a rotary movement, was adduced as a proof that she does *not* rotate. He argued thus: "If the moon turned at all on her axis, a little consideration will show that all her surface would be successively shown to the earth, and that it is because she has *no* rotary motion at all, that one side only is seen by us. She performs precisely the same motion in relation to the earth, that a point on the tire of a wheel does to the box or axle, or that the round end of the minute-hand of a watch does to the pivot in the centre. It is easy to construct a small instrument similar to this, by fixing a ball on one end of a strip of wood to represent the earth, and fastened by a pivot serving as its axis, and on the other end a smaller ball, also fastened by a pivot. If the strip of wood be turned round on its pivot at the end representing the earth, the small ball will exactly represent the moon, and will present the same face, through the whole of its revolution, to the large ball; but if the small ball be made to rotate on its axis ever so little, it will immediately present a change of face to the larger ball, and so would the moon to the earth."

The charge was met by a great outburst of counter-ridicule and indignation. A gentleman, who was an astronomer and a wag at the same time, said, "I beg to inform him that I live in the moon, and that as I walk round the earth in order to keep my weather-eye open, so as continually to have it in view, I am obliged to perform a rotation on my axis once a month. I tried the other plan long ago, by always keeping my face to the north as I made my rounds; but then I turned in succession my face, my left side, my back, and my right side to the earth. I soon, however, got a 'round robin' from the earth, requesting me to go upon the old plan; so I gave up the experiment." Another advised the accuser thus: "Let him walk round a circular table, with his face always turned towards its centre, and by observing that the objects which originally appeared on his right, will appear, on the completion of one half of his perambulations, to be on his left, he will probably be able to convince himself that he has been turning round a vertical axis."

But as the accuser refused to be beaten down by ridicule, numerous practical illustrations were suggested to his attention; some of which may be usefully transcribed.

1. "Suppose that a mariner's compass is fixed on the edge of a wheel

placed in a horizontal position, and made to revolve about its axis. In this case the needle of the compass will always point in the same direction—namely, towards the north, and the index card that is fixed to it will be carried round by the motion of the wheel without any rotation about its own axis. But this is a very different motion from that of the moon; and, in fact, if the moon moved round the earth in a manner similar to that just described, all the parts of its surface would be in succession visible from the latter."

2. "Take a common compass, and place it at the extremity of one of the arms of a turnstile. When the turnstile has gone half round, look at the compass, and you will find that the northern end of the needle points to the south of the card. By the time the turnstile has got all the way round, the needle will again, as at first, point to the north of the card. Now, here it is very plain that either the needle has moved on its axis round the card, or the card has performed a revolution on that which is the common axis of itself and the needle; the eye will inform us that the former is not the case, and therefore that the latter must be."

3. "Take a cup and ball, and marking the latter at four opposite points with the letters N., S., E., and W., carry it, suspended by its string, round the flame of a candle. You will find that if N. be kept always to the north, the ball consequently remaining without axial motion, the light will fall in succession on W., S., and E., until it reaches N. again. But if you wish N. to be always illuminated, you must turn it continually towards the flame; in so doing, you will cause an axial rotation of the ball upon its string at each revolution which it performs round the candle."

4. "A body is said to have no rotary motion when any line drawn in it continually points in the same direction in space. If the moon had no rotation, a line drawn from her centre to any point on her surface would continually point towards the same place in the heavens—that is, towards the same fixed star. A body, on the other hand, is said to have a rotary motion about an axis, when any line drawn through that axis and at right angles to it gradually turns round, so as to point successively to all points of the heavens lying in a great circle."

5. "Take a disc of tin for the moon, hollowed a little on one side to make it balance easily on a strong needle stuck point upwards near the end of a bar of wood revolving horizontally. You can hold the disc with your finger while you turn the bar, so as to keep some mark upon the disc facing the axis on which the bar turns, and let it go just before you stop the motion of the bar. In the converse experiment you have only to turn the bar, leaving the disc alone; and then it will not revolve (except in its orbit), but will present all its circumference in succession to the axis of the bar—thus showing that an additional force was necessary to make the moon turn on its axis, besides turning round the earth."

At the last meeting of the British Association, the subject was brought up by Dr. Whewell, who presented the following paper:—

The moon's motion may be described, in one way among others, by saying that in each month she revolves about the earth nearly in one plane, turning always the same face to the earth. But a body rigidly fastened to a rigid radius which revolved about the earth nearly in one plane, would during that revolution turn always the same plane to the earth. Now, would such a body be described as revolving upon its axis during such a revolution? By many persons it would not be so described. But the moon is described by astronomers as revolving about her axis in the course of every month. What are the reasons for such a description? The reasons are briefly these: —1. The moon is not fastened to the earth rigidly, nor fastened at all. 2. The moon being thus detached, the reference of the moon to the earth as a centre of revolution is arbitrary. 3. The other celestial bodies which revolve about centres also revolve about their axes, and the rule regarding them as not revolving about their axes when they turn always the same face to the centre, would produce confusion: it would, for instance, compel me to say that the earth revolves upon her axis 365¼ times in a year, whereas with regard to the fixed stars she revolves 366¼ times. Also, when a body revolves about a centre turning always the same face to the centre, then is mechanical force required to make it so turn; but no mechanical force is required to make it remain parallel to itself while it revolves round a centre. 1. The moon is *not* fastened to the earth rigidly, as the ancients supposed when they invented the crystalline spheres as the mechanism by which the heavenly bodies revolve, and by which they are connected with one another; and as the body representing the moon is fastened to the body representing the earth in machines made by man. The moon in nature is entirely detached from the sun, and the fact of her turning the same face to the earth does not at all form the machinery of her monthly revolution. Hence it is ascribed to a separate motion, her monthly revolution on her axis. 2. The reference of the moon to the earth is *arbitrary*. The moon revolves about the earth, but she revolves about the sun also. She revolves about the sun *more* than about the earth; for when she is between the sun and the earth, her face is concave to the sun and convex to the earth's orbit. There are, in some respects, stronger reasons for regarding her as fastened to the sun than as fastened to the earth. But in truth she is not fastened at all; and the simplest way is to regard her as quite detached, and to consider her motion by which she turns her face different ways as quite separate from the motion by which she revolves about any centre. 3. The other celestial bodies also revolve about their axes, and especially the earth. All persons agree in thus expressing the fact in the case of the earth; and as there are 365 days in the year, the earth revolves 365 times on her axis with reference to the sun. By doing this she revolves 366 times on her axis with reference to the fixed stars.

ON THE DISCOVERY, CONSTRUCTION, AND EXPLANATION OF THE GYROSCOPE.

During the past year no little discussion has been occasioned by the re-appearance before the public of an old but beautiful mechanical toy, to which the name Gyroscope has been generally applied. As the principles involved in the motions of this arrangement have been the theme of much discussion, we present the following articles as containing the essence of all that has been published of value on the subject. We would also say, that the mechanical arrangement referred to is not of recent origin, but has been known for many years. Those interested in the subject would do well to examine the articles published in the Annual of Sci. Dis. for 1855, pp. 179–186.

The following is an abstract of a paper recently read before the American Academy, by Prof. Lovering:—

"Since the time of Foucault's celebrated experiment for illustrating the rotation of the earth by the stability of the plane of oscillation, increased attention has been given to the law of *inertia* as determining the stability of *planes* of motion. The planes of *rotation* conform to this general rule of stability. Astronomy furnishes the only examples of perfect free rotating bodies: and astronomy, here, as elsewhere, must be invoked, whenever it is required to give an exact experimental illustration of the fundamental laws of mechanics. Artificial experiments realize but imperfectly this perfect freedom of the spinning earth and other planets. Besides the top and the *devil-on-two-sticks*, in which 'philosophy in sport' has been made 'science in earnest,' there are Bohnenberger's less familiar apparatus, first described in 1817,* and Johnston's *Rotascope.*† The necessity has recently been shown of adding to the description of the former the new *condition* of placing the axis of the apparatus parallel to the earth's axis to avoid the disturbance of the earth's rotation, and the new *application* of the instrument, when otherwise placed, to detecting this rotation.‡

"In 1853, Plücker published an account of Fessel's apparatus for experiments on the laws of rotation;§ and, in 1854, Magnus presented to the public an account of his *Polytrop*, also designed for similar illustrations.‖

"Plücker preludes his description of the Fessel machine with some remarks on Poisson's mathematical investigations on the subject of rotations,¶ and alludes to Poinset's successful attempt to make the motions generally hidden under the veil of mathematical analysis more sensible to the imagination and the eye.** Poinset thinks that, if many new truths are contained in analysis, they are buried in it for all but a few gifted minds. 'Thus our true method is but this happy mixture of analysis and synthesis, where calculation is employed only as an instrument, a precious instrument, and necessary without doubt, because it assures and facilitates our progress; but which has of itself no peculiar virtue; which does not direct the mind, but which the mind must direct like any other instrument.'

"The origin of Fessel's machine was as follows: About 1851 this skilful artist of Cologne, who a few years before had distinguished himself by his beautiful *Wave-machine*, particularly adapted for illustrating the mechanical laws of light, was examining the wheel of a model steam engine, and observed that, while rolling it on his hand, the horizontal axis did not require to be supported at both ends, while there was a tendency in the axis to move in a horizontal plane. Fessel's practical skill, aided by the suggestions of the eminent physi-

* Ann. Gilbert, LX. p. 65.
† Silliman's Journal, XXI. p. 265.
‡ Ann. Pogg., XC., pp. 350, 351.
§ Ann. Pogg., XC. p. 174.
‖ Ann. Pogg., XCI. p. 298.
¶ Journ. de Polytechn. Ecole, XVI. p. 247.
** Elemens de Statique, 8th edition, 1842.

cist Plücker, resulted in the construction of the apparatus, which during the past year has excited much attention and discovery, being regarded by many as an entirely new and inexplicable contrivance.

"Upon a heavy base, stands a hollow brass column, supporting a steel pin, terminating at the end in a point. At right angles to this pin are fastened metallic arms. On one of these arms, and at the distance of two inches from the pin, is fastened a vertical ring. Inside of this ring is placed a metallic disc, loaded at the edge, and which turns, independently of the ring, upon an axis. The motion is communicated by a thread wound upon the axis of the disc. The metallic arms contain a hinge, working on a horizontal point, which allows the ring containing the disc to move in its own plane. This motion can, however, be prevented by a revolving slide underneath. In some experiments the slide is placed so as to prevent the motion on the hinge, and the arms are balanced upon a fixed and pointed rod which is pushed into the brass column. For this purpose there is a little cap and a counterpoise which slides on the opposite arm to balance the disc. The top has less friction than Bohnenberger's or Fessel's apparatus. Also in Fessel's machine the disturbing force is the whole weight of the disc and ring, and not, as in Bohnenberger's machine, simply an access of weight on one side of the rotating body. Hence the precession is more rapid in the first than in the last.

"If the disc is not rotating, it naturally drops down upon the hinge from its own weight.

"But when the disc is made to rotate rapidly by means of the thread, and then left free, it seems indifferent to gravity, and, instead of dropping, it begins to revolve about the vertical axis. So that the axis of the disc acquires a motion similar to the *Precession of the Equinoxes* in Astronomy. The motion of revolution is opposite in direction to the rotation of the disc. When one of these motions is the greatest, the other is the least. If the motion of revolution is increased artificially, the disc appears lighter. If this motion is retarded, the disc appears heavier. Reciprocally, if the gravity of the disc is artificially increased, the motion of revolution is greater. If the gravity of the disc is artificially diminished, the motion of revolution is less. This variation in the gravity of the disc is easily effected upon an iron disc by means of a magnet. If the action of gravity is prevented by the slide which confines the hinge, there is no motion round the horizontal axis.

"The following popular explanation is given of these peculiarities of motion.* Place the disc in a vertical plane and make it rotate. The tangential motion of each particle has a horizontal and vertical component. As soon as the disc begins from its weight to incline from its original vertical position, the horizontal components still remain parallel to the new position, but the vertical components do not. If the upright edge of the disc nearest to the eye is ascending, this edge is pushed to the left and the opposite edge to the right. These two forces, resulting out of the deviation of the original vertical components from parallelism with the disc, act as through a bent lever to turn the whole disc round a vertical axis in a direction opposite to its

* Ann Pogg., XC. p. 348.

rotation. This can be shown experimentally by pressing with the fingers upon these two parts of the edge. As soon as the motion round the vertical axis begins, the horizontal components of the original rotation no longer retain their parallelism with the disc. But the tendency to preserve this parallelism, in other words, the tendency of the disc to preserve unchanged its plane of rotation, generates forces which act on the top of the wheel to the left and on the bottom of the wheel to the right. These forces, acting by leverage, tend to lift the wheel, as may be seen by pressing in the same way with the fingers. When friction is excluded, this uplifting force is an exact balance of gravity, and the wheel neither rises nor falls.

"The results of these experiments are remarkable, as showing how differently gravity acts upon a body at rest and upon the same body in motion. When it acts upon a body at rest, it tends to give it a motion round a horizontal axis, but not about a vertical axis. When a body is rotating in a vertical plane, gravity tends to give it no descending motion round a horizontal axis, but simply to turn it upon a vertical line. This apparent mechanical paradox is beautifully illustrated in the Precession of the Equinoxes. The disturbing influence of the sun and moon, which represent the gravity to be considered in this astronomical example, would make the equator drop down into coincidence with the ecliptic, if the earth were not spinning on its axis, and would make the precession an unknown phenomenon. But the same forces, acting upon the rotating earth, move the line of equinoxes backward, and leave the obliquity essentially unchanged. It follows, from the experimental illustration, as well as from the mathematical theory, that, if the disturbing forces were greater, the precession would be greater; and if the earth's rotation were diminished, *cæteris paribus*, the precession would be increased.

2. The *Polytrop* of Magnus consists of two rotating vertical discs, arranged upon an axle as the two wheels of a carriage. These discs can be set in motion by cords wound upon the hub of each disc, the free ends of the cords being attached to the same handle. The axle which carries the discs is movable at its centre around a vertical and also a horizontal axis, but either of these motions can be prevented at pleasure. If both discs are made to rotate in the *same* direction, or if only one disc rotates, it is not easy to turn the whole apparatus on its horizontal axis. But if the machine is prevented from moving round a vertical axis, there is no difficulty in disturbing it around its horizontal axis.

"Thus it appears in this experiment, as well as in those made with the Bohnenberger and Fessel machines, that a force acting upon a free body is prevented from producing motion *in its own direction* by the conical motion which exists around a rectangular axis. The same experiments can be made with the Bohnenberger apparatus, by holding or releasing the middle ring. In mechanics, a body has lost its stability of rotation when it has lost its freedom: and the most complete stability is consistent with perfect freedom. Astronomy hangs up for ever in the sky a splendid illustration of this principle. It cannot be that a less noble law prevails in the kingdom of mind than in that of matter. When the two discs are made to rotate in opposite directions with the same velocity, there is no stability, even when the apparatus is most free. For the tendency of the two rotations when combined with a foreign disturbance being to produce equal and opposite conical motions, the result is the same want of stability as if there was no conical motion in either direction."

Proceedings of the American Academy.—In a paper read before the American Association Meeting, at Albany, by Prof. W. B. Rogers, on the above subject, the following passage occurs:

"It always affords a sort of intellectual surprise to perceive for the first time the application of some simple and familiar mechanical principle to the grand phenomena of astronomy; to see that it is but one and the same set of laws which govern the motions of matter on earth and in the most distant regions of the heavens; to perceive a celestial phenomenon, vast in its relations both to time and space, and complex in its conditions, identified as to its mechanical cause, with the rotary movement of a little apparatus on the table before us."

A writer in the New York *Tribune* also discusses the principles involved in the Gyroscope as follows:—

"There seems to be an inverse relation between the two motions. As the spinning motion (corresponding to the diurnal motion of a planet around its own axis) gradually dies away, the travelling motion (corresponding to the annual revolution around the sun) increases in velocity; but at first, when whirling at a very rapid rate, the mass travels around the support only about once in ten or fifteen seconds—too slowly for the 'centrifugal force' due to *that* (the annual) motion to be of any practical weight. The centrifugal force of the particles, due to their very rapid motion around the axis or shaft of the wheel, is of course immensely great, but as it acts equally in all directions, up, down, and laterally, it is difficult to see by what authority the weight is diminished in the least thereby; and the evident absence of any very deep-laid humbug in a toy which any one may purchase for a dollar or two and operate for himself, has seriously excited the curiosity of thousands of earnest practical men, and some space has been devoted to it in scientific and technical journals, without seeming to touch the root of the phenomenon. It has been suggested by some that the intense rapid revolution might act on the air in some way to resist the attraction of the earth; or again, that sufficient electricity might be evolved to aid in this effect; while some have such weak and confused ideas on all subjects that the simple words 'central forces' or 'planetary motion' are considered very satisfactory and full explanations.

"It will be found on trial that the experiment will succeed equally well in a vacuum, and what is still more interesting, if possible, the absolute weight of the whole is not affected in the least by the anomalous condition described. Whatever the position of the axis, as it hums gaily around with one end resting on nothing, the other extremity will be found always to pull on the string or to press on the stand with precisely the weight due to the whole. This removes all apprehensions that nature's laws are about to collapse or decay, and serves to take us a step nearer to an explanation of the secret.

"Every particle in a whirling mass tends to pull from the centre with considerable force. This, which is termed the centrifugal force of the particles, although it does not contribute one iota to diminish its weight, tends very powerfully to prevent its change of plane. A wheel so situated does not 'lie round loose,' but every portion of its rim is very strongly pulled directly from the centre, the effect of all which is to hold it very stiffly. The 'inertia,' which tends to prevent the change of position of any mass, is increased ten, or perhaps one hundred fold when the mass is set in violent rotation. The wreath in the play of 'Graces' is sent whirling in its flight, to diminish the chances of its turning itself into an edgewise position; and the obstinacy with which a mass holds its relative position when very rapidly rotated, is availed of in the rifle to keep the conical ball point foremost. The Minié ball is in form like a hay stack or sugar loaf, and the rifle is grooved so as to twist or screw the ball around at the rate of one complete revolution in every three or four feet of its path. In pitching quoits or pennies the same principle is to a certain extent availed of, to steady the projectile in its flight through the air; freely suspended within rings like a mariner's compass, a whirling mass will exhibit a strong desire to revolve constantly in the same plane, and thus to keep its axis always in the same position. If, however, such a mass be forcibly acted on by some exterior agency, and compelled to change its plane, as if, for example, one extremity of the axis be pulled to one side, the mass does not tend either to remain quietly where it is left, nor to resume its first position, but leaps suddenly towards a new position at right angles to both these. The immediate cause of this unexpected result is somewhat difficult of popular explanation, but the fact exists, and from it directly results all the peculiarities in the toy under notice.

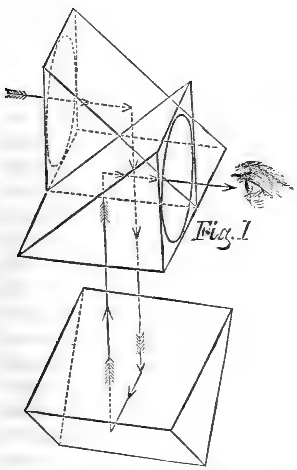
"The effort of the unsupported end of the shaft to fall to the earth induces a horizontal twisting of the axial line, which, as one end is confined by the support, results in a revolution of the whole mass around that point. As the tendency to fall is continuous, so the tendency to revolve is of the same constant character, and this revolution, by continually changing the plane in a horizontal direction, generates another twisting effort, tending to elevate one end and depress the other. It chances that the end depressed by this force is the supported one, while the other is correspondingly lightened, and so long as the motion is sufficiently rapid to make this twisting force equal to the whole weight to be supported, it will sustain itself apparently on nothing, to the great delight of juveniles, and the profound amazement of graver thinkers. The slow travelling motion of the whole around its support is vitally essential to its operation, and it immediately displays its ordinary weight at both extremities whenever this revolution is stopped. This motion is, in short, the effect of its tendency to fall, and the cause of its tendency to climb upon its support, so that the motions and forces described mutually cause and sustain each other, and preserve of themselves their proper relations and intensities.

"The same principles are, to some degree, called into action in the spinning of a top, although the result is less remarkable and more familiar. The top gains its steady equilibrium by changing its base in diminishing circles, but is meanwhile preserved from falling immediately over by the agency first alluded to, *i.e.* the great force with which it resists any change of plane. If the foot of a top accidentally drops into a depression which retains it, the mass does not fall, but gyrates rapidly around at an inclination which diminishes until it retains a perpendicular position. When thus constrained, the action of the top somewhat resembles the toy under notice, except in its disposition gradually to right itself, which proceeds from its being already in a position nearly perpendicular. It will be found on carefully experimenting with the new toy, that it sustains itself quietly only when started at or near a level position. If inclined upwards it acts like a top, and rights itself very gradually up until in some cases it loses its hold on the support, and falling upon the table, commences a series of circumgyrations far more vigorous than is consistent with drawing-room etiquette."

PRRMANENT REPRODUCTION OF "NEWTON'S RINGS."

M. Carrère has shown to the French Academy that Newton's rings may be reproduced by letting fall on water a drop of a solution of bitumen of Judea, with benzoin and naphtha. It is a curious optical experiment, and the more so, as the film may be taken off the surface of the water on a sheet of paper, and kept, when dry, for permanent observation.

THE NAPOLEON III. SPY-GLASS.



The above is the name given to an ingenious contrivance by its inventor, Mr. I. Porro, a retired officer of the Piedmontese military engineers. We condense the following description from the Paris *Illustration*:—

The improvement consists in so arranging a series of prismatic lenses that the larger portion of the spy-glass may be placed in a vertical case; as, for example, in the head of a cane. Convenience in holding, travelling, and economy of space is thus secured, while the power of the spy-glass is, in some respects, improved.

A short instrument, like that shown in fig. 2, when held in the hand, is less liable to oscillation, and enables the observer to point it correctly and steady, and to measure by means of an *ocular micrometer* the distance to a given point, whenever the absolute size of the body observed is known, and *vice versâ;* it is also very convenient for transportation, making a pocket instrument without the usual sliding tubes, which prevent a correct centring of the lenses.

This spy-glass consists of an objective rectangular prism, fig. 1, ground in the shape of a lens on one of its catheti, and throwing back below, by reflection on its hypothenuse, the horizontal rays from the exterior body observed. These rays meet a second rectangular prism, where, by the last

Fig. 2

reflection, they are thrown on the ocular or anterior cathetus, also shaped like a lens. The distance between the objective glass and the eye is consequently but the thickness of a prism (hardly two inches), the real length of the apparatus becomes vertical, is hidden inside the handle, which affords the observer a means to hold it in a steady position. The arrows indicate the direction in which the rays of light are reflected. The exterior shape, fig. 2, is very handy, not liable to get out of order, and the whole is quite portable, and the instrument very powerful. A is the eyeglass. B thumb screw for regulating the focus. The greatest difficulty the inventor had to contend against was to obtain perfect achromatism; in this, we are told, he has fortunately succeeded perfectly; his instruments are as free from colored spectra and aberration as the most perfect spy-glasses constructed in the ordinary manner. A small micrometer is also adapted for the purpose of computing distances.

CURIOUS USE OF THE MICROSCOPE.

Recently, on one of the Prussian railroads, a barrel which should have contained silver coin, was found, on arrival at its destination, to have been emptied of its precious contents, and refilled with sand. On Professor Ehrenberg, of Berlin, being consulted on the subject, he sent for samples of sand from all the stations along the different lines of railway that the specie had passed, and by means of his microscope, identified the station from which the interpolated sand must have been taken. The station once fixed upon, it was not difficult to hit upon the culprit in the small number of employées on duty there.

INVESTIGATIONS RELATIVE TO THE STEREOSCOPE.

Motion in Stereoscopic Portraits.—M. Lugeol, in making the stereoscopic portrait of one of his friends, had the idea of taking the two images or proofs one after the other, and making his friend each time look upon a different object. Thus, during the first sitting, he looked at the glass of the camera obscura, and during the second to the right at an object fixed nearly at an angle of 45 deg. These two images being placed in the stereoscope, let the observer stand opposite a window, and, without ceasing to look at the portrait, turn himself to the left or right, he will see the eyes of the portrait follow him as if they were animated. More than this has been effected by an adaptation of Sir David Brewster's natural magic toy, whose figures drawn on a circle are moved quickly round, so that three or four of them catch our eye at a particular angle, at almost the same instant, or rather at imperceptible intervals, the effect of motion is given to the limbs of the stereoscopic portrait.

On various Phenomena of Refraction through Semi-Lenses producing Anomalies in the Illusion of Stereoscopic Images.—A paper was presented at the last meeting of the British Association by Mr. Claudet, the well known photographist, having for its object to explain the cause of the illusion of curvature given to pictures representing flat surfaces, when they are examined in the refracting or semi-lenticular stereoscope. The author showed that all vertical lines seen through prisms or semi-lenses are bent, presenting their concave side to the thin edge of the prism, and as the two photographic pictures are bent in the same manner, the inevitable result of their coalescence in the stereoscope is a concave surface. The only means to avoid this defect is to employ the centre of the lenses to examine the two pictures; but as the centre does not retract laterally the two images, their coincidence cannot take place without placing the optical axis in such a position that they are nearly parallel, as if we were looking at the moon, or a very far object. This is an operation not very easy at the first attempt, but which a little practice will teach us to perform. Persons capable of using such a stereoscope will see the pictures more perfect, and all objects in their natural shape. Mr. Claudet presented to the meeting a stereoscope made on this principle, and many of the members present could see perfectly well with it. The author explained the cause of a defect which is very often noticed in examining stereoscopic pictures, viz. that the subject seems in some cases to come out of the openings of the mountings, and in some others to recede from behind—this last effect being more favorable and more artistic. Mr. Claudet recommended photographers when mounting their pictures to take care that the openings should have their correspondent vertical sides less distant than any two correspondent points of the first plane of the pictures, which could be easily done by means of a pair of compasses, measuring those respective distances. Mr. Claudet illustrated the phenomenon of vertical lines, by bent prisms forming by coalescence concave surfaces. He stated that if holding in each hand one prism, the two prisms having their thin edges towards each other, we look at the window from the opposite end of the room, we see first two windows with their vertical lines bent in contrary directions; but by inclining gradually the optical axes, we can converge them until the two images coalesce, and we see only one window: as soon as they coincide the lateral curvature of the vertical lines ceases, and they are bent projectively from back to front: we have then the illusion of a window concave towards the room, such as it would appear reflected by a concave mirror.

ON THE TRANSMISSION OF THE ACTIVE RAYS OF LIGHT THROUGH THE EYE, AND THEIR RELATION TO THE YELLOW SPOT OF THE RETINA.

The following is an abstract of a paper, communicated to the Edinburgh Philosophical Journal, on the above subject, by Dr. Wilson. Hartmann, as long ago as 1849, stated, that the eye arrests the chemical radiations which accompany the more refrangible rays of light. Dr. Wilson not being wholly satisfied with this statement, determined to re-examine the whole subject, and to test conclusively the question, whether the eye can transmit the chemical rays of light. An ox eye was prepared by cutting away the sclerotic coat, until the choroid came into view; a circular aperture of one-eighth of an inch in diameter was then made through the membranes and the retina, which laid bare the vitreous humor at a point opposite to that where the light enters. The eye was then supported in the brass mountings of a photographic lens, resting at the posterior end on a ring of cork, which fitted tightly into the tube, and retained in front by a diaphragm, so as to permit the cornea to protrude. From the arrangement of the fittings no light, except that which passed through the eye, could enter through the camera. A collodion glass plate being placed in the box and the camera being properly directed, an image was developed after an exposure of fifteen seconds. Other experiments subsequently made under a variety of conditions, such as would seem to obviate every objection, give similar results; and from these it appears certain, that the chemical or active rays of light are not arrested in their passage across the chamber of the eye.

An important question to be next considered is, what change do the actinic rays undergo when they fall upon that particular portion of the human retina which anatomists distinguish as the "yellow spot." This "spot," almost peculiar to man, presents a diameter of $\frac{1}{12}$ of an inch, and occupies the bottom of the eye, in the exact axis of its transparent humors. It is more transparent than the rest of the retina, and has long been recognised as the seat of the most perfect vision in the eye of man. Now this colored medium of the eye must produce a certain effect on the light which reaches it, and on the actinic rays which traverse it. Prof. Goodsir has shown, that it is not merely the case that light traverses the retina to the choroid, and is then reflected so as to return through the retina, but it is only the rays thus returned which produce a luminous sensation. The light, therefore, which traverses the yellow spot, and is then reflected forwards on the choroidal extremities of the optically sensific constituents of the retina, must be deprived, to a greater or less extent, of its actinic rays (by passing through the yellow spot) before it determines a luminous sensation, unless the portion of the retina under consideration differs from all other transparent media known to us, in not arresting the chemical rays. If it be not in this respect exceptionable, then the theory of perfect human vision may be simplified by the exclusion from consideration of the actinic rays; and one use of the yellow spot, for which it has hitherto baffled physiologists to find a use, may be to extinguish these radiations. It may be further remarked, in reference to the absorption of the actinic rays by the yellow spot, that the views of those who have described visual impressions on the retina as phenomena of the same kind as photographic impressions on chemically prepared surfaces must fall to the ground, if the actinic rays of light are stopped before reaching the optically sensific constituents of the retina. The similar opinion, also, that "spectral vision" and other abnormal peculiarities of sight, are phenomena of the same kind as the development (as it is technically called) of latent photographic images, must, for the reason mentioned, be abandoned. It will still of course be competent to compare normal and abnormal vision with photographic effects, as phenomena displaying analogy, though not affinity.

One other relation of the retina to light may be referred to. If only these rays which are reflected from the choroid produce by their impact on the retina the objective perception of light, and if the depth of tint of the yellow spot be considerable and its color at once homogeneous, then perfect vision must be exercised by yellow, and not by white light. But if this be the case we should be unconscious of red and blue when seeing best, or at least should receive from them an impression very different from that which they occasion when they affect the general surface of the retina.

NEW FORM OF TELESCOPE.

At the American Association for the Promotion of Science, Mr. Alvan Clarke, of Cambridge, gave a description of a new instrument of his own invention, for measuring the distance apart of stars too distant to be brought into the field of view of a telescope. Within a year from the first thought of the instrument entering his mind, he had built a telescope of six inches aperture, and 103 inches focal length, mounted it equatorially, governing its motion by Bond's spring-governor clock, provided the two eye-pieces, and as a substitute for a filar-micrometer, arranged a mode of using pieces of glass ruled with a ruling machine. Experiments have demonstrated the feasibility of using the two eye-pieces in this way, and of obtaining by them very accurate measures of the distances of stars, which are from three to one hundred minutes of space apart. The success of the instrument was, however, greatly due to the spring-governor which keeps each star upon the wire accurately bisected.

Professor Pierce said there were two other things besides the double eyepiece in this instrument, to which attention should be directed. The eyepiece must be tested by experiments, but the new mounting of the telescope, a modification of the Munich, was exceedingly beautiful, more so than even the Munich, and vastly superior in convenience and value. The spring-governor also was put into the best condition for good action there, the heavy mass of the telescope acting directly as a balance wheel, and controlling all irregularity of movement. In short, the instrument satisfied all reasonable requirements for equatorial mounting.

KOBELL'S STAUROSCOPE.

At the German Association for the Promotion of Science, Dr. Grailich exhibited Professor Kobell's Stauroscope, for the investigation of the optical properties of mineral substances. The principle of this very simple apparatus consists in the disappearance of the dark cross shown by plates of calcareous spar, when placed between two tourmalines set across, by the interposition of any crystallized substance whose principal section of elasticity is not coincident with the polarizing planes of tourmaline. By turning the interposed plate of crystallized substance, a position of it is found in which the principal sections of elasticity coincide with the polarizing planes of the apparatus, and this coincidence is manifested by the reappearance of the dark cross.

GEOLOGICAL SPECIMENS FOR MICROSCOPIC PURPOSES.

At the recent meeting of the German Association for the Promotion of Science, Professor G. Rose exhibited Dr. Oschalz's collection of lamellæ of minerals and rocks, reduced to a degree of thinness sufficient to render them transparent, and fit for microscopic investigation. This mode of investigation has led to the observation of many interesting facts respecting the crystalline structure of simple minerals, and the real constitution of composite substances, such as basalt, solenite, porphyry, &c. These plates, overlaid with Canada balsam, are placed between two pieces of glass, so as to be easily brought under the microscope. The price of the set of seventy-three plates is thirty-five thalers (about 5*l.* 8*s.*).

ON THE PERMANENCE OF PHOTOGRAPHIC PICTURES.

The Committee of the English Photographic Artists, appointed to consider the question of the fading of photographic pictures on paper, have submitted a first report as follows:—

The committee have unquestionable evidence of the existence of photographs which have remained unaltered for more than 10 years, prepared by salting plain paper with a chloride, afterwards making it sensitive with either nitrate or ammonio-nitrate of silver, fixing with a freshly made solution of hyposulphite of soda, and washing with water; also of positives produced by Mr. Talbot's negative process.

They have not been able to obtain evidence of photographs having been prepared at all upon albumenized paper, or colored with a salt of gold, or fixed with "old hypo," so long as ten years. They have, however, ample evidence of the existence of unaltered photographs so prepared five, six, and seven years ago.

They have not found that any method of printing which has been commonly followed, will necessarily produce fading pictures, if certain precautions be adopted, nor have they evidence that any method which has been adopted, will not produce fading pictures unless such precautions are taken.

Causes of Fading.—The most common cause of fading has been the presence of hyposulphite of soda, left in the paper from imperfect washing after fixing.

The committee think it right to state, that they have been unable to find any test to be relied upon, which can be used to detect a minute portion of hyposulphite of soda, in the presence of the other substances which are obtained by boiling photographs in distilled water and evaporating to dryness; yet they have no doubt of the truth of the above statement, from the history given of the mode of washing adopted.

The continued action of sulphureted hydrogen and water will rapidly destroy every kind of photograph; and as there are traces of this gas at all times present in the atmosphere, and occasionally in a London atmosphere very evident traces, it appears reasonable to suppose that what is effected rapidly in the laboratory with a strong solution of the gas, will take place also slowly but surely in the presence of moisture, by the action of the very minute portion in the atmosphere.

The committee find that there is no known method of producing pictures which will remain unaltered under the continued action of moisture and the atmosphere of London.

They find that pictures may be exposed to dry sulphureted hydrogen gas for some time with comparatively little alteration, and that pictures in the coloration of which gold has been used, are acted upon by the gas, whether dry or in solution, less rapidly than any others.

They also find that some pictures which have remained unaltered for years, kept in dry places, have rapidly faded when exposed to a moist atmosphere. Hence it appears that the most ordinary cause of fading may be traced to the presence of sulphur, the source of which may be intrinsic from hyposulphite left in the print, or extrinsic from the atmosphere, and in either case the action is much more rapid in the presence of moisture.

Mode of Mounting Photographs.—The committee find that, taking equal weights, dried at a temperature of 212°, of the three substances most frequently used, viz. gelatine, gum, and paste, the latter attracts nearly twice as much moisture as either of the former, and as in practice a much smaller weight of gelatine is used than of gum, gelatine appears to be the best medium of these three; and the committee have evidence of fading having in some cases been produced by the use of paste.

In illustration of some of the circumstances alluded to above, the committee think it well to mention some instances of prints at present in their possession:—Out of several prepared together in 1844, three only were unaltered, and these were varnished soon after their preparation, with copal varnish. Half of another print of the same date was varnished, and the other half left; the unvarnished half has faded, the varnished part remains unaltered. Three pictures were prepared in 1846, all at the same time, with the same treatment; when finished, one was kept unmounted, the other two were mounted with flour paste at the same time, one of these latter having been first coated with Canada balsam; at present the unmounted one and the one protected by the balsam are unchanged, whereas the other has faded.

A picture prepared in 1846 was so exposed that the lower part of it became wet by rain; at present the part so wetted has faded, while the rest of it remains unaltered. Several pictures were prepared and mounted about ten years ago, and kept in a dry room for about three years without any change, after which they were placed in a very damp situation, and then faded decidedly in a few months.

IMPROVEMENTS IN PHOTOGRAPHY.

Taking Photographic Images under Water.—Mr. Penny, of England, publishes in the Journal of the Society of Arts, the following account of his experimental researches in taking photographic images under the surface of water.

A box, made as nearly water-tight as possible, is prepared large enough to enclose the camera. This box is fitted, in part, with a piece of plate glass, and on the outside is a wooden shutter, heavily leaded, and which is raised by a string attached to it and communicating with a boat.

On each side of the box is an iron band, terminating in a screw, and projecting beyond the back, which is loose, and fitted with an iron bar, having a hole at each end, through which the screws of the band pass, and thus the back is screwed down tight against the body of the camera by means of a nut; the inner surface of the back is padded, so as to make the camera box, as far as possible, water-tight, when the back is screwed into its place.

The box is fixed to an iron tripod, and a band, with an eye on its upper margin, is passed round both camera, box, and stand; to this eye is attached the rope that lowers the camera to the sea bottom, and by which it is raised. This is the whole of the apparatus employed.

The first thing to be accomplished is to focus the camera, which process is thus described by Mr. Penny:—

"The camera is placed in the box on the shore, and a view is focussed, taking as the foreground an object at ten yards' distance. This I did with the view now sent, but I fear it is too much. I then fix the stand by means of a triangular wooden frame forced up between the legs of the tripod stand, and which is prevented from slipping down by being attached to the top of the tripod by a line; this keeps the camera frame the exact distance from the ground that it was when focussed on land, and the camera being focussed for the same distance, it stands to reason that, provided the optical and chemical properties are the same, we shall obtain a similarly good picture.

"The next thing to be done is to prepare the plate and inclose it. The plate is prepared with collodion, in the usual way, under the tent. It is then placed in the camera (my camera used for this purpose takes a plate five inches by four inches). I then take the camera to the box and stand, and throw a black cloth over all. I examine the shutter in front of the camera box to see that it is tight; then, uncapping the camera under the cloth, I place it in the box, and finally draw up the slide. I then push the camera completely into the box, until the front of the lens presses against the plate glass front of the box, and screw on the back tight. The camera is thus light, tight, and properly focussed; and nothing remains to be done but to lower it to the bottom of the sea.

"Up to the present point everything has been done on land. We now lash the whole of the apparatus, properly set, to the stern of the boat, and, when we arrive at the proper spot, sink the camera. By means of the lowering rope we can find when the camera is upright at the bottom. When satisfied on this point, we raise the shutter in front of the camera box, by means of the string attached to it, and the other end of which communicates with the boat. The camera is now in action.

"The time I allowed for my negative was ten minutes, and you will perceive it is a weak one. It took some time to develope with three grains of pyrogallic acid to the ounce.

"There are one or two points worthy of notice as having occurred in the experiment. The first is, that the image is formed on the plate in its natural position, and not inverted. From this it would appear that the piece of glass in front of the camera box, and the water conjointly, act in the same way as a parallel mirror. Another fact is, that the salt water does not materially injure the plate. With all my care, the great pressure at the depth to which I sunk my camera forced the water into the camera itself, and covered the collodion plate. When I opened the camera and found it full of water, I despaired of having obtained a view; but it would appear that salt water is not so injurious as I had feared. I took the precaution of washing the plate gently with fresh water, and then of dipping it for an instant in the silver bath.

"This application of photography may prove of incalculable benefit to science. We may take (to a reasonable depth) sketches of submarine rocks, piers of bridges, outlines of sand banks, in fact, everything that is required under water. Should a pier of a bridge require to be examined, you have but to suit your camera, and you will obtain a sketch of the pier, with any dilapidations; and the engineer will thus obtain far better information than he could from any report made by a diver."

On the Application of Photography to the Copying of Ancient Manuscripts, &c. —Dr. Diamond, of England, in a recent communication, states, that he has turned his attention to this branch of the art for some years with perfect success, and recommends the following treatment as the result of his experience:—An old mixture of collodion originally made sensitive with a compound of iodide and bromide of ammonium is best; but any old collodion is to be preferred to newly mixed. A light object (such as the page of an ordinary book), half size, if a single lens is used with an ordinary diaphragm, is to be exposed about three minutes; full size, 12 or 15 minutes; a double combination lens takes only half the time, but should be much stopped with a diaphragm. The picture is to be developed as usual with a weak solution of pyrogallic acid freely dashed over the surface. After cleaning the picture *perfectly* from the hypo, a mixture should be passed over it composed of 2 drachms of bichloride of mercury and 2 drachms of chloride of ammonium dissolved in 10 oz. of common water. The picture now assumes a bluish tint. Wash it quickly and thoroughly, and pour over it at once a solution of hyposulphite of soda, five grains to the ounce of water. This produces a most intense black, and the negative, being washed and varnished, is finished and permanent. Dr. D. concludes by affirming that this process is applicable to the production of photographic copies not merely of MSS. on vellum and paper, but of engravings, medals, seals, oil paintings, and all similar objects.

Artificial Light for taking Photographs.—A very brilliant light has been produced by directing a stream of oxygen gas into the flame of coal gas which had been previously made to pass through cotton and naphtha in order to surcharge it with carbon. With this light, using a reflector, a photograph of an engraving could be taken by the camera in a very short time.

Transferring Collodion Photographs.—Alexander Rollasen, of Birmingham, England, has obtained a patent for an invention in photographs, the nature of which consists in transferring to paper, linen, ivory, wood, metal, or stone, collodion pictures taken on glass. The glass plate on which the picture is to be taken is first cleansed with spirits of wine, naphtha, and tripoli, and is finally buffed with buff leather, which has a slightly greasy surface. The glass is then covered with iodized collodion, or albumen, and is immersed in a bath of nitrate of silver, to render it sensitive. It is then placed on the camera, the picture taken in the ordinary manner, and afterwards developed by first washing in a solution of nitrate or acetate of iron, then with a solution of hyposulphate of soda. After being well washed in pure water it is dried. If the collodion be of a very adhesive quality it is sometimes necessary, before drying the picture, to immerse it for two or three seconds in a bath of dilute nitric acid. The picture thus taken is removed from the glass by transferring the film on which it is impressed. When it is perfectly dry it may be colored and tinted on the back, according to the taste of the artist, and then covered with varnish. If it is desired not to color the picture while on the glass it is covered at once with a varnish made of asphaltum dissolved in naphtha to about the consistency of cream. The varnish is now allowed to dry to a certain point, namely, when it does not seem sticky to the touch; but it is not allowed to dry further, lest it should crack. It is then coated with a thin solution of shellac, which prevents further hardening of the varnish. The next operation is to remove this film of collodion, with the picture on it, from the plate of glass. A thin mucilage, composed of two-thirds gum arabic and one of honey, is now laid on the varnish of the picture, and if the transfer is to be made on paper, it is damped first, and also coated with mucilage. The paper is now laid on the back of the picture, and both are laid flat on a table, and clamped between two pieces of wood. The surface of the paper is then rolled over with a small India rubber tube, to press out the air bubbles between the paper and glass. When the transfer is to be taken on wood or stone care must be taken that the surface is perfectly smooth, and the air bubbles may be driven out by commencing at one end, and laying the picture gradually down, from end to end. When the mucilage is dry enough—which may be ascertained by raising one corner of it—the film should begin to separate itself from the glass. When this is the case, its complete removal may now be effected. A few drops of water are now introduced with a feather between the glass and film, and gradually the picture separates from the glass to the paper. It can be transferred in the same manner on cloth. The surface of the picture is now gently touched up with fine varnish on a pellet of cotton wool, care being exercised not to injure the delicate surface. This varnish makes the surface slightly sticky to receive any of the dry colors for tints. When these are laid on, the transferred picture is complete.

Gutta Percha Photograph.—The following is a description of a new process recently patented by Mr. F. S. Archer, of London:—The negative picture is produced in the ordinary manner upon the collodion film on a sheet of glass, and it is fixed and dried in the ordinary manner; it is then dipped into a solution of gutta percha, and after draining off the excess it is dried by a gentle heat, and a nearly transparent film of gutta percha will be found upon the collodion. If the film is not sufficiently thick this operation is repeated one or more times until a sufficiently thick film of gutta percha is formed. The whole is next immersed in water, which causes the collodion to separate from the glass and come away with the film or sheet of gutta percha firmly adhering to it. These films or sheets are sufficiently transparent, and are tough and flexible, and may be handled without injury, when they may be preserved in a book or portfolio. The inventor employs these films for producing the positives in the same manner that the ordinary glass negatives are employed. They may be placed with either side in contact with the paper, according as it is wished to obtain a correct or a reversed picture. In producing the negative picture in the camera, the sheet of glass may be placed either with the collodion surface towards the object, or with the plain surface towards the object. In lieu of glass a smooth sheet of silver, or other metal or material which is not injuriously acted upon by the chemical agents employed, may be used. The solution of gutta percha should be made with a solvent like benzole, which evaporates with rapidity. The plate may be coated or covered with a film of gutta percha before applying the collodion, which is afterwards poured upon it in the ordinary manner. The picture is then to be produced and fixed, and washed and coated with the gutta percha, and removed from the plate, as described—thus a collodion film coated on both sides with gutta percha will be obtained. If the glass plate be covered with a stout film of gutta percha before pouring the collodion upon it, as above mentioned, the picture may afterwards be simply varnished with any suitable varnish instead of the gutta percha solution, and then removed from the plate mentioned.

Mayall's Photographic Ivory.—E. Mayall, of London, has obtained a patent for the application and use of a new material in photography, known by the name of "artificial ivory." This substance is formed of small tablets of gelatine or glue immersed in a bath of sulphate of alumina (alum) or the acetate of alumina. A combination takes place between the alumina and glue, and forms the substance for receiving the photographic pictures, as a substitute for the common metal plates and prepared paper. It is stated that it receives a polish equal to ivory, and the tints of the pictures have an exquisite softness, far surpassing those of the daguerreotype. The process for obtaining pictures is the same as that commonly pursued in photography.

The Oxymel Process in Photography.—This is the name given to a new process in photography, discovered by Prof. Delamotte, of King's College, London, and which is said to be the most important improvement in this branch of art which has been brought out since the discovery of the collodion process.

The new compound, called oxymel, consists of acetic acid 7 fluid ounces, distilled water 8 fluid ounces, and honey (despumated) 5 pounds.

"By the help of oxymel, all the beautiful delicacy of the finest collodion pictures may be obtained, with the convenience of the paper process, and with much more certainty and much greater ease. Tourists may take a dozen or two plates ready prepared, and during a week or a fortnight may expose them in the camera as they may require, and in the evening, or even in a day afterwards, may develope the pictures they have obtained at their convenience."

PHOTOGRAPHIC VIEW OF A PORTION OF THE MOON'S SURFACE.

M. Secchi, astronomer at Rome, has sent to the French Academy a photographic view of the part of the moon's surface in which stands the crater named *Copernicus*. The scale is about $\frac{1}{665,000}$. The photograph was not taken direct from the moon, but from a design executed with great care on a somewhat larger scale, and having for its base a micrometric triangulation of the principal points of the area. The details were brought out with a lens magnifying 760 to 1000 times: the work, seemingly easy, was attended with great difficulties, on account of the change in the shadows with every hour, the moon's libration and change of distance. To avoid all these difficulties a general sketch was first made under the most favorable light and view for marking out the crater, such as is ordinarily had when the moon is ten days old. After this, the details were separately made out, and then all were combined in their true relations, so as to make the complete sketch. The result thus reached was corrected by several examinations made from the first point of view. A professed draughtsman was occupied with the work during seven consecutive lunations, without counting the time employed previously in practising preparatory to the work.

As the drawing was intended to represent the great central crater, the area around is not yet filled with all the details that may be introduced. After completing the design with every possible care, M. Secchi has had copies taken by photography, one of which he has sent to the Academy. The crater or annular mountain has two circular walls. The outer, which is the lowest, has a diameter of about 48 seconds (one second corresponds to 1·820 meters); the inner, the true border of the crater, has a mean diameter of 38 seconds, and has a peak, somewhat elevated, on its western side. The inner area is 20 seconds across. The interior has a steep escarpment around, and a triple circuit of broken rocks and a great number of large masses piled up at the foot of the escarpment, as if they had fallen from above. There are two great depressions in the north and south borders of the crater; and it is remarkable that in the direction of this line, outside, both north and south, there are some small craters.

After having established the perfect resemblance which exists between the volcanic mountains of the environs of Rome and the lunar mountains (comparing with the chart of the Roman territory made by the French officers),

M. Secchi adds, "The question whether volcanic action in the moon is actually extinct, can be answered only after there shall have been made a map of the moon's surface for a given period with the utmost accuracy and on a large scale." It is to help onward this project, that he has undertaken the work above described.

IMPROVED METHODS OF ENGRAVING.

The following are the details of a discovery by M. Devincenzi, of Paris, as communicated by him to the French Institute, which it is thought may to a considerable extent supersede wood, lithographic, and copper-plate engraving:—

Electrography has for its principal object to convert into an engraving in relief all drawings made with a greasy, a bituminous, or a resinous body upon a metallic plate. Amongst all metals, zinc is the most proper for this kind of engraving, and its low price renders it still more desirable. The kind employed is the laminated zinc of commerce, the surface of which is grained with sifted sand, in the same manner as the stones are grained in lithography. You may draw on these plates, either with a crayon, with lithographic ink, or with any other substance employed in lithography. The plate, once drawn upon, is then prepared in the same way as if it were intended to be used for a lithographic impression; indeed, zinc plates have often been employed instead of stones, and it is to Senefelder himself, the inventor of the lithographic art, that this application is due. The effect of the preparation is:—First, to render the crayon or drawing ink insoluble in water, and to fix them on the plate; and next, to change the affinity of the metal. Zinc, in its natural state, has a great affinity for greasy substances, and for this very reason can be easily drawn upon. But once prepared, this affinity is altered: after the preparation the zinc has a greater affinity for gum and water than for greasy substances. The slightest humidity on its surface suffices to repel the latter. I give this preparation to the zinc plate by plunging it for a minute into a simple decoction of gall nut, and afterwards wash the plate with clear water, and then cover it again with a solution of gum arabic. The decoction of gall nut is made with the gall broken into good sized lumps, in the proportion of 125 *grammes* (something less than $\frac{1}{4}$ lb.) in a *litre* (about $1\frac{3}{4}$ pint), reduced by boiling to half the quantity. The zinc plates, which are used in lithographic fashion, are generally prepared with the same decoction of gall nut; but, in imitating the preparation of the stones, nitric acid is added, and often hydrochloric acid. These acids I entirely do away with. It is known how delicate the operation is of preparing stones for lithography, on account of these acids, for the preparation very often injures the half tints by the action which the acids exercise both on the ink and the stone. On the other hand, the simple decoction of the gall nut, while it makes an excellent preparation, exercises no ulterior action either upon the drawing or the plate. This experiment may be safely repeated. After the drawing is made with lithographic chalk or ink upon a zinc plate, the latter may be left for hours or even days in the gall nut decoction without any alteration being produced either in the lines or the surface of the plate. In lithography, on the contrary, by prolonging the acidulation, both the drawing and the surface of the stone are destroyed. The unalterability of the drawing by the preparation is a very remarkable feature in this species of engraving, for after its application the drawing remains exactly the same as when it came from the artist's hand. The plate thus prepared with the gall nut decoction and afterwards gummed, is then immediately cleared of the gum with water, and I wash the drawing with essence of turpentine. In this state, scarcely anything is visible on the plate; but every part of the drawing has a strong affinity for greasy substances, and all the other parts of the plate repel them. If one wished to print lithographically, it would be sufficient to damp the plate and pass a roller over it charged with printing ink, in order to obtain proofs. By my process of engraving, instead of printing ink, I apply in the same manner, by means of a roller, a varnish which, on account of the different affinities of the plate, perfectly replaces the chalk or draughtsman's ink, and is as easily applied as printing ink upon a lithographic drawing, and it takes up no more time to lay on the varnish than to pull a lithographic proof. This varnish is composed of asphaltum, of linseed oil boiled with *litharge*, and of essence of turpentine. When the varnish is dry, the plate of zinc is placed in metallic connexion with a copper plate of equal size. Over the plate which has the drawing a very weak solution of sulphuric acid is passed with a brush in order to cleanse it, and the two plates are then plunged horizontally and facing each other, at a distance of five *millimètres* (somewhere about $\frac{1}{4}$ inch), into a solution of sulphate of copper of fifteen degrees. The sulphuric acid from the decomposition of the sulphate of copper dissolves all the parts of the zinc plates which are not covered by the varnish, and this substance not being decomposed by contact with the sulphate of copper, does not experience the least alteration. On account of the great affinity which the sulphuric acid has for the zinc, in comparison with the slight affinity which it has for the copper, the employment of this salt and the approximation of the plates give rise to a very energetic electro-chemical action, and at the end of a few minutes the plate is engraved. During the operation the zinc plate is frequently withdrawn and washed with pure water, in order to get rid of the parts of the sulphate of zinc and of metallic copper which adhere to its surface. To prove the unalterability of my varnish, you may make a drawing on a porcelain plate and fill it with the solution of the sulphate of copper: the drawing will undergo no change. The voltaic pile has for some time been employed to engrave on copper, but no one before I made the experiment has attempted relief-engraving by electro-chemical means. Nevertheless, it has often been observed that by the aid of electricity very deep lines could be cut in copper plates without widening the strokes,—for while the chemical action alone bites on all sides, an energetic electro-chemical action only takes effect on the depth. This superiority of galvanic electricity over the simple action of acids renders possible that kind of engraving in relief which requires great depth."

After recognising the assistance rendered to this new invention by the processes of lithography and the science of electro-metallurgy, M. Devincenzi goes on to illustrate its importance. This is chiefly shown by the facilities which it offers for producing, like ordinary types, an almost unlimited number of impressions. M. Devincenzi observes that lithographic presses and copper plates throw off variously two, three, four, or five hundred copies in a day: with his electrographic plates he has hitherto not attempted to produce more than three thousand within the same space, but considering the properties of zinc, and analogous facts, he is of opinion that any number of copies could be printed. Zinc, he says, is as hard as copper, and with copper stereotypes millions of impressions may be struck off, nor is there any reason for supposing that zinc stereotypes would prove less serviceable. In its relation to wood engraving, M. Devincenzi demonstrates a manifest advantage on the side of electrography, as regards the more direct application of the latter. In the art of xylography recourse is had both to the engraver and the draughtsman. In electrography the work of the draughtsman is not more difficult, while that of the engraver disappears, and the extraordinary degree of perfection which can be obtained, together with the surprising celerity with which it can meet the various exigencies of the moment, cannot fail to add to its importance. Finally, electrography offers precisely the same facilities in its execution as lithography, and exceeds it illimitably in its power of production; and, comparing it with line engraving, electrography has all the advantages of a far more facile execution, of a greater variety of style, resulting from the use of crayons, of a typographical use of the press, and of a faithful reproduction of the artist's labor.

We append to this notice of M. Devincenzi's invention, an extract from the Report made by the Committee appointed by the Academy of Sciences to inquire into its merits, and test its practicability:—

"The process of engraving in relief, of which we now report, fulfils the object proposed by M. Devincenzi,—that of superseding engraving on wood by engraving on zinc. In the former, a draughtsman and an engraver are necessary; in the latter, a draughtsman only. In comparing this process with that of lithography, either on stone or zinc, we find this great advantage—that the printing by electrography is very considerable as to numbers, and costs very little, while the other mode is very limited and dear."

Engraving by Light and Electricity.—M. Pretsch, late manager of the Imperial Printing Office at Vienna, in a recent paper read before the Society of Arts, London, described a process, by which he obtains, on a glass or other plate, covered with glutinous substances, mixed with photographic materials, a raised or sunk design, which may be copied by the electrotype process so as to produce plates for printing purposes. His process is based on the action of light on a film of glue mixed with bichromate of potash, nitrate of silver, and iodide of potassium. After exposure, the plate is washed with water, a solution of borax, or carbonate of soda. The image then comes out in relief. When the image is thus sufficiently developed, the plate is washed with spirits of wine, then covered with copal varnish, which is afterwards removed with spirits of turpentine, and then the plate is immersed in a weak solution of tannin. It is then ready for copying by the electrotype process. A sunk design is produced by a slight warmth being used after washing with the spirits of wine.

PAINTING WITH BOTH HANDS.

The above is the title of a work recently published in England, by John Lone. Its design will appear from the following extract from its pages:—

"It is clear, from the approaches to perfection which all great artists have made, that they have so managed their lines, as to involve to a certain extent both the lines of binocular pictures. It is possibly connected with this reason, that straight, sharp, and manifestly single lines have no place in works of art; but breaks, compromises, and indeterminateness, run like a gauze before a picture, and set the imagination free to realize more than the eye has fairly before it. Thus, within certain limits, the least determinate artists, as, for example, Turner, are the nearest to suggesting the verity of natural things, simply because they are the nearest to the double lines of nature. The solution which I have to offer, is comprised in the position, that *ambidextrous or two-handed painting will realize in art also, binocular or two-eyed pictures:* that pictures painted with both eyes, or what is the same thing, both hands, will at length repose upon the basis of a complete physiological truth. Drawings and paintings hitherto, as the productions of man's right hand (and the same remark applies to a large part of the manual arts), have been produced from right to left. But the stereoscope shows that the mode whereby nature imprints her pictures on the brain of two-eyed persons, is by the double or decussating method; by one picture proceeding from right to left, married to another picture proceeding from left to right. It is, however, perhaps impossible that any artist should follow out this way literally, by painting two pictures of a scene, each true for one of the eyes; and then uniting them by means of an instrument like the stereoscope. Nor does it seem at all probable that the stereoscopic plan is the only one by which the natural decussation can be produced. At all events, the ambidextrous method of producing pictures deserves a trial, as tending to realize artistically the same end."

EFFECTS OF COLOR ON HEALTH.

From several years' observation in rooms of various sizes, used as manufacturing rooms, and occupied by females for twelve hours per day, I found that the workers who occupied those rooms which had large windows with large panes of glass in the four sides of the room, so that the sun's rays penetrated through the room during the whole day, were much more healthy than the workers who occupied rooms lighted from one side only, or rooms lighted through very small panes of glass. I observed another very singular fact, viz. that the workers who occupied one room were very cheerful and healthy, while the occupiers of another similar room, who were employed on the same kind of work, were all inclined to melancholy and complained of pain in the forehead and eyes, and were often ill and unable to work. Upon examining the rooms in question I found they were both equally well ventilated and lighted. I could not discover anything about the drainage of the premises that could affect the one room more than the other; but I observed that the room occupied by the cheerful workers was wholly whitewashed, and the room occupied by the melancholy workers was colored with yellow ochre. I had the yellow ochre washed off and the walls and ceilings whitewashed. The workers ever after felt more cheerful and healthy. After making this discovery, I extended my observations to a number of smaller rooms and garrets, and found, without exception, that the occupiers of the white rooms were much more healthy than the occupiers of the yellow or buff colored rooms, and wherever I succeeded in inducing the occupiers of the yellow rooms to change the color for whitewash, I always found a corresponding improvement in the health and spirits of the occupiers.—*Correspondent of the London Builder.*

THE PERCEPTION OF COLORS IN PICTURES.

Every one knows that, owing to the peculiar relation that colors have to each other, it is difficult, in arranging a selection of pictures, to prevent them injuring one another: but the fact is not "so generally familiar, that the impression produced by a color upon the eyes does not cease immediately the eye is removed from the color."

Mr. Sydney Smirke, A.R.A., has recently addressed a letter to Sir Charles L. Eastlake, P.R.A., directing attention to this circumstance, and suggesting a remedy. "Let any one," says Mr. Smirke, "who wishes to receive a full measure of enjoyment in a picture gallery, hold in his hand a *tablet painted of a neutral tint*, on which to rest his eyes as he passes from one picture to another. Has his eye become inebriated by some florid colorist? A draught of the neutral tint on his tablet will sober it down, and bring it to the full use of its senses. Has he been contemplating a glowing Italian sunset, 'A Masquerade at Naples?' A glance at his tablet will prepare him for the next picture, perhaps 'A Mist in the Highlands.' By means of this tablet, his eye becomes, on each occasion, a *tabula rasa*—a cleansed palette, prepared to meet a fresh assortment of colors. Its discriminating powers are restored; its bias corrected; and thus each picture will stand on its own merits, unimpaired by the disturbing effects produced by the impression left behind by the subject of the spectator's previous examination. A late eminent medical writer on cookery recommended that a saline or other appropriate draught should be administered to the cook on the eve of a banquet, so that his or her taste might be purified and rendered so sensitive as to secure to each *entrée* and condiment the exact flavor that shall best recommend it to the fastidious gastronomer. Very analogous to this would be the operation of the proposed tablet upon the powers of the eye; it would 'purge the visual ray,' and so fit it to discern and appreciate the niceties of the colorist."

In the case of landscapes, where it is desired that the eye should appreciate tints of green, the water suggests that the reverse of the tablet—a blank page in the catalogue, for example, where there is one—should be colored with a deep pure, but not bright *red.* Let the eye absorb a dose from this side before it contemplates a landscape, and it will be at once found to have been brought into a right condition for duly appreciating the artist's labor.

IMPROVEMENT IN LIGHT HOUSES.

The following is an abstract of a paper upon the above subject recently read before the Society of Civil Engineers (Eng.) by Mr. Herbert:—

The floating sea-marks, as ordinarily constructed, labored under these several defects—of riding uneasily on the waves, of being frequently submerged, and also of being carried away from the mooring chain being broken, not an uncommon occurrence in heavy weather. To obviate these defects a wrought iron pear-shaped buoy was proposed, of a circular form in plan, the centre of gravity being placed a little below the water floating line; the bottom was made concave, being indented internally in the form of a cone, to the apex of which the mooring chain was attached. An experiment made with one nine feet in height, six feet six inches in diameter, and submerged to the extent of two feet, presented under all circumstances of wind and tide an upright body seven feet out of the water; the power of retaining a vertical position arose from the tide or wave acting simultaneously, and with almost equal force, on the exterior of the buoy and the interior of the cone. It is now proposed to have floating light houses upon this principle of construction. The security of such light towers would of course depend upon the moorings. Now, from observations made at Bishop's Rock, the most westerly of the Scilly group, it was ascertained that of waves measured from the hollow to the unbroken crest those which had a height of 8 feet were in number thirty-five in one mile, and eight per minute; of 15 feet, five or six in a mile, and five per minute; of 20 feet, three in one mile, and four per minute; and it was calculated that, with moorings sufficiently strong, neither the pressure of the wind nor the action of the waves would cause any inconvenience upon any sea light tower on this construction. The present light houses could be placed only to act as warning points to mariners, whereas these sea light towers might be advantageously employed as "guiding" or "fair way" lights. Of course these beacons could be placed in almost any and every position, and would thus "form a new era in the system of lighting, at once double the safety of navigation, and be the means of saving many valuable lives." There was also this very important consideration, as contrasted with light houses, that the expense was very materially less, and the time required for construction and mooring would be very much lessened. For instance, the light house on the Skerry-vore Rock occupied seven years in building, and cost upwards of £90,000; whereas, by means of the sea light tower, the same object might be accomplished, in one year, at a cost of £30,000. These new forms would also possess the advantage of being accessible in all weathers. If this principle of construction proves to be correct, it would be evidently applicable for floating forts, and to almost every other description of stationary floating bodies.

One of the most brilliant results of the World's Fair at London, was a book upon it, by Charles Babbage. Among the chapters of that work is one devoted to light houses and their improvement, and containing the general principles and many details of a most admirable system for distinguishing lights by causing them to show their numbers by rapid eclipses and flashes of light. Any digit may be expressed by an equivalent number of occultations and restorations of the light; thus, one eclipse and one restoration would stand for the number one. The value of the digit, whether belonging to the units, tens, or hundreds' place, might be indicated by occultations preceded by shorter or longer intervals of light, as three occultations at intervals of a second would express three units, then a pause of several, say three seconds, then five occultations, would express five in the tens' place, then a pause of say three seconds and two occultations would express the hundreds, then a longer pause of say ten seconds, would show that the number was complete. Thus the number of a light house might be repeated more than once in a minute, even where the figures are quite high, and each light house would continue the repetition of its own number. Such lights can be seen at least as far as others which are not temporarily obscured, and by arranging the numbers of the light houses along a coast, upon such a system, that the adjacent lights shall have very different numbers, the figures representing units, tens, and hundreds of the number not recurring in the adjacent lights, the distinctions can practically be made very complete. For the world-wide purpose of its inventor, but three digits are required. The mariner who approaches Sandy Hook, for example, would see constantly repeated number *one*, a flash for a second, darkness for three. Let his pulse beat ever so irregularly from toil and anxiety, he could discern by it infallibly, that the dark interval was three, the light *one*, and thus that this was the cynosure to lead him to the haven whence he would be. Nor could he mistake Fire Island light for that at Sandy Hook, for it would signal twenty-two, first two, next two—but never *one*.—*Prof. Bache, Address before the American Institute*, 1856.

NEW METHOD OF DETERMINING THE DENSITY OF THE EARTH.

At the Albany Meeting of the American Association, Prof. Alexander remarked that the celebrated experiment of determining the density of the earth by the deflection of a plumb line near a mountain, was open to many objections, arising from the imperfections of the measurement of the density of the mountain, and of the deflection of the line; and proposed the reverse of Mohamed's doctrine, instead of carrying the plumb line to the mountain, he would bring a mountain to the plumb line. He would build up by the side of a plumb bob, on which bob he would attach the most delicate spirit levels, a mass of lead or iron, in the form of a sphere twenty-five or thirty feet in diameter, and observe the change of the spirit levels.

Dr. Gould observed that this method was not equal to that of Cavendish, since the torsion balance is a more delicate test of minute forces, such as the attraction of the artificial mountain, than a spirit level can be. He also repeated the suggestion of Weber, that the Gaussian mirror be used, by which a radius of unlimited length may be obtained.

Prof. Bartlett thought there was a more fundamental objection to Prof. Alexander's method; that the spirit level would only show its own level surface, and that would be the resultant of the combined action of the earth and the artificial mountain.

Mr. Vaughan proposed to use the tide-water in the Bay of Fundy as the movable mountain.

Prof. Henry said this had already been suggested, and added that this delicate problem of the density of the earth was under investigation by the Smithsonian Institution.

NEW APPARATUS FOR TAKING SPECIFIC GRAVITY.

Messrs. Eckfeldt and Dubois, of the Philadelphia mint, have described the following new method of obtaining specific gravities:—The apparatus for taking the specific gravity of solids, is essentially a tin cup with a spout at the side. Five vessels are here shown, of different sizes and shapes, to suit different cases. Four of these are cylindrical, ranging from six to ten inches high, and from two to five inches in diameter. The tall one (ten inches by two) is intended for the trial of silver spoons and forks, or articles of similar shape; the others are adapted to lumps of stone or metal, or blocks of wood, of various sizes. The fifth vessel is rectangular, measuring 6½ inches high, 1¾ inches long, and ¼ inch broad, being intended for coins, not smaller than the half eagle or quarter dollar, and for small medals and gems of admissible size. This vessel is provided with a brass plate, as a *plunger*, for diminishing the surface. The smaller vessels are set firmly in mahogany blocks, to insure steadiness in the operation; and these blocks have screw feet, for convenience of levelling. The spouts extend upward, with a curve outward, the beak being far enough below the top of the cup to allow for the space to be taken up by the specimen, that it may not force the water over the top, nor leave any point uncovered by water. The aperture of the spout is tapered to the one-sixteenth of an inch, and a small bit of wire projects downwards from the beak, to carry the drops of water properly. A small cup is placed directly under, to catch the water displaced, and a brass weight, equal to the weight of this cup when empty, is found convenient (though not necessary) as a counter-weight.

When the operation is to be performed, suppose upon a gold or silver ore, the ore is first weighed, and afterwards its surface is moistened. The vessel is then nearly filled with water, and so much as is superfluous, or above the level of the beak of the spout, runs or drips off, to a final drop. The small cup is then set under the beak, and the lump is carefully lowered into the vessel by a hair wire or waxed thread. This, of course, displaces its own bulk of water, which runs off into the small cup, gradually coming back to the former level, by a final drop. The weight of this water is the divisor, the weight of the lump the dividend, and the quotient is the specific gravity.

ACTION OF WAVES ON SEA BEACHES.

An attentive examination of the accumulative and destructive action of the waves upon shingle beaches has produced a rule, so far as one can be formed upon this subject. It has been observed that when seven, or any less number of waves fall upon the shore per minute, that then a destructive action is going on—or, in other words, that the shingle is disappearing. But that when nine or any greater number of waves beat upon the shore in the same time, then an accumulative action is going on, or the beach is increasing. This rule, however, must be received with caution, for it has been remarked that shingle generally accumulates with off-shore winds, and is scoured off during on-shore winds, and we believe that, however acute and scientific observations may be conducted upon the action of the sea at particular localities, it would not be prudent to receive such conclusions as applicable to beaches in general. There was an instance of this last winter, when a heavy ground-swell, brought on by a gale of five hours' duration, scoured away, in fourteen hours, three million nine hundred thousand tons of pebbles from the coast near Dover, England. But in three days, without any shift of wind, upwards of three million tons were thrown back again. It should be mentioned that these figures are, to a certain extent, conjectural, but they approximate to the truth; the quantities having been derived from careful measurement of the profile of the beach.

ON THE GREAT OCEAN CURRENT OF THE PACIFIC.

Lieut. Bent, of the U. S. Navy, recently read a paper before the Geographical and Statistical Society of New York, of which the following is an abstract, upon the great ocean current of the Pacific, corresponding with the Gulf Stream of the Atlantic. The Japanese have known it for many years, and call it the Kurosino or Black stream, from its dark blue color compared with that of the adjacent ocean:—

The fountain from which this stream springs is the great equatorial current of the Pacific, which in magnitude is in proportion to the vast extent of that ocean, when compared with the Atlantic.

Extending from the tropic of Cancer, on the north, to Capricorn, in all probability, on the south, it has a width of nearly three thousand miles. With a velocity of from twenty to sixty miles per day, it sweeps to the westward in uninterrupted grandeur around three-eighths of the circumference of the globe, until diverted by the continent of Asia, and split into innumerable streams by the Polynesian Islands, it spreads the genial influence of its warmth over regions of the earth, some of which, now teeming in prolific abundance, would otherwise be but barren wastes.

One of the most remarkable of these offshoots is the Kuro-Siwo, or Japan Stream, which, separated from the parent country by the Bashee Islands and south end of Formosa, in lat. 22° north, long. 122 east, is deflected to the northward along the east coast of Formosa, where its strength and character are as decidedly marked as those of the Gulf Stream on the coast of Florida. This northwardly course continues to the parallel of 26° north, when it bears off to the northward and eastward, washing the whole southeast coast of Japan as far as the Straits of Sangar, and increasing in strength as it advances, until reaching the chain of islands to the southward of the Gulf of Yedo, where its maximum velocity, as shown by our observations, is 80 miles per day.

Its average strength from the south end of Formosa to the Straits of Sangar is found to be from 35 to 40 miles per twenty-four hours at all seasons that we traversed it.

Near its origin the Kuro-Siwo, like the Gulf Stream, is contracted, and is usually confined between Formosa and the Majico-Sima Islands, with a width of 100 miles. But to the northward of this group it rapidly expands on its southern limit, and reaches the Lew-Chew and Bonin Islands, giving it a width to the northward of the latter of about 500 miles.

To the eastward of the meridian of 143° east, in latitude 40° north, the stream takes a more easterly direction, allowing a cold current to intervene between it and the southern coast of Yesse, where the thermal change in the water is from 16° to 20°; but from the harassing prevalence of fogs during our limited stay in that vicinity, it was impossible to make such observations or experiments as to prove conclusively the predominant direction of this cold current through the Straits of Sangar, particularly as the tide ebbs and flows through them with great rapidity. Yet, from what we have, I am inclined to believe that it is a current from the Arctic ocean running counter to the Kuro-Siwo, and which passes to the westward through the Straits of Sangar, down through the Japan Sea, between Corea and the Japanese Islands, and feeds the hyperborean current on the east coast of China, which flows to the southward through the Formosa Channel into the China Sea. For to the westward of a line connecting the north end of Formosa and the south-western extremity of Japan there is no flow of tropical waters to the northward, but, on the contrary, a cold counter current filling the space between the Kuro-Siwo and the coast of China, as is distinctly shown by our observations. As far as this cold water extends off the coast, the soundings are regular and increase gradually in depth, but simultaneously with the increase of temperature in the water the plummet falls into a trough similar to the bed of the Gulf Stream, as ascertained by the United States Coast Survey.

The influence of the Kuro-Siwo upon the climate of Japan and the west coast of North America, is, as might be expected, as striking as that of the Gulf Stream on the coasts bordering the North Atlantic. From the insular position of Japan, with the intervening sea between it and the continent of Asia, it has a more equable climate than we enjoy in the United States; and since the counter current of the Kuro-Siwo does not make its appearance on the eastern shores of the islands, south of the Straits of Sangar, and as these islands, in their geographical position, have a more eastwardly direction than our coast, the Kuro-Siwo, unlike the Gulf Stream, sweeps close along this shore, giving a milder climate to that portion of the empire than is enjoyed in corresponding latitudes in the United States.

The softening influence of the Kuro-Siwo is felt on the coasts of Oregon and California, but in a less degree, perhaps, than that of the Gulf Stream on the coasts of Europe, owing to the greater width of the Pacific Ocean over the Atlantic. Still, the winters are so mild in Puget's Sound, in latitude 48° north, that snow rarely falls there, and the inhabitants are never enabled to fill their ice houses for the summer; and vessels trading to Petropaulowski and the coast of Kamtskatka, when becoming unwieldy from accumulation of ice on their hulls and rigging, run over to a higher latitude on the American coast and thaw out, in the same manner that vessels frozen up on our own coast, retreat again into the Gulf Stream, until favored by an easterly wind.

HINTS ON VENTILATION.

Why do we want ventilation? Why do we want fresh air? Why do we want to take in oxygen? And why do we want to get rid of carbonic acid? Shortly, we want oxygen because of its chemical energy—it is the main spring of our life. On it the production of animal heat depends, and the vital powers—sensation and motion, no less than nutrition and secretion, are directly influenced by its action.

Why do we want to get rid of surrounding carbonic acid? Literally, because the carbonic acid stops the way, and prevents the escape of newly formed carbonic acid from within. If we were placed in an atmosphere containing as much carbonic acid as exists in the lungs, the carbonic acid of the atmosphere would not pass from the lungs to the blood and act as a poison, but that carbonic acid which was passing out from the blood would stop in the lungs and prevent more from escaping out of the blood, and that carbonic acid which was formed in the body would act as a narcotic poison. From experiments on animals, it appears that the air must contain 20 per cent. of carbonic acid before absorption of that gas by the blood is observed. Moreover, the escape of gases from the blood affects the circulation of the blood. In sudden death from suffocation, the side of the heart which throws the blood to the lungs is found distended, whilst the side which throws the blood from the heart is empty; there has been obstruction in the flow. By stopping respiration and causing pressure we can stop the pulse and the heart's sounds and impulse when we please. This is more the result of pressure than of any arrest of escape of carbonic acid, and is a striking evidence how suddenly the action of the heart may be influenced by the respiration. When the escape of carbonic acid from the blood is retarded or prevented, the want of ventilation of the blood causes more or less stoppage of the blood in the vessels, and makes the blood a narcotic poison to all the tissues with which it is in contact. We may consider oxygen as our most necessary food, and carbonic acid as the refuse which passes into our sewers. We all fully believe that a house badly drained causes disease and death, but will scarcely admit to ourselves that a house or body without good means of ventilation is a house or body badly drained. At present our chimneys are our chief aërial drains, which almost cease to act as soon as the temperature outside and inside the house is the same; and even when these drains are in action, we are unwilling to think that that fire which ministers to our warmth, like most contrivances for doing two things at once, does neither well.—*From a Paper read by H. Bence Jones, M. D., before the Royal Institution of England, April* 18, 1856.

SELF-REGISTERING ANEMOMETER.

Mr. Welsh, Superintendent of the Kew Observatory, exhibited and described to the British Association a model of a self-registering anemometer, invented by Mr. Beckley. In this Mr. B. has adopted Dr. Robinson's method of measuring the velocity of the wind by the rotation of a system of hemispherical cups, the direction being indicated by a double wheel fan like the directing vane at the back of a windmill. A stout tubular support carries the whole of the external part of the instrument, including the measurer of velocity, the direction vane, and a rain gauge. This support is so made that it can be easily adapted to the roof of any building upon which it may be necessary to mount it. All the rotary parts of the anemometer run upon friction balls. The shaft of the apparatus for measuring the movement of the wind, by means of a diminishing train of wheels, is made to turn a cylinder upon which is wrapped a sheet of paper of the kind used for "metallic memorandum books," this paper having the property of receiving a trace from a style of brass. The sheet of paper is divided into two sections, upon one of which is recorded the motion of the wind and upon the other the direction. As the cylinder is being turned by the action of the wind a clock carries a pencil along the cylinder at a uniform rate of 12 inches in the 24 hours. To the lower end of the direction shaft is attached a spiral of such a figure that equal angles correspond to equal increments of radius; the edge of this spiral consists of a thin slip of brass which touches the paper and records the direction of the wind on a rectilinear scale. When the sheet of paper is unwrapped from the cylinder after 24 hours, the motion of the wind and the direction are both found projected in rectangular co-ordinates.

TO ASCERTAIN THE DIRECTION OF THE WIND.

Mr. T. Stevenson has communicated to the *Edinburgh New Philosophical Journal*, the following accurate and easily applied method of ascertaining the direction of the wind, by observing the reflected image of the clouds:—

In making some experiments, in which it was necessary to know accurately the direction of the wind, Mr. Stevenson was much annoyed by the insufficiency of vanes and all ordinary methods employed for that purpose. The under currents of air are so numerous and conflicting, more especially in towns, where the houses are lofty, that the author has seen it proclaimed to be due east at one end of the street, while at the other it seemed with equal certainty to be coming in a westerly direction.

In this dilemma, it occurred to him that a more accurate conclusion might be arrived at, by observing the direction of the drifting clouds when reflected in a mirror. At first, Mr. Stevenson used a common mirror, placed horizontally, so as to have the sky reflected in it; and having fixed upon a cloud, he watched its progress in the mirror, taking care to keep the eye steadily in one position, and carefully marking the track of the cloud upon the glass with a pencil of soap. When this was done, it was easy, by placing a compass on the mirror, to ascertain the direction of the wind from that of the cloud's path traced on the glass. A more convenient and portable instrument has since been constructed, consisting of an ordinary compass having a silvered disc in the centre of its covering glass of such a size as to allow the points of the needle and the graduated circle of the compass to be seen beyond it. The glass has cross lines cut upon it, passing through the centre, and drawn so as to correspond with the cardinal points marked on the divided circle. The whole compass can be made to revolve in the horizontal plane, upon a point projecting from the bottom of the outer case. When the cloud which is to be observed has been selected, as near the zenith of the observer as possible, the compass should be gradually turned round until one of the lines upon the glass remains coincident with one well-defined edge of the cloud as it passes across the field of view. The angle indicated by the magnetic needle being then read off, the azimuthal bearing of the cloud's track from the magnetic north is at once ascertained. The convenience of this instrument might be increased by having an eye-piece attached to it, capable of being fixed in such a manner as to point to the intersection of the cross lines in the centre of the circle, so that the eye may be kept steadily in the same direction. By means of an apparatus on the principle of a camera obscura, the direction of the wind could be easily ascertained by observing the compass bearing of the cloud's track. And, in the absence of better instruments, the reflection by a mirror ought certainly in all cases to be preferred to the indication of vanes, whose action must always be vitiated more or less by friction, and perhaps by other causes, besides being liable to be acted upon by currents which have been distorted from their true direction by obstructions due to houses, trees, and the configuration of the earth's surface. The changes of wind and weather so characteristic of our climate, might, perhaps, be more certainly or more speedily predicted by comparing the motions of the clouds in the higher regions of the atmosphere, with those nearer the earth's surface, than from information derived from other sources. Mr. Stevenson has observed a change of wind apparent in the direction of the high clouds for two days before the currents near the earth's surface were affected, although they ultimately assumed the same direction.

IMPERFECTIONS OF THE ANEROID BAROMETER.

Prof. Guyot, at the last meeting of the American Association, in a communication on the Aneroid, freely acknowledged its great conveniences, but he entered his formal protest against dependence on it for nice measurements of mountain altitudes. The instruments are all individuals, their errors subject to no rule except that of great variability. He had made many experiments and comparisons with good mercurial barometers, and found it worthy of reliance as a scientific instrument, only under the condition that it is kept stationary, and individually tested to learn the corrections for temperature, &c. Had he trusted to his aneroid barometer in a recent visit to the Black Mountains, he would have been led to errors of 400 to 500 feet, as was proved by the two good mercurial barometers that he carried. A traveller who carries an aneroid alone with him, must not expect accuracy within two or three hundred feet. Simply from motion or from having been subjected to great changes of pressure, it will change its zero without giving any external indication.

ON THE SIMILARITY OF FORM IN SNOW AND CAMPHOR UNDER CERTAIN CONDITIONS OF CRYSTALLIZATION.

Mr. Glaisher, in a recent paper before the London Meteorological Society, stated that Mr. Spencer had endeavored to observe snow crystals, but, from their perishable nature, he has experienced a great difficulty, as they require to be maintained at a temperature below 32° of Fahrenheit's thermometer. Mr. Spencer became desirous, in the study of snow crystals, to find some substance similar in its habits of crystallization, but of a less perishable nature, and which would enable us to trace the progress of the crystals from the simplest up to the most complicated forms, so that, reasoning by analogy, we might be able to throw some light on the subject. Camphor crystallized slowly does not wholly assume the form of hexagonal crystals; but, like snow or ice, takes the arborescent form, very similar to the fronds of ferns; but does so when the process is quick. The most convenient way to repeat the experiment on camphor is, to make a solution of this substance in alcohol, and add thereto some water of ammonia. The field of inquiry thus opened by Mr. Spencer has since engaged a portion of the author's attention. The process of crystallization appears to proceed rapidly, and to commence simultaneously with the action of the air upon the liquid, but to be by no means certain of proceeding similarly under apparently similar conditions. The process of its crystallization bears the closest analogy to that of snow, and the one of most frequent occurrence presents an endless succession of little dots passing to and fro with the restless movements of animalcula; every instant these globules very perceptibly increase in size, and develop points, generally six in number, which continue to enlarge until they assume the character of arborescent pinnæ, the addition of the elementary figure being effected at an angle of 60°. The crystal, when arrived at perfection, immediately begins to simplify, and continues to do so till it is evaporated. One main difference between these figures and those of snow is, that they exhibit an entire want of angularity, and only approximate, even when at their greatest perfection, to the snow crystal just as it appears before finally dissolving. The author observed that sometimes the figures were octagonal, and at times, when few were present, many would be double, for they share in this respect a peculiarity of the snow crystal, but differ in their being united by a point of contact common to the two, instead of being united by a slender axis, as in the crystals of snow. The author concluded by observing, that these bodies chiefly resemble the crystals of snow in their hexagonal star shape and in the arborescent form of their pinnæ. If not, however, intimately allied, it is interesting to observe and compare the manner of their change; and a continuation of these observations, varied by experiments and the employment of other solutions, may yet give increased information on a subject which, as Mr. Spencer remarks, is of peculiar interest, as uniting the confines of meteorology and chemistry.

NUMBERS IN NATURE.

Physical science shows that numbers have a significancy in every department of nature. *Two* appears as the typical number in the lowest class of plants, and regulates that pairing or marriage of plants and animals which is one of the fundamental laws of the organic kingdoms. *Three* is the characteristic number of that class of plants which has parallel veined leaves, and is the number of joints in the typical digit. *Four* is the significant number of those beautiful crystals which show that minerals (as well as stars) have their geometry. *Five* is the model number of the highest class of plants, those with reticulated veins and branches, is the typical number of the fingers and toes of vertebrate animals, and is of frequent occurrence among star-fishes. *Six* is the proportional number of carbon in chemistry, and 3 × 2 is a common number in the floral organs of monocotyledonous plants, such as the lilies of the field, which we are exhorted to consider. *Seven* appears as significant only in a single order of plants (Heptandria), but has an importance in the animal kingdom, where it is the number of vertebræ in the neck of mammalia, and, according to Mr. Edwards, the typical number of rings in the head, in the thorax, and in the abdomen of crustacea. *Eight* is the definite number in chemical composition for oxygen, the most universal element in nature, and is very common in the organs of sea-jellies. *Nine* seems to be rare in the organic kingdom. Ten or 5 × 2 is found in star fishes, and is the number of digits on the fore and hind limbs of animals. Without going over any more individual numbers, we find multiple numbers acting an important part in chemical compositions, and in the organs of flowers; for the elements unite in multiple relations, and the stamens are often the multiples of the petals. In the arrangement of the appendages of the plant we have a strange series, 1, 2, 3, 5, 8, 13, 21, 34, which was supposed to possess virtues of an old date, and before it was discovered in the plant. In natural philosophy the highest law, that of forces acting from a centre, proceeds according to the square of numbers. In the curves and relative length of branches of plants, there are evidently quantitative relations which mathematics have not been able to seize and express.

CHEMISTRY.

PRODUCTION OF VERY HIGH TEMPERATURES.

Sainte Claire Deville has published an extended description of the methods employed in his laboratory to produce high temperatures, and his paper possesses great value and interest. For operations on a small scale, Deville employs a lamp of peculiar construction, in which the vapor of oil of turpentine or any other liquid hydro-carbon is completely burned by means of a powerful artificial blast of air. The lamp in question would be scarcely intelligible without a figure, and we must refer for fuller details of its construction to the original memoir. By its means a heat, sufficient to melt feldspar, can be easily produced, provided that the table bellows employed is of sufficient size and power. [We have found it in practice less safe and convenient than the gas blast lamps with sixteen jets, introduced by Sonnenschein, but it gives a higher temperature.] The other apparatus discovered by the author is a blast furnace, in which platinum and many other substances can be fused. It consists of a cylinder of fire clay 18 centimetres in diameter and somewhat higher than its width. This may be surmounted by a dome to prevent the escape of the coals from the force of the blast. This cylinder rests upon the edge of a hemispherical cavity connecting with a good forge bellows. A circular piece of cast iron pierced with openings about 10 millimetres in diameter, and disposed round the edge of the plate, forms the bottom of the cylinder and separates it from the cavity below. The author employs as fuel, cinders from the hearth of a furnace heated with the dry coal of Charleroy. These cinders are found mixed with pieces of coal, and are sifted upon a sieve with square holes of 2 millimetres in the side. What passes through the sieve is rejected. The coals employed must vary from the size of a small pea to that of a nut. The crucible is placed in the centre of the cylinder and surrounded with kindled wood, upon which pieces of coal of the size of a nut are laid, and upon these the proper fuel of the furnace. The blast is then forced in slowly and gradually increased. The force of the maximum temperature begins about 2 or 3 centimetres above the iron plate, and is only 7 or 8 centimetres high. The coals above remain cold from the transformation of the carbonic acid into carbonic oxyd, which gas in the author's furnace burns with a flame 2 metres in height. The heat produced by this arrangement is called by the author the "blue heat," from its peculiar tint. In it the best ordinary crucibles run down like glass. The author uses three kinds of crucibles. The first is of quicklime, and is made of well burned lime slightly hydraulic, which is cut with a knife or saw into prisms, with a square base 8 or 10 centimetres in the side, and 12 or 16 centimetres high. The edges are rounded, and a hole is made in one end of a convenient size. Sometimes an inner crucible is used, each having its own cover. When the substance to be heated is very refractory, only one crucible is used, and the walls of this are made 3 or 4 centimetres thick. The base of the crucible must be 5 or 6 centimetres below the bottom of the cavity. The space between the crucible and the walls of the cylinder must be 5 or 6 centimetres. In using a lime crucible, charcoal is first to be introduced, little by little, till the crucible is covered; the heat is then very gradually increased till the crucible becomes red, when the coals are removed to make sure that the crucible is not cracked, after which the heat may be urged to the utmost. The second kind of crucible is of carbon. The author uses gas-retort carbon, and fashions it on a lathe. To free the material from impurities, it may then be strongly heated in a current of chlorine, by which process it loses weight. These crucibles are placed within crucibles of lime, the intervening space being filled with calcined alumina. The third species of crucible is made of alumina, obtained by calcining ammonia-alum. Thus prepared, it is plastic, but shrinks much on drying. To prevent this, the author mixes the mass with a calcined mixture of alumina and marble. A mixture of plastic and alumina, calcined alumina, and aluminate of lime, in equal parts, gives a very hard and infusible mass, which softens a little at the melting point of platinum. Once backed, these crucibles resist all tests; even sodium has no action on them. The lime crucibles may be used whenever the alkali is not injurious; the carbon crucibles have a more limited use in consequence of their reducing agency. The alumina crucibles may be used almost always when lime will not answer. With respect to the heat produced by this furnace, the author gives the following details:—Platinum fuses in a crucible of lime into a single well united button. This platinum possesses properties very different from those of ordinary platinum condensed from the sponge. When copper is plated with the fused platinum rolled out into a very thin sheet, nitric acid has no action whatever, as it does not penetrate the leaf of metal. A plate made from fused platinum does not cause the union of oxygen and hydrogen even after several hours. Fused platinum possesses a perfect softness and malleability. In a crucible of carbon, platinum melts easily but yields a brittle alloy of platinum, carbon, and silicon. By raising the heat above the temperature required for fusion, Deville succeeded in volatilizing the metal with remarkable ease, so that it condensed in small globules. Pure peroxyd of manganese heated with carbon from sugar in quantity less than sufficient to reduce the oxyd, gave fused metallic manganese as a brittle mass, having a rose reflection like bismuth, and as easily reduced to powder. Its power decomposed water at a little above the ordinary temperature. Chromium as prepared in a similar manner was well fused, but not into a button, at the temperature at which platinum volatilizes. The metal is brittle and cuts glass like a diamond. It is easily attacked by chlorhydric acid, but little by sulphuric acid, and not at all by nitric acid, either strong or weak. Metallic nickel fuses to a homogeneous button which may be forged with great facility. It has a ductility almost without limit, and is more tenacious than iron in the ratio of 90 to 60, according to Wortheim's experiments. This nickel contained traces of silicon and copper. Fused cobalt is as ductile as nickel, and still more tenacious. According to Wortheim, its tenacity is to that of iron as 115 to 60, or nearly double. The most refractory body which the author fused was silica, which, however, in quantities of 30 grammes was not perfectly liquified. The author considers the fusion of this body as the limit beyond which processes do not go.—*Ann. de Chimie et de Physique*, xlvi. 182, 1856.

GAS IN DWELLING HOUSES.—ITS USES, CONVENIENCES, AND ECONOMY.

We give below the principal points and statements of a miniature pamphlet recently published in London, on the "Uses, Conveniences, and Economy of Gas in Dwelling Houses," by Mr. Rutter, F.R.A.S. Of this little volume, over thirty thousand copies have been disposed of, and its practical suggestions will, we think, commend themselves to every intelligent reader:—

Gas is superior to every other material as a light-giving agent, not only on account of the brilliancy of its effects, and its cheapness, but because it is safer, economizes time and labor, and is more easily managed. Always in their places, the lighting and putting out of gas lights is the work only of an instant. No sparks or impurities are blown, or otherwise scattered about; and, consequently, there is no risk of damaging, or setting fire to clothes or furniture, as so often happens with lamps and candles. The time usually occupied in cleaning candlesticks and trimming lamps is no trifling matter; to say nothing of the dirt, the disagreeable odors, and the waste, consequent thereon.

The management of gas is perfectly simple and easy. All that is really necessary to be known about turning it on, and adjusting the supply, and turning it off, to insure perfect safety, might be acquired, by practice, in a few minutes. The most ordinary degree of care and observation are sufficient to guard against an escape of gas. When that happens, whether by mistake, neglect, or defect in the pipes or fittings, it is easily remedied. The odor of gas is so unlike every other, constituting one of its most valuable properties, that it can thereby be instantly detected, traced to its source, and immediately prevented. Let it not be supposed that the odor of gas in a house is a common occurrence. Such a case is exceptive, and is as unnecessary as that drains, or sewers, or cesspools, should be choked, or overflowing, or left uncovered. When an escape of gas is suspected or known to exist, open the door and window of the room, and search for it immediately—but not with a lighted candle—and the cause will soon be discovered.

It must be conceded that in a house well lighted with gas, there are comforts and means of enjoyment which are unknown where, from necessity or preference, candles or lamps are still in use. The advantages of a good light in all parts of a house, from the cellar to the attics, as contrasted with an indifferent or a positively bad one, are not likely to be denied. By a *good* light is intended just so much as is necessary—a moderate, but not an excessive quantity—sufficient for all practical purposes, but no waste. In lighting private apartments this is a condition of the utmost importance. In shops and other places of business, where doors are constantly open, and there are other means of ventilation, it is not so. There a great quantity of light is necessary, and, as frequently happens, the number and arrangement of the gas-burners are intended to attract attention even more than the goods displayed for sale. In the quietness of the family this must be avoided. For special purposes, it may be desirable to have the means of brilliantly lighting up particular apartments; but on ordinary occasions, gas should be used solely with reference to comfort and utility.

It is sometimes said that gas light is injurious to the eyes. During twenty years of careful observation and inquiry, no instance of the kind has ever come to my knowledge. A powerful light imprudently used, or improperly directed, might be expected to be hurtful; but in that case light from oil, tallow, wax, or turpentine, would be equally objectionable as that from gas. To say that a good light, in the sense in which the term is here employed, is injurious, and that an indifferent or bad one is not so, is about as reasonable as to affirm that the light of the moon is more useful than that of the sun, or that it is easier and more congenial to the feelings to read, or write, or work by fire light, than by that from candles.

The eyes are more distressed, and sight more impaired, by a few days of over-straining in the dimness of candle light, than by years of closer application in the light from a properly regulated gas-burner. A good gas light, producing as nearly as possible the same effects as diffused sun light, placed at a proper distance from, and above, the eyes, is not injurious; but, on the contrary, exceedingly agreeable and eminently preservative. The direction in which artificial light falls upon the eyes has not received sufficient attention. Table lamps and candles are, in most instances, too low; that is, the light is too near the plane of the axis of the eye to be comfortable, or to produce the best illuminating effects. The natural, and, therefore, the most appropriate position for the light, is at a convenient distance above the eye; the angular direction being, of course, dependent on the height and dimensions of the room. In this respect, gas has an advantage over other modes of lighting; the situation as well as the quantity of the light, being determinable with the greatest accuracy.

An uncomfortable degree of heat is sometimes complained of as one of the results of lighting a room with gas. By a little forethought, and a few simple contrivances, this might be prevented. Let it be remembered that the quantity of heat emitted by lamps, candles, and gas lights is, in practice, very nearly in proportion to the quantity of light obtained. It matters not, therefore, what means are employed or materials used in procuring light; for, if a certain quantity be considered necessary, and there be more at one time than another, or by using gas instead of candles the quantity be permanently increased, the heat diffused throughout the apartment must necessarily be increased in the same proportion.

It must also be understood, that the products of combustion are precisely the same in their chemical constitution, whether the light-giving material be wax, tallow, oil, or gas. If gas be well purified, it not only yields a more brilliant light from a flame of the same dimensions, but its combustion is more perfect than that of lamps and candles. In using the latter, there is a preparatory process of vaporization—a necessary part of the light-giving operation. In burning gas this is dispensed with, and many unpleasant odors are thereby avoided.

How happens it that a room once considered so comfortable when lighted by candles, should all at once become oppressively warm when lighted by gas? This is a question not very difficult to answer. It is an every-day occurrence. In the room referred to on ordinary occasions, there had probably been two candles used. On special occasions, the number might have been increased to four. Gas light is introduced. The usual habits of prudence and economy in the use and management of light seem to be entirely forgotten. Gas being much cheaper than candles, the light more agreeable, and the quantity so easily increased, all the thoughts are absorbed in lighting the room effectively. If only one gas-burner be used,—and that perhaps may not be the proper form and size adapted to the room—it is likely that in the first experiences of a good light, the quantity may be equal to that from eight, or ten, or even twelve candles. If two burners instead of one be used, even supposing them to be appropriate, and of a smaller size, it is not likely that there will be less light than from eight or ten candles.

In the case here described, is it wonderful that the room should be uncomfortably warm? What is to be done? Be more economical of light. Obtain the advice of those whose knowledge and experience may be relied on, and, following their directions, use suitable burners and glasses, admit a continuous supply of fresh air to the room, and adopt some of the simplest and cheapest methods of ventilation. All will then go on well. Every room and passage in a house might be properly, that is, effectively lighted; and there need be no waste of gas, no excess of light, no uncomfortable degree of heat, and what is likely to be of equal importance, no cause of complaint about expense. These conditions imply good management; by which is meant just the same amount of care and watchfulness as are usually exercised over other domestic arrangements.

There is no reason why gas should be wasted, or used extravagantly, any more than that the most ordinary articles of food, or clothing, or fuel, should be thrown away or misapplied. This is a part of domestic management in which servants require to be well instructed. Until it is explained to them, it is difficult for some persons to understand how that which can be seen only by its illuminating effects can so easily be lost, or improperly used, or wilfully wasted. A few lessons on this subject will be very useful. Masters and mistresses will increase their own knowledge, by thus endeavoring to impart a little of that which ought to be possessed by other members of their household.

When it is said the cost of gas is equal only to one-seventh of that of (mould) candles, be it remembered the comparative cost of the materials has reference to equal quantities of light from each. To suppose that the light in a room hitherto supplied by two candles, and afterwards by gas equal to twelve candles, would cost less in the latter case than in the former, would be a very great mistake. Experience soon corrects these errors; but it sometimes brings with it a feeling of disappointment, if not of dissatisfaction. The low price at which gas is sold, leaves a wide margin for practising economy. It is impossible for any one, in the transition from candles to gas, to be satisfied with the same quantity of light they had formerly used. This is a practical result; and so long as the excess is kept within reasonable limits, every statement here made about the cheapness of gas, in comparison with candles and lamps, will be fully verified.

There is no burner better adapted for private houses than the union-jet, commonly called the fish-tail. It is made of various sizes, and is cheap and durable. The smallest sizes answer the purpose of single-jet burners for bed-rooms and passages; whilst the larger are so easily adjusted as circumstances require, that the combustion of the gas is perfect when the quantity of light is small.

In choosing fittings no special directions are necessary. So great is the variety, and so easy is it to obtain whatever is suitable, both in price and appearance, that every one's wants can be supplied. As a matter of taste, it is desirable to think of the height and area of the rooms, the color of the walls, the style of the furniture, and the uses to which the rooms are applied. Light and elegant fittings, tasteful in design and beautifully got up as respects workmanship, have taken the place of the unmeaning masses of metal which formerly disfigured, and assisted in over-heating, the best rooms in a house. This is an important change, and in the right direction; due, in a great measure, to the cheapness of gas, and the increased demand consequent thereon. The cost of fittings was formerly an obstacle to the use of gas. There is no longer any cause for complaint in this department. Cheapness, usefulness, durability, and embellishment are easily found so to harmonize that the pocket need take no exception to what is most approved by the eye.

It deserves notice that the use of ground (roughed) glasses is attended by loss of light, and, as a consequence, more gas is required, and, therefore, an additional quantity of heat produced. Under the most favorable conditions, at least one-fourth of the light is absorbed; and when the glasses lose their color a still greater quantity, varying from a third to one-half. Everything need not be given up to utility, nor must too much be yielded to appearances. A middle course is the easiest and the wisest. All kinds of gas glasses, especially those used with fish-tail burners, may be made sufficiently ornamental, if the lower parts were left perfectly bright. The light would, in that case, be most abundantly diffused, exactly where it is most needed; whilst comfort and economy would be easily and pleasantly combined.

Ventilation is a subject much too difficult to be discussed in a few pages. Some general directions are all that can be promised, and it is hoped they will prove sufficient.

Taking any number of houses in a given locality, it is not to be denied that those well lighted with gas are more easily and efficiently ventilated than the others. Spontaneous ventilation, that which most closely imitates natural processes, is greatly promoted, and indeed is always in operation, in a house whose walls, and ceilings, and furniture are dry and warm. In such circumstances it is impossible that air can remain at rest. A constant interchange is effected; fresh air forcing itself in, and having its temperature raised; when, making its escape, it gives place to a further supply at a lower temperature.

The process just described might be greatly assisted by the admission, by day and night, and at all seasons, of a certain quantity of cold air into the principal passages of a house. An opening in a door or window, properly protected from weather, and on the most sheltered side of the house, is all that is required. Partition walls, and others which are battened, usually supply a means of indirect communication, between floors and ceilings, with the roof of the house. No better system of ventilation can be adopted than to admit a properly regulated quantity of air, in this way, to particular rooms where it is most needed. Taking the air from the top of the house, that is, from the roof, instead of the bottom (the kitchen and other domestic offices), it is always cool and wholesome. In many instances advantage might be taken of a picture, or a looking-glass, or a book-case to conceal an opening in the plastering, the nearer the ceiling the better, say ten or twelve inches square, for the ingress of air. This should be covered with perforated zinc, to keep out insects, and fitted up with a sliding-door adjustable at pleasure.

In devising plans for ventilating, many persons are greatly troubled about getting rid of the heated air, and they are disappointed because it will not make its escape at any opening they may choose for it. It is easier to begin by admitting a continuous supply of cool pure air; just so much of it, according to season, and temperature, and other circumstances, as shall be agreeable, and yet its presence should not be indicated by creating a draught. If this be well looked after, there need be no anxiety about what becomes of the vitiated air. That must be displaced by the entrance of fresh air. Both kinds cannot occupy the same place at the same time. This is ventilation on the truest principles, and without risk of having the head almost blown off, or the feet frozen.

The gas meter is now so generally used that any description of it is here unnecessary. As an accurate and disinterested measurer, between buyer and seller, it has no equal in commercial transactions. Its construction and mode of operation, the working of the index, and its means of recording the quantity of gas which passes through the machine, are easily explained and quickly understood, by those who wish to possess the necessary information.

In estimating the relative cost of gas light, as compared with the light from tallow, wax, and oil, it has been already stated, that equal quantities of light from each material form the basis of such calculations.

The several standards of comparison and their respective prices are as follows, namely—

Tallow candles (dips)	at 6*d*. per lb.
Do. do. (moulds)	8*d*. ditto.
Composition candles	10*d*. ditto.
Wax ditto	2*s*. 4*d*. ditto.
Common lamp oil	5*s*. 6*d* per gal.
Sperm ditto	12*s*. ditto.

When the charge for gas is 6*s*. per 1,000 cubic feet, a quantity sufficient to produce light equal to that to be obtained from a pound of tallow (mould) candles at 8*d.* will cost only 1½*d.*; which is less than one-fifth the price of candles. Compared with wax candles the cost of gas light will be one-sixteenth.

In comparison with the cheapest kind of lamp oil, the cost of light from gas will be less than one-fifth, and compared with sperm oil only one-ninth. Gas is admirably adapted, and is coming extensively into use, for warming, ventilating, and cooking; and for many other purposes both domestic and commercial. Cooking by gas is easily understood, and is very cleanly and convenient. In many other respects it possesses advantages so peculiarly its own, that it needs only to be fairly tried to realize all that can be said in its favor. Roasting by gas is the perfection of that part of the culinary art. The meat thus prepared, both in flavor and nutritive properties, is superior to that cooked by an open fire; and this is as applicable to the smallest, as it is to the largest joints. In baking cakes, or pastry, the requisite knowledge is acquired in a few hours; the heat being regulated with such accuracy as always to insure success. In warming by gas it is desirable that the stove should communicate with a flue or chimney; but always in such a manner as that, whilst the products of combustion escape, as much as possible of the heat might be retained in the apartment.

INVESTIGATIONS IN CHLORIMETRY.

The anomalies presented at times in the process of treating with hypochlorite of lime (commonly called chloride of lime) the standard test liquors of Gay Lussac, have just been explained by MM. Fordos and Gélis. A normal solution of the hypochlorite having, at the end of some time, lost its standard value without having lost its bleaching power, these chemists examined the liquid and found that a part of the hypochlorous acid was changed to chlorous acid, which bleaches indigo well, but does not act on the arsenous acid employed in the process of Gay Lussac.

This fact is of great importance in commerce; for on examining a hypochlorite of lime or soda, the merchant or dyer is not anxious to learn the quantity of hypochlorous acid present, but wishes to know the quantity of coloring matter a given weight of the hypochloric will bleach.

MM. Fordos and Gélis have therefore sought for a better process; and after employing it for four years in the fine establishment founded by them on the Seine, they publish it for the benefit of the trade. They replace the arsenous acid with hyposulphite of soda, a salt that is definite in composition and unalterable of itself, and which chlorous acid destroys easily. It is very soluble in water, and not poisonous, and therefore every way preferable to the arsenous acid.

Excepting this substitution, the process resembles that of Gay Lussac. 2·77 grammes of crystallized hyposulphite of soda dissolved in 1 litre of water, constitutes the test liquor, corresponding to the arsenical solution of Gay Lussac. After having taken 10 cubic centimetres of this normal liquor, 100 parts of water are added and some drops of indigo; and as the hypochlorites are generally alkaline, and since the hyposulphite of soda does not decompose readily except in an acid liquid, some drops of sulphuric acid are added. As the solution of hyposulphite has been previously diluted with water, there is no danger that the hyposulphurous acid will be immediately decomposed in consequence of the slight excess of sulphuric acid added.

This hyposulphite is also an excellent antidote of bromine and iodine, which are largely in use in the operations of photography.

ATOMIC WEIGHT OF LITHIUM.

Prof. J. W. Mallet has, during the past year, accurately re-determined the atomic weight of lithium, heretofore a not fully settled point. Prof. M., by a series of analyses, has shown, beyond a doubt, that 86.89 must be taken as the equivalent of this metal, a number corresponding to 6.95 upon the hydrogen scale.

ON THE COMPOSITION OF THE PHOSPHATE OF LIME FOUND IN WATERS NATURALLY.

In the Scientific Annual for the year 1855, an investigation of a guano of remarkable composition by Dr. A. A. Hayes, is given. The restriction imposed on him by those having an interest commercially in monopolizing the article being removed, we can now state that the remarkable body named by Dr. Hayes rock guano, abounded in Monks Island off the coast of British Guiana. In the experimental course adopted for the purpose of explaining how comminuted fish bones and animal matter could form a solid, compact, and hard rock, which some persons considered as a *lava*, it was demonstrated that the decomposition of organized bone in pure or saline water, offered points of great interest to chemists and geologists. The following is a brief abstract of the results obtained:—

Where bones immersed in water, either pure or saline, are exposed to the temperature of 80° F., a fermentative decomposition of the tissues of the bones commences and continues for some time. The gases evolved are mixed with the acids and ethers usually produced in the decomposition of muscle, and the sulphur compounds are also present, air being freely admitted. The fat-cells of the tissues become broken, fats and oils are separated, while a superficial breaking up of the structure of the bone occurs; translucent bones, like fish bones, become more opaque, and an evident chemical change of composition advances.

The water becomes greyish in color from suspended matter, and contains the whole series of acids known to attend organic decomposition in presence of azotized compounds, but most remarkably it is *alkaline* in its action on test papers. At a certain stage of the action, *no ammonia is present as a base.* The fluid either from pure water, or saline, or sea water, will bear heating to 200° F., and a coagulation of albuminous compounds ensues, *the fluid remaining alkaline.*

Tested for bone phosphate of lime, this salt is found to be present in the same proportion as we find dissolved from recent bone by warm water digestion, and without further examination the case might be passed as one of simple solution of bone phosphate in a gelatinous solvent.

If an excess of ammonia be used to separate the bone phosphate dissolved, and a moderate heat, or even boiling, be resorted to, the whole of the bone phosphate can be separated, leaving a clear fluid, which, thus deprived of most of its organic matter, readily passes the filter.

On adding to this filtered solution an ammoniacal solution of lime, an instant abundant precipitation of a hydrated salt takes place to such an extent that the whole fluid becomes a jelly in consistency. This salt is principally bone phosphate of lime, crenate of lime being present, besides other organic salts of lime.

The *phosphoric acid* thus separated from the bone in putrefaction, leaves the lime base in the presence of arsenic and other organic acids, for the carbonic acid to unite with and form carbonate of lime, at the same moment *phosphoric acid dissolves in the fluid without preventing an alkaline reaction.*

Recently prepared bone phosphate of lime can be decomposed by a current of carbonic acid in pure water; the bicarbonate of lime separates partly as carbonate and partly remains in solution. Ammonia causes bone phosphate to fall, but the filtrate contains much phosphoric acid, which is uncombined with an earthy base.

The fluid which dissolves phosphoric acid from the bone, also holds a small quantity of bicarbonate of lime in solution, but the alkaline action is not wholly due to the presence of this compound. It appears that a portion of protein or other animal organic base holds the phosphoric acid engaged at the moment of its separation.

In two cases of poisoning by phosphorus, which were chemically examined by Dr. Hayes, the contents of the stomach, and even the parts of the tissues, altered by the phosphorus were strongly alkaline. Both cases afforded a compound in which the phosphorus as phosphorous acid was in union with organic matter.

This elimination of phosphoric acid in the progress of putrefactive fermentation, explains, as had been done, the formation of rock guano. It shows us how readily bones give to sea water and other waters their phosphoric acid. In connection with physiology, the experiments show that phosphoric acid may exist in the tissues, although the compound be alkaline or neutral, and that a phosphate may pass away or be so placed without the disturbance which might have been expected.

Wohler has more recently shown the solubility of bones in water, but it is possible the beautiful decomposition here described may have escaped his attention.

ON THE COMPOSITION OF THE DEPOSIT OBTAINED BY THE EVAPORATION OF SEA WATER.

An extended research on the composition of natural waters, carried on for some years, by Dr. A. A. Hayes, has demonstrated the existence in all natural waters of certain organic salts, which, present in only minute quantity relatively, have yet a very important and wide bearing on the origin of cemented rocks. It became important, therefore, to study with much minuteness the composition of sea water, omitting the more obvious and well known materials which form the saline parts, and keeping in view those which elude the ordinary analytical processes. A part of these results has been published in the proceedings of the Boston Society of Natural History, while some of the more important conclusions have not yet appeared. The present article is intended to illustrate the method resorted to in a particular case, and to give the composition of the matter which forms by the evaporation of sea water, in presence of a large volume of the water, and excluded from matters in suspension, in its relation to the new facts. Analysis had shown that the water of the Carribean Sea, at different depths and in different months of the year (which, from the currents and great evaporation, may be considered as representing the main composition of sea water), contained organic salts of lime, one of which, the *crenate*, was easily recognised, while one less easily determined awaits further examination. This fact, established by analyses of many samples, suggested the importance of a re-examination of the deposit which falls from concentrated sea water affected by heat, although the deposit in the water of sea-going steamers had been analysed by skilful chemists before.

A moment's consideration of the circumstances shows that the supply pump of the boilers of a sea-going steamer must take up an average of the superficial waters through which the vessel passes and re-passes, and any deposition taking place in the water of the boilers would represent an average composition in the earthy salts susceptible of deposition. The fine steamers of the Collins line to Liverpool from the port of New York, are provided with boilers composed in large part of vertical tubes, formed of fine brass, drawn from ingots. The water of the ocean is pumped into horizontal reservoirs, from which it rises only so rapidly as the evaporation demands, and hence any deposition taking place in the brass tubes will be free from suspended impurities, and represent such compounds, whether pre-existing in the water, or formed in it by heat as it becomes concentrated, while abundance of water is present. A quantity of this deposition obtained from the polished tubes of brass, when subjected to analysis, gave about twelve per cent. of sub-carbonate of magnesia, to about eighty-three of sulphate of lime, besides phosphate of lime and other products.

The sub-carbonate of magnesia results from the action of the organic salts of brine on magnesian salts contained in sea water, as takes place in the analysis of sea water, and hence this decomposition, which had been referred to the presence of bicarbonate of lime, becomes a simple case of double decomposition. Experiments show that bicarbonate of lime does *not* decompose magnesian salts, but dissolves with them; while carbonate of lime, boiled with magnesian salts, decomposes them: the action is never perfect in presence of sulphate of lime. A portion of carbon derived from one of the organic acids by the action of heat, is always present, as is also a silicate of iron, which had been dissolved in the water.

The phosphate of lime found is not bone phosphate existing in the water, but the phosphate containing *two* proportions of base to one of acid, as found by Dr. Hayes to result in all cases of decomposition of bones in water, either pure or saline. The action of this organic salt, proved to exist in sea water in cementing rocks, is a subject to be considered by itself.

TO MAKE RANCID OIL SWEET.

A correspondent of the London *Builder* gives the following results of his experiments upon rancid oil.

The following substances will *prevent* oil from getting *rancid*:—

1. Sweet spirits of nitre. A few drops added to the oil. The effect is due to the *nitric acid* of the spirit, oxidizing every thing but the oil itself. The *hydrogen* has *nothing* to do with it.

2. Creosote appears to answer even better than the last.

3. Methylic alcohol (common "wood-spirit"), if added in small quantity to oil, will prevent its putrefaction, probably from the creosote, &c., it contains.

4. Hypochlorite solution. The hypochlorite of soda is about the best, but a little *strong* solution of chloride of lime does very well, shaken up with the oil: when required for use, the oil may be decanted from the top, or drawn off with a syphon; or let the mixed *oil* and *solution* be poured upon a circular filter, *thoroughly wetted with water*, and placed in a funnel, when the *solution* will pass through the filter, the *oil* being left. Any liquid which does not perfectly mix may be separated in this manner; the filter paper to be previously wetted with the fluid intended to pass through.

5. Small pieces of charcoal, soaked with diluted nitric acid, I have found to possess similar properties to the above.

Substances that will make rancid oil sweet:—

1. Sweet spirits of nitre.

2. Creosote (*very uncertain*—cannot be depended on).

3. Methylic alcohol (*very uncertain*—of little use).

4. Hypochlorites (*quite effectual* in a few hours; in a few minutes if boiled: the *dry salts* are of little use).

5. Peroxide of manganese (very good).

6. Animal charcoal (very good, but takes a few days, unless boiled with the oil).

7. Charcoal (of no use unless boiled with the oil: that from *beechwood* is best).

IMPROVEMENTS IN THE MANUFACTURE AND PREPARATION OF OILS AND FATS.

Oil from the Avocado Pear Tree.—The Avocado pear tree (*Laurus Persea*), a native of the West Indies, produces a highly oleaginous fruit, which yields an oil that promises to be useful in the arts. The Governor of Trinidad lately forwarded some specimens of this oil to Prof. Hoffman, who states that the oil has an acrid principle in it which he has been unable to separate, and also contains much mucilage; but that when treated with a small quantity of sulphuric acid, after the manner practised in France for the refinement of rape oil, a very excellent oil for purposes of illumination was obtained, being, in fact, nearly as good as sperm oil. The oil is also very suitable for the manufacture of soap, either in its unbleached state or after having been bleached with chlorine.

Vulcanized Oils.—A patent has been taken out in England, by Alexander Parkes, for treating oils with the chloride of sulphur, which changes their character, rendering them similar to vulcanized india rubber, and insoluble in mineral naphtha and sulphuret of carbon. He heats about 2 parts, by weight, of the chloride of sulphur with 8 parts, by weight, of oil, up to about 250°, when the combination of the two is effected. This vulcanized oil, it is stated, can be mixed with gutta percha or india rubber, to cheapen the manufactured articles made from these materials.

Oil for Painting.—P. Gontier, of Paris, has taken out a patent for treating poppy, linseed, and other oil for mixing with paint, by adding to these oils, when slightly heated in a caldron over a fire, sulphuric acid, resin, manganese, and litharge. One pound of oil of vitriol and 1 pound of manganese are sufficient for 10 gallons of oil and 10 pounds of resin. They must be added cautiously, and stirred well for three or four hours.

Products of Castor Oil.—A patent has been obtained by Wilson and Payne, of London, for an improvement in treating oils to obtain a new elastic product. Castor oil is placed in a still, and the temperature of it is raised to 600° or 650° Fah.—superheated steam being used in heating. As the act of distillation goes on at this heat, it is found that when about one half of the contents of the still have passed over in the form of fat acids and glycerine, a few drops of a milky-white substance also come over. The heat is then cut off, and the distillation stopped. On the interior of the still there is now found a peculiar spongy elastic matter, which has an offensive odor, which is removed by a current of low pressure steam, and washing with a solution of the carbonate of soda. We understand that this elastic product possesses some of the qualities of India rubber.

A Mr. Durant, of London, has also obtained a patent within the past year for extracting a very clear oil from the castor beans. The outer skin is first removed by rollers previous to the crushing and heating of them. This simple improvement produces a clear and fine oil, which it is proposed to call "castrine," the outer cuticle being then applicable for manure and other purposes. By this process the thicker portion, or stearine, which is now lost (by being mixed and left with the outer skin or cuticle), is obtained, and the oleaginous or thin portion of the oil is not colored and deteriorated.

Oil from Petroleum and Coal.—Mr. Bancroft, of Liverpool, has lately patented a method of manufacturing oil from petroleum, or earth oil, found in Burmah and other countries of the East, which process is as follows:—The crude petroleum, or earth oil as imported, is placed in a cast iron still of ordinary construction, to the centre or body of which a spiral worm of copper is fixed, attached to a steam pipe passing out of the side near the bottom, and communicating with an ordinary steam boiler capable of resisting a pressure of 60 lbs. to the square inch. The copper worm should be open at the top, and terminate one foot above the cylindrical part of the still, or one foot within the dome. The still should be supplied with longitudinal copper condensing pipes placed in an iron or wooden cistern lined with lead, which is to be supplied also with a steam pipe communicating with the boiler, and filled with water. The still being charged with the crude petroleum, the first part of the distillation is carried on by the aid of high pressure steam being passed through the spiral worm until the most volatile parts, among which is eupion, are driven off; the steam so applied should not be less than fifty, and not more than sixty pounds' pressure to the square inch. Fifty pounds' pressure is found to answer in practice. The distillation is then continued, aided by a gentle fire placed underneath the still, until one-fifth part of the contents of the still have passed over into the receiver, and that one-fifth part is found to be eupion nearly pure. The contents of the receiver are then discharged into another vessel, and kept separate from the further distillation, which is continued, the fire being urged and the steam supplied to the still, until the remaining ninety-five parts, or nearly so, have passed over; these will be impure eupion, that is, eupion combined with other carbo-hydrogens, holding a large quantity of paraffine in solution, and called eupion oil, the production of which is the object of the second course of distillation. During the latter part of this distillation, large quantities of paraffine and a small part of pyrolaine pass over; and great care must be taken to keep the condensing pipes at a temperature of about 90 degrees Fahrenheit at the middle of the distillation, gradually raising it to about 120 degrees Fahrenheit towards the end. This object is obtained by means of the steam pipe passing into the water contained in the refrigeratory cistern surrounding the condensing pipes. There will remain a residuum in the body of the still after the charge has been worked off, containing a large quantity of paraffine; this is placed in an iron retort (similar to those used in gas works), and is heated to a low red heat; paraffine vapors pass off, and are condensed by means of a straight iron condensing pipe of at least three inches in diameter, issuing from the interior of the retort, and maintained at a temperature of about 120 degrees Fahrenheit, by passing it through a cistern of hot water kept at a uniform temperature of 120 degrees Fahrenheit, or thereabouts, throughout the distillation. The impure paraffine thus produced is mixed with the eupion oil before mentioned, or it may be purified.

Treating Bituminous Mineral Products for the Extraction of Oils, &c.—M. Barry, of France, has recently patented some improvements in the treatment of bituminous shale, Boghead mineral, and other schistose bodies, to obtain various commercial results therefrom. The produce is, highly rectified mineral oil, mineral oil for lighting, fat unctuous paraffine oil, and mineral grease. The inventor uses retorts for decomposing the schistose bodies, and a receiver. The pipes which conduct the gases from the retort, enter partly into the receiver, which is placed at some distance from the retorts; a condenser, provided with refrigerating tubes, condensing the raw oils and ammoniacal waters. Purifiers formed of wooden cases, lined with lead, and provided each with an agitator, are employed to place the oils, after their separation from the thick tar, in contact with 5 per cent. by weight of sulphuric acid. The matters must be agitated for about three hours, then left to settle down, and drawn off into a second purifier, placed under the first, where they have added to them about 5 per cent. by weight of caustic soda, or a sufficient quantity of lime water, and the whole is to be well stirred for several hours, and then allowed to settle. The distilling apparatus for the raw oils, is composed of a cucurbit, placed over the furnace; it is fitted with a man-hole for clearing it out, and communicates by a pipe with a coil, from which the products of distillation are discharged into a receiver. After submitting the raw oils to a primary distillation (to separate the semi-liquid tar which remains in the cucurbit), they are heated successively with sulphuric acid, caustic soda, and lime water, and are then re-distilled in the same manner as molasses or rum. The oils separated from the thick tar yield (under a properly-regulated distillation) first, the light essential oil; and afterwards, oils of a denser character. The distillation may be further proceeded with, but the heat must be progressively increased, and the product resulting will be unctuous oil, fit for greasing and lubricating. A nearly liquid tar will still remain in the cucurbit, which may be converted into a black grease by mixing it with caustic soda. After being well stirred, at a temperature of from 75° to 85° Fahr., for two or three hours, saponification takes place, and the matter, being run into appropriate receivers, forms what the inventor terms mineral paraffinised grease. The unctuous oil is placed in refrigerators with double bottoms, wherein it is submitted to a low temperature, at which the paraffine will be separated, the remainder being gathered in bags and submitted to pressure, in order to extract whatever little oil it may contain. In the decomposition of schistose substances, the heat for the production of the oily matters must never exceed 400° to 600° Fahr., for if carried beyond, all the gas would be converted into carbonated hydrogen and carbonic oxide, to the detriment of the hydro-carbonated and hydro-carburetted liquids obtained.

Improvements in the Preparation of Oils.—A patent has been taken out in England by H. Hart, for a lubricating oil which can be made by any person. It consists of seven gallons of lard or other oil mixed with one gallon of crude turpentine. They are stirred together until the turpentine is fully incorporated with the oil. It is stated that this mixture also makes a good and safe burning oil.

EGG ALBUMEN IN CALICO-PRINTING.

Some curious statistics have been recently published, indicating the extent to which egg albumen is employed in calico-printing. This substance is used as a medium for affixing upon the cloth certain insoluble pigments, such as artificial ultramarine, not attachable in the ordinary process of dyeing, and is a new and valuable auxiliary in calico-printing. A single calico-print establishment at Mulhausen, Germany, uses per annum, 8,000 kilogrammes of dry albumen, at a cost of 10 francs per kilogramme, equal to 80,000 francs; 320 eggs produce one kilogramme, which multiplied by 8,000 is equal to 2,500,000 eggs. One hen produces 200 eggs per annum; and, therefore, 12,800 hens are required to supply this one factory.

ARE WE TO EXPECT ANY IMPROVEMENTS IN THE MANUFACTURE OF SOAP?

The following are the conclusions of a paper on the theory and manufacture of soap, recently read before the London Society of Arts, by a gentleman of much practical experience and knowledge. After detailing the *rationale* of the experiments and patents brought forward for the past ten years, he said that the only patent relating to the manufacture of soap which appeared likely to succeed and to lead to a practical result, was for combining the materials by mechanical means without the aid of fire, the object being to avoid the formation of glycerine. He felt satisfied that much inquiry, and a series of accurate experiments on a large scale, must be devoted to this subject, before the success looked for can be achieved. He says:—

"If the theory of the manufacture now generally received be correct, we must not be sanguine of great improvements being made in the process.

"It is hardly possible to have a purer or cheaper alkali.

"The process of combination, by the joint action of steam and fire, or by steam only, is simple and rapid, and the treatment of the soap, cooling it in frames and then cutting it into bars, after the chemical process is perfect, cannot be much improved or cheapened; but if we seek for new principles under which the saponification may take place, there is room for great economy in the raw materials, and, therefore, for the production of an equally good, if not superior, article at a very low price.

"At present, from 8 to 10 per cent. of the fatty matter used in soap-making is converted into glycerine, and is wasted. We make nearly 100,000 tons of soap annually, requiring 60,000 tons of tallow, oil, &c., one-tenth of which is absolutely thrown away. 6,000 tons, at £30 per ton, or £180,000 per annum, is the measure of this waste.

"The quantity of fatty matter required to make a ton of perfect soap, is 13 cwt. 3 qrs. 0 lbs., or 1,540 lbs., but analyse the soap so produced by what means you may, you cannot reproduce more than 1,400 lbs., not of tallow, but of fatty acid or hydrogenated tallow, and therefore representing really but little more than 1,300 lbs. of tallow. The difference between these quantities is to be found in the glycerine."

IMPROVEMENTS IN THE MANUFACTURE OF SOAPS AND CANDLES.

Bleaching Rosin for Soap.—J. Buncle, of England, patentee. This improvement consists in melting the resinous substances by a jet of steam, and boiling the same with caustic alkali, adding a little salt when boiling, and then passing currents of air through the resin, which is then allowed to stand for a little while until all impurities settle to the bottom of the vessel. The clear is then run off and used in the soap boiler, and as resin is now used, and for the same purpose.

Hardening Fatty and Oily Bodies.—R. A. Tilghmann, of London, has secured a patent for hardening oil and fatty bodies, by subjecting them to the action of a small portion of sulphur or phosphorus at a high temperature.

An improvement of A. J. Austin, London, said to be of value, has for its object the hardening of the outside or surface of the candles. Stearic acid is mixed with five per cent. of white wax, and then dissolved in half their weight of methylated spirits of wine. By rapidly dipping tallow candles into this solution and withdrawing them they will be found covered with a thin hard film, and may be immediately handled.

An Improved Soap called "Japonitoline."—The invention consists in manufacturing a gelatinous soap in the following manner:—

"Supposing (says the patentee) that I wish to manufacture one thousand five hundred pounds of the said soap, I proceed as follows: I first pour in a copper boiler about eighty-eight gallons of soft water, and mix with it about one hundred and twelve pounds of crystal soda, or about seventy-nine pounds of salts of soda. Two or three hours after the soda has been in contact with the water, I agitate the mixture, and add to it about one hundred and twelve pounds of common hard or soft soap. The fire being placed under the furnace, I leave the mixture to be heated until the temperature attains forty or forty-five degrees centigrade, when I add to the liquid about seventeen pounds of Russian or American pearlash; I well mix the whole, and when the soap is nearly dissolved, I suspend in the middle of the copper a white linen bag, containing about seventeen pounds of pounded quicklime. This linen bag, strongly tied at its upper extremity to avoid any of the matters escaping, must be immersed in the liquid to a depth of about eight inches.

"When ebullition has commenced in the copper, I slowly agitate the liquid mass, and pour therein about five gallons of mucilage of linseed, marshmallow, or psyllium seed—after which, I add seven and a half pounds of borax, or about two and a half pounds of calcined alum. When the whole is well mixed in the copper, and the liquid presents the appearance of being perfectly homogeneous, I leave it to boil on a slow fire during three quarters of an hour. The fire should then be extinguished, and the copper covered over. When the temperature falls to fifty-five or sixty degrees, I pour the liquid into barrels, where it becomes solidified in about twenty-four hours (supposing that hard soap has been used); if otherwise, it will remain in a gelatinous state."

Laporte's Improvement in Candle Manufacture.—M. Laporte, of Paris, has obtained a patent for the following improvements in manufacturing candles:

The invention consists, first, in the employment of a tubular wick, composed of a great many threads, woven, plaited, or otherwise united together; also in the employment of a jacket or case round the moulds, capable of being heated from 112° to 132° by steam; also, in a general process to manufacture a candle, composed wholly of vegetable wax, or having vegetable wax for its base.

The manner of carrying this invention into effect is as follows:—To make two hundred weight of candles, for example, take 66 parts, by weight, of vegetable wax, and 34 parts of tallow, or of cocoanut oil, or other suitable oil, or of any fatty liquid or solid body suitably prepared, and heat the same to about 194°, by means of steam or a water bath. The fatty body is combined with the vegetable wax, for the purpose of rendering the vegetable wax less friable and brittle, and of increasing the intensity of the light. Previous to melting, the wax must be crushed up, and then thrown, together with the tallow or fatty matter, into a vessel containing water, acidulated by sulphuric acid. The melted mixture must be allowed to remain until it becomes sufficiently fluid, when it is drawn off into another vessel, where it is left to get a little cooler, an even temperature being maintained throughout the mass by keeping it well stirred. The mixture is next run off into moulds containing wicks, and heated, as before stated, up from 112° to 132°; and the temperature is gradually lowered down to from 59° to 67°, when the candles may be removed from the moulds. The wicks may be composed of from 60 to 150 threads, woven, plaited, or united in any suitable manner, to form a capillary column, large in bulk, and at the same time very divided; and they may be made to burn either so as to require snuffing or not. Vegetable wax, if submitted to too high a temperature, turns black; while if the temperature be not high enough, it curdles, and does not produce a perfect candle.—*Newton's London Journal.*

IMPROVEMENTS IN BLEACHING CLOTH AND PAPER.

Two patents have recently been taken out in Europe for different methods of bleaching. The one by Pierre J. Davis, of Paris, is quite an original process; he employs for this purpose chloroform in a state of gas. The cotton fabrics are placed in a close wooden box to which steam is admitted from a boiler, at a pressure of 60 lbs. to the square inch; this box contains a liquor made of carbonate of soda (crystallized soda), of a strength about 4° in the hydrometer, and the goods are steamed in this for about two hours, then allowed to cool. The box must have a safety valve on it, and an emission steam pipe. After this the goods are taken out, dripped, and placed in another close wooden box lined with lead, but communicating by a pipe with a chloroform generator. This consists of an earthenware vessel into which 3 lbs. of bleaching powder (chloride of lime), 3 lbs. of slacked lime, a quarter of a pound of alcohol, and 9 lbs. of water, are placed together and stirred. About one pound of hydrochloric acid is then poured upon these materials, when the chloroform gas begins to generate, the cover is then put on the generator, and the gas conducted by a pipe into the leaden chamber which contains the fabrics. This gas half bleaches the goods in the course of an hour or so; when hydrogen gas is introduced into the box, to expel the chloroform. The goods are then submitted a second time, for a few hours, to the action of chloroform gas, made of a like quantity of materials, but distilled from a zinc retort heated to 145° Fah. After this operation oxygen gas is admitted to the goods, which imparts to them a bluish shade. They are then taken out, washed, dried, and finished.

The other patent is that of H. Hodgkinson, of Belfast, Ireland, and consists of a steam-tight box half filled with bleaching liquor (chloride of lime) heated by steam, and having within this box a revolving wheel made with apartments containing the fabrics to be operated upon. Each apartment has a door to put in and take out the goods, also opening in the bottom, to allow the entrance of the liquor. As this wheel revolves, the goods are dashed, as it were, through the hot liquor in the box, and are thus bleached rapidly and evenly.

By the common method of bleaching, the liquors used are all cold, because the chlorine gas is expelled by a very moderate heat, but as the gas operates far more rapidly when hot than cold, it certainly can be saved, and the process accelerated, by bleaching in tight boxes heated by steam.

Bleaching Paper Pulp.—M. Didot, of Paris, has prepared the following new method of bleaching paper pulp:—He immerses the pulp in a solution of bleaching liquor, which is made by saturating chloride of lime in water, and using the clear liquor, and then passes carbonic acid gas through it. It is stated to be an improved process for bleaching both pulp and textile fabrics.

Bleaching Straw Pulp.—In the specification of a patent lately granted to J. Cowley, and D. P. Sullivan, of England, it is stated that in bleaching straw pulp, the liquor (chlorine) used is about one and a half to two degrees in Twaddle's hydrometer, in strength; that a lower strength will not bleach the pulp, and a stronger liquor will injure it, and not produce so good a color. When the straw is undergoing bleaching, it is carefully watched, and as soon as it assumes a reddish color, just merging on the white, a jet of steam is cautiously let on and continued for two hours, until the liquor has attained to a blood heat, or about 90°, at which temperature it is maintained for about two hours longer, when the straw will be completely bleached, and fit for the beating engine. Unless the steam is gradually introduced, the color will not be good.

ON THE GUANOS OF THE ATLANTIC.

At a recent meeting of the Boston Society of Nat. His., Dr. A. A. Hayes presented the following paper on the Guanos of the islands of the Atlantic Ocean.

About two years since, an enterprising commercial firm in Boston discovered on Monks Island,—a small island off the coast of Guiana, a remarkable rock, covering a deposit of the kind of guano now so well known, as coming from the Atlantic side of South America. The rock and guano were sent to me for chemical analysis, and finding both to possess a high economical value, I recommended the introduction of them as sources of phosphate of lime, for agricultural purposes. A large quantity of these products has been imported, and numerous analyses by myself and others have shown a considerable uniformity in the composition of thousands of tons.

In the specimen which I have called Guano Rock, we have irregular incrustations of from one inch to two feet in thickness, pale yellowish brown, or nearly white, while its fracture is of some shade of dark brown, and shows bands of very dark, alternating with those of a lighter color. Like compact calcareous concretions, the upper surface presents rounded elevations and nodules, while below the mass is full of cavities and irregularities. Its fracture is generally splintery, and its average hardness, greater than that of Fluor spar, is next to that of Feldspar. Sp. Gr. 2·440 (average).

The arenaceous guano may be considered as comminuted fish bones, mixed with minute shells, still retaining organic matter; and one of the specimens shows the first step in aggregation, by which solid masses form. These eventually, by chemical operations, become consolidated, so that the resulting body has all the characters of a firm rock. The rounded grains of the arenaceous guano are generally of the size of mustard seed, and in forming the sandstone aggregate; and they show individually as the grains of sand in that rock. In the guano-rock, this individuality is entirely lost, and the eye detects nothing in the close-grained and compact banded mass, which indicates its origin. Indeed, it would be difficult to find two bodies mineralogically more diverse than the two specimens before you. It is to this loss of the granular form, and the production of a compact, remarkably close textured rock, that I wish especially to call attention.

This guano-rock has a composition not very different from that of the arenaceous guano; both, however, present a very novel result, by analysis. In stating the composition, I purposely omit several constituents which occur in minute quantity only, and keep in view the bone phosphate of lime and organic matter, as the prominent constituents of both.

100 parts of the Guano Rock consist of, Moisture, 0·80; Dry Organic Acids, &c., 11·00; Sulphate of Lime, 7·90; Bone Phosphate Lime and Magnesia, 110·20; Sand, 0·80.

100 parts of the Arenaceous Guano, from below the guano rock, contain, Combined water, 6·84; Dry Organic matter, 1·80; Sulphate of Lime, 7·00; Bone Phosphate Lime and Magnesia, 114·40; Sand, 0·60.

Considering the mineral matter of each, that in 100 of guano rock weighs $88\frac{2}{10}$, in 100 of arenaceous guano $91\frac{3}{10}$; the proportion of bone phosphate of lime and magnesia becomes 110 nearly in each, when an equal weight is taken. The question, from whence does phosphate of lime, of this composition, come? at once arises in the mind of any one who has a recollection of the composition of fish bones, and especially the composition of the ordinary Atlantic guano of the Aves, and other Islands. In 100 parts of calcined ox bone, there are 86 parts of bone phosphate of lime and magnesia, and 14 parts of carbonate and silicate of lime; rarely 88·5 parts as given by Heintz. Fremy has recently classed the bones of man, elephant, lion, calf, kid, ostrich, serpents, codfish, and other fish, as identical in composition. I have found the bone phosphates of lime and magnesia, in the burnt bones of the halibut, to equal 86·80 per cent., while the bone and organic matter of the vertebra of this fish, as extracted by acids, afforded 92 per cent. of the mixed phosphates. Taking, therefore, the highest result on any fish bones, we have in the dry matter only 92 per cent. of bone phosphate of lime and magnesia, while 100 parts of the dry mineral part of the guano rock afford the phosphoric acid sufficient, when combined with lime, to produce 125 parts of the same salt.

As we can look to no natural source for bones having the composition of guano rock, we inquire into the chemical influences exerted while the excrement of birds, mixed with more or less of other animal remains, undergoes decomposition at a temperature never lower than 85° F., moisture and water being present.

Experiment shows that under these conditions, the putrefaction proceeds with the production of acids. The bones of the halibut give to sea-water lime salts, at the expense of a portion of the bone. Abstracting lime from the bone, leaves in excess the phosphoric acid, and the washing away of the soluble salts of lime formed, by rains, adds them to the constituents of sea-water. Recurring to the composition of guano-rock, we see that the proportion of organic salts and other organic matter, is much larger than exists in the guano from which it was derived. The physical characters of the rock are modified by the presence of these compounds, but the most remarkable change is that from a granular to a compact solid. This change could be effected by infiltration, as takes place from calcareous waters; but as the rock guano is above the mass producing the soluble organic salts, it is necessary to consider another condition. When water holding saline matter in solution evaporates from the surface of the earth, pure water alone escapes, while the saline and colored organic compounds remain at or near the surface. In accordance with this law, the saline matters which can be dissolved, and the colored matters which can be suspended, in water, rise to the surface, and so long as capillarity can act, they are deposited in the porous parts, gradually filling the pores and consolidating the surface. Doubtless, while this process is proceeding, rains carry back a part, which is to be raised anew, until finally the surface rock, no longer pervious, becomes cemented into the compact state it now presents, by this action of capillarity. As the material of the guano-rock has been organized at one time, and may now be considered as mineralized, the specimens present a fine illustration of the action of the minor natural forces in changing the physical conditions of matter, as well as its chemical composition. On the other hand, the putrefaction of fish remains, being often accompanied by the formation of acids, we are able to trace to their sources the organic salts of lime, as well as the phosphate of lime, which analyses show to exist in sea-water.

ON THE PREVENTION OF THE OXIDATION OF METALS.

Those familiar with electrical science are well acquainted with the fact that zinc exercises positive relations with regard to most other metals. In other words, it possesses the power of keeping them in a negative state when in contact with them. In this negative state they are incapable of entering into combination with oxygen, and this circumstance may be applied with much advantage to the prevention of the oxidation of machinery, especially such parts of it as, in the case of marine engines, are liable to come in contact with water. Many instances will at once suggest themselves, in which much manual labor might be saved by the simple contrivance of appending either a ring or a slip of zinc to the metal to be preserved bright. It would be especially applicable in the case of bayonets and rifle barrels; and a zinc edging to a scabbard would prevent rusting of the sword.

THE MANUFACTURE OF ALLOYS, OR COMBINATIONS OF METALS.

It is a curious but nevertheless undeniable fact, that no kind of manufacture has received less benefit from the recent progress of chemical knowledge in this country than the fabrication of alloys. This is all the more surprising, when we consider the enormous field open to inquiry, and the richness of the harvest to be there gathered. A new alloy is really a new metal given to society; and although the apathy of scientific men with respect to the subject has hitherto led to the production of very few such metals, yet more than one example may be cited where a large fortune has followed upon an invention of this kind.

The origin of the word, as applied to metallic compounds, is no doubt coeval with the age of the so-called "noble" and "base" metals; a form of language naturally leading to the conclusion, that when any noble metal was mixed with a base one, its nobility was "allayed" or "alloyed," and consequently diminished. In this sense, the base metal came to be regarded as the allay or alloy, and as such is thus described by an old writer: "Alloy is the proportion of a baser metal mixed with a finer or purer; as the quantity of copper that is mingled with gold to make it of a due hardness is called the alloy;" and with this meaning the word is still used by our assayers of gold and silver. But it is clear, from the very nature of the example here chosen, that no admixture of one base metal with another like itself, could generate an alloy in the opinion of writers of the old school; nor can we anywhere find that brass, bell-metal, &c., were called alloys, until mixed with gold or silver.

If, however, we now proceed to examine the meaning of the expression alloy, in the present day, we shall find that it extends to every admixture of two or more metals, and is, perhaps, no less absurdly diffuse than it was previously limited. On the new system, 99 parts of gold and one of copper is an alloy of gold; whilst 99 of copper and one of gold is an alloy of copper: nor is there any fixed or recognised limit at which an admixture of metals ceases to bear the name alloy: in fact, almost every metal we now use might, from its casual impurity, come within the boundaries of this definition. Lead, with a trace of silver, will thus be an alloy of lead; and iron containing a trace of manganese an alloy of iron. Such a state of things cannot fail in the end to produce uncertainty and confusion; wherefore we propose to establish, for present purposes at least, a distinction betwixt what we shall call an alloy of metals and an admixture.

Many years ago Dr. Dalton drew attention to the fact, that many of the alloys in ordinary use, as brass, &c., were very nearly atomic compounds, or, in other words, mixtures of metals in such proportions, that one combining equivalent of the one was united with one, two, or three equivalents of the other; and this peculiarity was found to extend to what may be termed native or natural alloys. Thus, brass of good quality consists of about 34 zinc and 66 copper in 100 parts, which is very nearly in the proportion of one atom of zinc to two atoms of copper; and again, the native of alloy of gold and silver, called "electrum," is said by Boussingault to consist of two atoms of gold and one of silver. In fact, many such examples might be pointed out in support of Dalton's opinion, though it is quite certain that in this, as in many other of his assertions, he carried his views too far, and was misled by his mathematical bias. Silver and iron, for example, refuse to unite permanently, and separate on cooling; but the iron retains, in this case, a small and variable quantity of silver, whilst the silver retains a little iron: similarly lead and zinc comport themselves; and in neither instance can any reasonable grounds be found for inferring that an atomic combination has ensued. It would appear, therefore, that the union of some metals in atomic proportion can be effected, whilst with others it cannot; and hence for the former, we propose to retain the word "alloy,"—using the expression "combination of metals" for the latter. On this basis, therefore, an alloy will mean a mixture of one or more atoms, or equivalents of one metal, with one or more atoms or equivalents of another, so as to form what may be called a chemical compound, whereas a "combination of metals" will merely imply a mixture in no definite proportions, but suggesting the idea of a mechanical compound: thus, brass formed from 34 parts of zinc and 64 parts of copper, or 34 zinc and 96 copper, would be an alloy,—whilst our ordinary silver and gold coinage would be an admixture of metals.

With this preliminary definition, we will now proceed to examine the few alloys in common use in the arts, or, more correctly speaking, those compounds which nearly approach the nature of alloys. In such a list we may place brass, type-metal, bell-metal, speculum-metal, pewter, Britannia-metal, and solder. The first has already been described; the second generally consists of about 5 parts of lead and 1 of antimony, which closely approaches to 3 atoms of lead and 1 of antimony. Bell-metal is composed of 4 parts of copper and 1 of tin, and may be regarded as an alloy of 7 atoms of copper to 1 of tin. Speculum-metal contains about equal quantities of copper and tin, with small and variable proportions of arsenic: it may consequently be looked upon as composed of 2 atoms of copper and 1 of tin. Pewter and Britannia-metal are triple compounds of tin, antimony, and lead, in which the proportions approach, for the first, an atom of each ingredient, and for the second 3 atoms of tin, 2 of antimony, and 1 of lead. Solder is more variable than any of the others; but the best kind is made with 3 parts of lead and 1 of tin, which corresponds to about 2 atoms of lead and 1 of tin. There are other compounds which might, perhaps, have been brought within this group; but as, in reality, none even of those we have selected, are, strictly speaking, alloys in our limited sense of the expression, it is useless to follow the subject further than to show, by this near approach to atomic combination, how probable it is that the same substances, fabricated with a due regard to that proportion, would possess more useful qualities and less frequently disappoint the expectations of the artisan. Take, for example, the case of bell-metal, an article notorious for the uncertainty of its results; this compound contains, according to the caprice of its fabricator, from 12 to 22 parts of tin, with from 78 to 88 parts of copper, and a little antimony, arsenic, or even iron: if, however, it requires to be an alloy of 7 atoms of copper and 1 of tin, the proper proportions would be 79 copper and 21 tin. With facts of this kind before our eyes, it seems strange that nothing practical has arisen with respect to alloys; and we cannot help thinking that amongst the other elements of the working man's education, the doctrine of definite combining proportions might very properly be included.—*Engineers' Journal.*

NEW MODE OF COPPERING VESSELS.

M. Oudry, of France, has made preliminary experiments for applying electrotype on an enormous scale—no other than to the coppering of wood and iron ships of whatever tonnage. The vessel would be coated with an adherent species of varnish, then placed in a dock to which the cupriferous solution would be admitted; and then by a series of piles, the requisite thickness of copper would be deposited in from eight to ten days. The advantages promised are diminution of cost and perfection of result; for, there being no joints in the copper, destructive animals could not penetrate, neither would there be such an accumulation of weeds on the bottom as now takes place.

ON THE QUALITY OF COPPER FOR THE SHEATHING OF SHIPS.

From a series of articles published in England during the past year on the above topic, by James Napier, F.C.S., we derive the following *memoranda.*

Shortly after sheathing by copper was introduced, it was found that it did not wear equally—that while some lasted many years, others only lasted a few years; but it seems a general opinion that the sheathing, since its first introduction, has greatly deteriorated, and since these last thirty or forty years the rapid wear or waste in sheathing has become the rule, and instances of long wear exceptions—a fact which is certainly a serious matter, both for our merchants and our government. The quantity of copper required for covering a ship's bottom of course varies greatly. A ship of 120 guns consumed 4,738 sheets, weighing 17 tons 19 cwt., which, taken at an average cost of £100 per ton, amounts to £1,795 for the metal alone. This is not a great amount, considering the value of the vessel, and the object for which the sheathing is applied; but it becomes a vast amount if renewed every three years, instead of every twenty years. This is what makes the question a vital one.

Mr. Prideaux was of the opinion that the deterioration of the copper, recently so much complained of, originated in certain modifications introduced by the smelters of copper ore, or from the introduction of certain qualities of ore from abroad, which had affected the general quality of the metal.

Although there is no absolute proof on this point, yet it is probable that the supposition of Mr. Prideaux was in part correct.

Shortly after the South American ores were introduced came into use Muntz's yellow metal, an alloy of two equivalents of copper and one of zinc. The success of working this alloy depends much upon the purity of the copper used; hence, with an increased supply of impure ores came an increased demand for good quality of copper to make this alloy, which copper was, consequently, taken out of the copper market. This was obtained by the process termed "selecting;" and to show the bearing of these circumstances upon the subject under consideration, I must briefly describe the process and principle of smelting and selecting. The ore is first calcined by being placed on the floor of a large high roofed reverberatory furnace, and kept at a dull red heat for several hours, which expels a great quantity of the sulphur, and oxidates a portion of the iron. It is then fused in a separate furnace, the silica and oxide of iron combining forms scoriæ, or slag; the copper with iron and sulphur combines, forming what I have described as regulus; the slag or scoriæ floats, and is skimmed off, the regulus is tapped into a deep pit of water which granulates it. This granulated regulus is again subjected to calcining and fusing, until the iron is mostly all oxidized, when the copper remains as a sub-sulphuret, with a little iron and a portion of the impure metals. This product is now roasted, by being put into a reverberatory furnace furnished with air holes, and kept at a semi-fluid state, with a free current of air passing over the surface. The reaction may be thus explained: a portion of sulphur is carried off by the oxygen of the air, and the copper is oxidated, and this oxide of copper instantly reacts upon, or is decomposed by, another portion of sub-sulphuret, the copper of both being reduced to the metallic state without any carbonaceous matter. Copper in the fused state has a stronger attraction for sulphur than any of the other metals, so that when copper begins to be reduced, it will first reduce all the other sulphurets present, except iron. Therefore, by carrying on this roasting until about the half of the copper is reduced, and then tapping the furnace, this reduced portion will contain all, or mostly all, the less pure metals which had existed in the regulus. The sub-sulphuret remaining is selected and reduced by itself in a separate furnace, to make pure or select copper for yellow metal. Thus, the process of selecting affected the whole copper trade, and particularly the sheathing, for the yellow metal was not only a competing article with ordinary sheathing, but its production almost necessitated the deterioration of that against which it was to compete. The reduced copper with the impurities was taken and subjected to long roasting and refining; if the quality after that would bear rolling it was used up for sheets, if not, it was sold as tile.

The copper trade is now almost entirely relieved from these circumstances, by the abundant supply of Australian ores, which are mostly all pure, giving copper of the best quality; however, as far as regards the past, and the question under discussion, these circumstances all tend to show that the cause of the deterioration of sheathing is impurity in the copper.

However, the Australian ores having relieved the trade from the great pressure of impurities and the drain of the purest metal, there should now be a great improvement in the quality of the sheathing, Australian ores having been in use in great quantity these last ten years; still we have not heard of any marked improvement upon the copper sheathing since then.

Looking back upon the whole discussion, it will be seen that the subject is involved in difficulties. In the first place, we have seen it demonstrated by every experimenter and by experience, that pure copper dissolves more rapidly in sea water than copper with a little alloy in it. From our experiments it is also shown that pure copper, in contact with copper containing impurity, is acted upon more rapidly by sea water than when alone, so that, under any circumstances, this would go to prove that pure copper is not the best for sheathing, as it would be subject to the greatest amount of wear, from chemical action; while, in the early history of sheathing, the probabilities are in favor of the copper having been very pure, and the sheathing then lasted much longer than it is said to do now; and yet, when the circumstances came that necessitated an impure copper being more general, the rapid waste of sheathing instantly became apparent—fact and deductions seeming contradictory.

We had ourselves thought that purity was all that was required for a good sheathing metal, and all the sheets being of the same quality; but observations and experiments have tended to modify these views. Nevertheless, we are still convinced that a promiscuous impurity of copper will make a bad sheathing. It is not anything that may have remained in the copper during the manufacture, or that it is sufficient if the copper be about 98·5 or 99, rather than 100. Without regard to what the 1 or 1·5 per cent. may be, the thing required is *pure* copper, alloyed with a small portion of another *pure* metal; which other metal is best to use for this purpose, and the quantity, we are not yet prepared to say, our investigations not being complete.

There is another thing that is essential in the way of sheathing, whatever may be the quality used, that is, one equality of the quality over all the ship. If this be not attended to, then certain sheets and parts will give way much sooner than others—a circumstance that has led to many disputes and erroneous impressions upon the question. One sheet wears well, nay, is hardly affected, in the neighborhood of several that have decayed rapidly; the sheet is analysed and found very impure, and hence impure copper is recommended, while it was the presence of that one sheet caused the rapid destruction of the others, which, but for this, might have lasted well.

This subject, we think worthy a more full investigation than yet has been made: it is more a matter of time than expense; and if our shipowners were feeling more interested in the inquiry, and making arrangements so that data would be obtained, such as retaining samples of the metal used for sheathing, keeping a correct account of the work done by the vessel, and where; and then having such sheets found to wear well or ill tested and compared, as well as the general loss by weight and time of renewal, &c., in a few years we would not fail to have an amount of facts that would lead to the adoption of what was really best.

Yellow metal has been in use now these many years for sheathing, and is very generally adopted in the merchant service. Its first cost is considerably less than copper, which is an immediate inducement, and the uncertainty attending the wear of copper sheathing brings other metals or alloys into ready competition with it.

The following experiments were recently made by Capt. James, R. N.:—Specimens of different coppers were kept in sea water for nine months; the loss of each per square inch is given thus:

Electrotype copper lost	1·4
Copper with arsenic	1 2
Copper with phosphorus	none
Copper (suppose cementing)	0·8
Copper from Dock-yard	1·66
Ditto	8·
Ditto	2·48
Ditto	2 33
Yellow metal (Muntz's)	0·95

Experiments from which we are to deduce an application to such purposes as sheathing, may lead to false results, not being in accordance with the conditions of application, such as where one sheet of copper overlaps another, making a connection extending over the whole external surface of a ship, and embracing thousands of plates. Where a slight variation in the composition of a few will induce an electrical action throughout the whole, and thus give results entirely different to suspending any single sheet, so that we must make our experiments under the same condition, or have a thorough understanding of how to apply the results got from single sheets to the conditions to which these may be applied, such as the clear conceptions which characterize Sir H. Davy's inquiry, and from which I have no hesitation in saying, that were a ship sheathed with a mixture of all these coppers given in Capt. James' experiments, the few sheets of alloy of copper and phosphorus would induce a rapid waste of the whole, and to analyse those sheets destroyed first and those wearing best, we would have the conclusion that impure copper is best for sheathing. To test this deduction by experiment, I alloyed samples of the same quality of copper with two per cent. of metal of the different sorts referred to in the following table, had the samples beaten into small plates, and submitted them to the action of the sea in Lamlash Bay, Arran, for four weeks. At the termination of the experiment, the appearance of each specimen was worthy remark; some were coated over with a light green patina, others had become light and brassy looking, and some had a reddish brown color, much like that described as the appearance of sheathing that has worn ill. The quantity of loss on the square foot of surface exposed to the action of the water was then taken with the following results:—

Copper without alloy lost	144	grains
" with Bismuth	138	"
" " Lead	131	"
" " Antimony	111	"
" " Tin	98	"
" " Silver	65·5	"
" " Cobalt	62	"
" " Nickel	58	"
" " Iron	50·5	"

In these experiments we observe that pure or unalloyed copper is more rapidly acted upon in sea water than copper having a little alloy; but the next question was, how sheets of any of these coming into contact with pure copper, would affect the wear of the pure copper by a galvanic influence. I therefore took a small sheet of equal size of pure copper, and connected each with one of those alloyed pieces, and submitted them to the action of sea water (but in this instance it was artificial sea water made by dissolving the different ingredients according to the analysis given for the English Channel). The water was stirred several times every day, and the experiment was continued for twenty-seven days. Only the loss upon the pure copper was taken. I regretted that the weight of the alloyed pieces was not also taken; however, the following was the result of the experiment given upon one square foot of surface exposed:—

Pure copper, with the cobalt alloy	197·7	grains.
" " arsenic alloy	191·3	"
" " nickel alloy	179·2	"
" " antimony alloy	174·0	"
" " bismuth alloy	169·0	"
" " silver alloy	165·1	"
" " iron alloy	153·4	"
" " lead alloy	152·3	"
" " tin alloy	152·0	"
Pure copper alone	148·7	"

These results require little comment. We have seen that pure copper alone dissolves more rapidly in sea water than alloyed copper; but if it be brought into contact with a negative piece of copper, in which state copper alloys are in relation to pure copper, then the pure copper will dissolve much more rapidly with some of these alloys, to an extent of 33 per cent., which would be very destructive upon a vessel if a mixture of pure and impure sheets were used. However, looking upon these small laboratory experiments only in the light of a finger-post, I shall pause to inquire what others have said and found in similar inquiries and practice.

A correspondent of the *Mining Journal*, commenting upon the subject of sheathing two or three years ago, makes the following judicious remarks and observations:—

"With your permission I will state some facts, which show that fine pure copper is not the best adapted for the purpose under consideration. The copper formerly produced in Anglesey is truly stated to have been pure and ductile, but it proved to be very inferior when applied to sheathe ships—so much so, that a house in Liverpool who manufactured and sold this copper got into great disrepute with shipowners on that account, so that they were obliged to use Cornish copper, or at least a mixture of it, for sheathing.

"Above twenty years ago, when the first copper of the Bolivar Mines was smelted in this country, it was found to be very pure and malleable, and commanded a comparatively high price for export to the continent of Europe. This copper was also applied by another Liverpool house for sheathing ships, for which purpose it proved entirely unfit. The wear was so rapid that in about half the usual time the sheets were reduced to little more than a tissue.

"Here, then, are two well defined instances where copper of the purest description has signally failed when applied to sheathing ships. A curious circumstance connected with the Anglesey copper was related to me by a party interested. A buoy, sheathed with this copper, was placed in the run of the tide in the Menai Straits, opposite the mansion of the noble proprietor of the mines; and this sheathing wore comparatively well, notwithstanding the friction of an almost constant strong current; but sheathing *made at the same time*, from *the same copper*, and placed on the ship's bottom *with the same nails*, wore unsatisfactorily. Knowing these facts, I am of opinion that copper so pure and so ductile and malleable, as to be prized for other purposes, is *not* the best for sheathing ships; and that the assertions of shipowners, when they meet with copper that has worn unsatisfactorily, that it was *inferior* and *impure*, are the reverse of truth."

In the *Comptes Rendus* we have the opinion of one of our continental chemists upon this question of sheathing:—

"M. Bobierre has paid considerable attention to this subject, and has arrived at the following conclusions as to the cause of the rapid destruction of some copper and bronze sheathing:—1. When unalloyed copper is employed, the presence of arsenic appears to hasten its destruction. 2. All bronzes which appear to have stood well contained from $4\frac{1}{2}$ to $5\frac{1}{2}$ per cent. of tin, that quantity being necessary to form a homogeneous alloy. When the per-centage of tin is only 2·5 to 3·5, which is very frequently the case, no definite alloy is produced, and the mass is of unequal composition, and being unequally acted upon, is soon destroyed.—3. When impure copper is employed the alloy is never homogeneous, and is unequally acted upon in consequence. We thus see that the so frequent destruction of the sheathing of copper-bottomed vessels arises from the tendency to use inferior brittle copper, and by diminishing the proportion of tin, to economize the difference between the price of that metal and copper, at the same time that the cost of rolling is also less, in consequence of the greater softness of the poor alloy. Bobierre thinks that the addition of a very small portion of zinc very much improves the bronze, by producing a more perfect and uniform distribution of the positive metals, and consequently a much more definite alloy."

It will be seen, however, that the above refers more to a certain quality of bronze for sheathing than copper.

For experiments of a different kind, we take the following from Silliman's Journal:—

Copper Sheathing.—Some interesting experiments on this useful branch of the manufacture of copper have been made in the United States. Some which had resisted the action of sea water for a considerable period were found to contain no less than one ten-thousandth part of silver; this was found sensibly to modify the chemical relations of the metal, and observations had indicated that the quality for sheathing was improved. The subject was resumed again, when the argentiferous native copper of Lake Superior was first rolled by the Revere Copper Company; the alloy contained four parts of pure silver, or about 4 lbs. of silver per ton. A proximate analysis of the metal was taken, and it proved to be pure copper, throughout the mass of which an alloy of copper and silver was evenly distributed, thus forming either a mixture or compound alloy, in which one part of the copper is truly combined with the silver, and the other larger part simply combines with the alloy. It was assumed that the silver alloy would close the pores of the copper and confer durability. If corrosion took place, it was in accordance with observed cases that the silver alloy would act as a negative element, and the copper alone would be removed. These inferences proved erroneous, as the following results will show:—The Chicora was coppered in January, 1847, taking 7,392 lbs. of metal; she was employed in the China trade, but wore her copper so rapidly that she was removed in March, 1849, 2,682 lbs. only remaining; this was, after the usual operations, consolidated by "cold rolling." The Hamilton was coppered in October, 1847, requiring 7,706 lbs. of metal; this was in the annealed state; she was engaged in the Indian trade, but was obliged to be stripped in August, 1849; the copper remaining was 3,086 lbs. The Carthage was coppered in November, 1847, taking 8,727 lbs. of "cold rolled," likewise in the Indian trade; her sheathing was taken off in August, 1847; the copper remaining was 5,810 lbs. Allowing the same rate of corrosion for each, it will be seen the vessels lost respectively 64·45, 70·38, and 43·00 in 100. In the cases of the Hamilton and Carthage, the influence of the different processes of manufacturing will be seen on the durability of the copper, thereby exhibiting the superiority of the cold rolling over the annealed alloy, while it will be seen that the silver alloy, by taking the negative state in the mass of metal, hastened its destruction, while its own form and condition were such that it was separated as the copper corroded. The average duration of the wear of copper on American ships is three years."

Mr. Prideaux, after many trials and observations, as stated in his correspondence already referred to, seems almost inclined to abandon the quality of the metal, and seek the cause wholly in the conditions, which he states thus:—

"1. *Friction* from heavy shore work, faster sailing, and more active service.

"2. *Corrosive waters*, as the drainage of mines, manufactures, sewers, and putrescent matters in the sea.

"3. *Climate.*—Corrosive action being increased by heat, and sheathing is known to waste quicker in tropical climates.

"4. *Weather.*—Electrical and thundery, storms, &c.

"5. *Electro-Chemical.*—Nails and metal giving a positive tendency to waste.

"6. *Matters laid under sheathing*—as tar, paper, felt, which may have acid or alkaline properties.

"7. *Timber of the vessel.*—Some wood having acid properties, &c."

Nevertheless, he seems driven back to the original question, and sums up his inquiry with the following:—"To whatever extent the recently increased waste of sheathing may be due, such as constant employ, much greater velocity, &c., there is reason to fear the fault is still to be sought too often in the copper itself."

As to the effect of speed and friction, Sir H. Davy found that, on a vessel going at a speed of eight miles an hour, the copper most exposed to the friction of the sea lost more than double that which was least exposed; and Mr. Prideaux found that pieces of the same quality of copper put into sea water, from different localities, were differently acted upon. In thirteen days' exposure the waste of copper in water from—

Heart of Gulf Stream was	1·81
„ Caribbean Sea	0·40
„ Plymouth Harbor	0·31

Such circumstances as these are easily defined; but when two vessels sheathed at one time, and kept nearly under the same conditions, and the copper of the one lasting two or three times that of the other, or even one vessel, her sheathing at one time lasting seventeen or twenty years, and at another not more than three or four, and employed on the same service, are circumstances not so easily accounted for, and require a more strict investigation.

Another element in the consideration of this question is the sea water. Different seas act differently on sheathing, and often weak or diluted sea water more than strong, so that at the mouths of rivers the sheathing is often found to wear more rapidly than out at sea. As a sort of guide to this inquiry, I made the following experiments, taking the different ingredients of sea water alone, and mixed in different proportions, but the gross quantity of the salts in the water being always 3 per cent. of its weight, the results were, that the chlorides acted more rapidly upon the copper, than the sulphates. Of the chlorides that of magnesium acted most; calcium next, and sodium least. Now, according to Professor Graham's experiments, chlorides diffuse more rapidly than any other salts. This may give a preponderance of these salts at the mouths of those rivers, and may have a tendency to an increased wear occasionally in such places.

These important observations and remarks are of the greatest value in the study of the history of the causes that affect the wear of sheathing, and when all the circumstances of this wear are developed, some of the conditions may be found to agree with the observations just cited.

The quantity of salts held in solution in sea water, except in such as the Dead Sea, which is very dense, may be given at an average of from 3 per cent. to 3·8 per cent., of the weight of the water; but the different kinds of salts vary considerably in different localities. In order to set this variation before the reader in the most appreciable form, we have taken the analysis of different sea waters, and calculated the quantity of salts in the 100 parts. The following table exhibits the results, giving at the same time the quantity of the whole in relation to the water:—

PER CENTAGE OF SALTS.

Locality of Water.	Salts in 100 parts water.	Chloride Sodium.	Chloride Magnesium.	Sulphate Magnesia.	Sulphate Lime.	Other Salts not named.	TOTAL.
Nordeny	3·06	84·31	4·08	5·78	4·22	1·27	99·66
Havre..........	3 26	78·71	8·89	7·53	3·70	1·20	99·85
Mediterranean..	3·76	78·14	8·55	6·51	3 60	3·12	99·92
Mediterranean..	4·00	66·81	15·8	17·26	·33	·52	100·0
English Channel	3·50	76·74	10·40	6·49	3·97	2 26	99·86
River at Sierra Leone........	2·4	87·76	7·50	5·00	2·74	....	100·0
Mouth of the River Volta.....	3·5	92·32	1·93	4·34	1·41	trace	100·0
River Bonny ..	2·4	80·86	10·62	5·90	2·62	trace	100·0
River Mooney ..	3·	86·48	5 58	6·43	1·61	trace	100·0
River Gaboon ..	2·9	83·96	6·98	6·35	2·71	trace	100·0
Cape Lopez Bay.	3·7	88·75	4·39	4 69	2·17	trace	100·0
River Congo....	0·25	98·8	....	....	....	1·2	100·0
Frith of Forth..	2·6	79·8	10·1	6·9	3·2	....	100·
Laquin Venice..	2·9	76·73	8·89	9·44	2·06	2·86	99·98
Port of Leghorn	3·43	76·34	8·82	9·00	2·60	3·24	100·
Dead Sea.......	24·5	42·11	41·65	....	0·21	chl. calcm 15·94	99·91
Dead Sea.......	21·73	30·28	49·50	bromide magnesia. 1·10	0·41	chloride calcium. 13 25	chloride potassium 6·44

It will be seen from this table, that some of the salts held in solution vary considerably in their relation to each other; the chloride of magnesia ranges very wide, much more so than the chloride of sodium, or common salt, from the variety in the quantity of salts in the water, which will necessarily cause a great variety in the specific gravity of these waters, especially at the mouths of rivers. It has been observed, that sheathing generally wears very rapidly at the mouths of certain rivers; but if the observations have been made, we have not seen them made public, whether the wear under these circumstances was general over the whole sheathing of the ship, or on certain parts, either near the surface or near the bottom, because a vessel, lying at the mouth of a river, will be floating in water of different densities, which will set up a galvanic action between those parts of the ship, and thus necessitate a greatly increased action upon the metals. This may be easily tested by taking a tall glass vessel, filling it half full with sea water, and then gently filling with ordinary river water, taking care not to mix the two from top to bottom; then insert a slip of clean copper, and the action in a short time will be seen to be different on different parts of the copper, and greater on some parts than it would be if placed in a well mixed solution of the same density.

ON THE COMPOSITION OF SOME VARIETIES OF FORGED IRON.

The following paper on the above subject has been published by Mr. F. A. Abel, Director of the Chemical Establishment of the English War Department.

The Government having now taken the manufacture of iron ordnance into its own hand, directed attention first to iron reduced from its ores by charcoal, this being the material exclusively employed in some continental states; the authorities there laying much stress upon the greater fitness of this description of iron over hot-blast, or even of cold-blast iron, smelted with coal or coke. Experiments were consequently made to ascertain "whether guns manufactured from charcoal iron exhibit great superiority over those made according to the same system of iron reduced from its ores by mineral fuel." For this purpose, specimens of charcoal pig iron have been collected from different countries for comparative examination and experimental purposes. Of two specimens of white iron from Silesia, obtained from different ores, both were hard and brittle. These irons were proposed for admixture with dark grey irons, but were considered not fit for the purpose. Some French iron, reduced by charcoal from hæmatite ores, was dark, soft, fine-grained, and uniform in texture, and its general characters were similar to Swedish grey iron, but superior in reference to the amount of silicium contained. Specimens of Nova Scotian and American irons were of excellent quality. On analysing four specimens of iron gun metal of foreign manufacture, the composition was as follows:—From Belgium (specific gravity, 7·250); iron, 95·61; combined carbon, ·78; graphite, 2·12; silicium, ·99; sulphur, ·06; phosphorus, ·29; manganese, ·15, with traces of titanium, chromium, arsenic, zinc, and copper. The French metal showed the same specific gravity: of iron, 96·02; combined carbon, 1·03; graphite, 1·87; silicium, ·35; sulphur, ·03; phosphorus, ·45; manganese, ·25, with traces of chromium and tin. From Sweden (specific gravity, 7·05): iron, 95·87; combined carbon, ·18; graphite, 2·62; silicium, 1·19; sulphur, ·08; phosphorus, ·11, with traces of manganese, titanium, and chromium. From Russia (specific gravity, 7·135): iron, 94·36; combined carbon, ·47; graphite, 2·83; silicium, 1·10; sulphur, ·02; phosphorus, ·37; manganese, ·85, with traces of titanium and tin. The Swedish gun metal has great resemblance to the Russian. The French gun metal was from the cannon foundry at Rouelle; the Belgian from the Government foundry. The result of the analysis shows thus much as certain, that iron smelted with mineral fuel may be obtained in abundance in Great Britain, containing not more phosphorus or sulphur than is usually found in charcoal iron; and proofs exist of the ease with which silicium may be removed from pig iron; and it may therefore be confidently expected "that we are not dependent on a supply of charcoal iron for the production of durable guns" although it may be at present premature to compare from analysis the merits of charcoal iron with the better qualities of British cold-blast iron as materials for ordnance.

IMPROVEMENTS IN THE MANUFACTURE OF IRON.

No one invention or discovery of the past year has excited more general interest and attention, than the improvements in the manufacture of iron, first publicly announced at the meeting of the British Association by Mr. Bessemer, of England. The readers of the Annual of Scientific Discovery will doubtless recall the fact, that the name of Mr. Bessemer has for a series of years been associated with some of the most important English patents noticed in the successive volumes of this work. He appears to be an inventor by profession, and to a considerable extent successful in his various undertakings. The present invention was at first received with a general enthusiasm—then doubted, denied, and condemned. Nevertheless, the invention stands; is capable of performing all that has been claimed of it; and, theoretically at least, is a great advance in the manufacture of iron. We have seen and examined specimens of the iron produced and used by Mr. Bessemer, in every stage of the process, and the evidence they present is clear and convincing. Notwithstanding these remarks, we would also assert that the process of Mr. Bessemer is no improvement over the processes now used in several of the iron furnaces in the United States. The process of converting pig or cast iron into wrought iron, consists essentially in burning out or eliminating an excess of carbon existing in the cast iron. In the ordinary puddling furnaces, the pig iron is melted and the oxygen gradually burned out by currents of air blown over the surface, and constantly stirring and working. Mr. Bessemer effects the same end by forcing air under powerful pressure into the melted mass of pig iron from below. The fused metal under this action is thrown into violent agitation, boiling and frothing, until nearly every particle has been subjected to the influence of the air current. Oxide of iron is first formed, which, imparting a portion of its oxygen to the carbon, sets free the latter body in the form of carbonic acid. A portion of the carbon is also undoubtedly acted upon directly by the oxygen of the air. The oxide of iron formed also acts as a flux, in separating the silica and other impurities contained in the pig metal. The result of this operation is a direct loss of from 20 to 30 per cent. of metal, principally due to the formation of the oxide of iron. The mass, as it comes from the vessel in which it has been acted upon, is spongy and highly vesicular, resembling scoriæ. Subjected to the action of the hammer in this state when cold, it would undoubtedly crumble, but if it is first thoroughly heated, it may be hammered or rolled into bars of genuine fibrous iron.

The American process which we have spoken of as far in advance of Bessemer's, was privately brought out some years ago by one of our most eminent chemists, and at the present time is comparatively little known, although it has been employed by several furnaces for a number of years with great success. It consists in adding to the pig iron placed in the puddling furnace, such a proportion of a pure variety of iron ore (*i. e.* oxide of iron), that the oxygen of the ore shall exactly suffice for eliminating the carbon of the pig metal as carbonic oxide, or carbonic acid. This proportion, if we remember rightly, is about fifteen parts ore to one hundred of pig metal. The whole is melted up together in the puddling furnace. The oxide at first acts as a flux, but is gradually reduced to pure metal, giving up its oxygen to the carbon of the pig metal. When the operation is complete, the iron master finds that he has not only obtained a perfectly fibrous iron without loss, but for every one hundred pounds of pig metal put into the furnace, he draws out an average of one hundred and five pounds of fibrous iron. This is a step far in advance of anything that Mr. Bessemer, or any other inventor, has yet attained. With these prefatory remarks, we copy the following statement made by Mr. Bessemer at the last meeting of the British Association, as the best familiar explanation of his process:— EDITOR.

"I set out with the assumption that crude iron contains about five per cent. of carbon; that carbon cannot exist at a white heat in the presence of oxygen without uniting therewith and producing combustion; that such combustion would proceed with a rapidity dependent on the amount of surface of carbon exposed; and, lastly, that the temperature which the metal would acquire would be also dependent on the rapidity with which the oxygen and carbon were made to combine, and consequently that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action, in order to produce a temperature hitherto unattainable in our largest furnaces.

"With a view of testing practically this theory, I constructed a cylindrical vessel of three feet in diameter and five feet in height, somewhat like an ordinary cupola furnace, the interior of which is lined with fire bricks, and at about two inches from the bottom of it I insert five tuyère pipes, the nozzles of which are formed of well burned fire clay, the orifice of each tuyère being about three-eighths of an inch in diameter; they are so put into the brick lining (from the outer side) as to admit of their removal and renewal in a few minutes when they are worn out. At one side of the vessel, about half way up from the bottom, there is a hole made for running in the crude metal, and on the opposite side there is a tap hole stopped with loam, by means of which the iron is run out at the end of the process. In practice this converting vessel may be made of any convenient size, but I prefer that it should not hold less than one, or more than five tons, of fluid iron at each charge. The vessel should be placed so near to the discharge hole of the blast furnace as to allow the iron to flow along a gutter into it; a small blast cylinder will be required capable of compressing air to about 8lbs. or 10lbs. to the square inch.

"A communication having been made between it and the tuyères before named, the converting vessel will be in a condition to commence work; it will, however, on the occasion of its first being used after re-lining with fire-bricks, be necessary to make a fire in the interior with a few baskets of coke so as to dry the brick work, and heat up the vessel for the first operation, after which the fire is to be all carefully raked out at the tapping hole, which is again to be made good with loam. The vessel will then be in readiness to commence work, and may be so continued without any use of fuel until the brick lining in the course of time becomes worn away and a new lining is required. I have before mentioned that the tuyères are situated nearly close to the bottom of the vessel; the fluid metal will therefore rise some eighteen inches or two feet above them. It is therefore necessary, in order to prevent the metal from entering the tuyère holes, to turn on the blast before allowing the fluid crude iron to run into the vessel from the blast furnace. This having been done, and the fluid iron run in, a rapid boiling up of the metal will be heard going on within the vessel, the metal being tossed violently about and dashed from side to side, shaking the vessel by the force with which it moves, from the throat of the converting vessel. Flame will then immediately issue, accompanied by a few bright sparks. This state of things will continue for about fifteen or twenty minutes, during which time the oxygen in the atmospheric air combines with the carbon contained in the iron, producing carbonic acid gas, and at the same time evolving a powerful heat. Now, as this heat is generated in the interior of, and is diffusive in innumerable fiery bubbles through, the whole fluid mass, the metal absorbs the greater part of it, and its temperature becomes immensely increased, and by the expiration of the fifteen or twenty minutes before named that part of the carbon which appears mechanically mixed and diffused through the crude iron has been entirely consumed. The temperature, however, is so high that the chemically combined carbon now begins to separate from the metal, as is at once indicated by an immense increase in the volume of flame rushing out of the throat of the vessel. The metal in the vessel now rises several inches above its natural level, and a light frothy slag makes its appearance, and is thrown out in large foam-like masses. This violent eruption of cinder generally lasts about five or six minutes, when all further appearance of it ceases, a steady and powerful flame replacing the shower of sparks and cinder which always accompanies the boil. The rapid union of carbon and oxygen which thus takes place adds still further to the temperature of the metal, while the diminished quantity of carbon present allows a part of the oxygen to combine with the iron, which undergoes combustion and is converted into an oxide. At the excessive temperature that the metal has now acquired the oxide as soon as formed undergoes fusion, and forms a powerful solvent of those earthy bases that are associated with the iron. The violent ebullition which is going on mixes most intimately the scoria and metal, every part of which is thus brought in contact with the fluid oxide, which will thus wash and cleanse the metal most thoroughly from the silica and other earthy bases which are combined with the crude iron, while the sulphur and other volatile matters which cling so tenaciously to iron at ordinary temperatures are driven off, the sulphur combining with the oxygen and forming sulphurous acid gas. The loss in weight of crude iron during its conversion into an ingot of malleable iron was found on a mean of four experiments to be twelve and a half per cent., to which will have to be added the loss of metal in the finishing rolls. This will make the entire loss probably not less than eighteen per cent., instead of about twenty-eight per cent., which is the loss on the present system. A large portion of this metal is, however, recoverable by treating with carbonaceous gases the rich oxides thrown out of the furnace during the boil. These slags are found to contain innumerable small grains of metallic iron, which are mechanically held in suspension in the slags, and may be easily recovered. I have before mentioned that after the boil has taken place a steady and powerful flame succeeds, which continues without any change for about ten minutes, when it rapidly falls off. As soon as this diminution of flame is apparent the workman will know that the process is completed, and that the crude iron has been converted into pure malleable iron, which he will form into ingots of any suitable size and shape by simply opening the tap hole of the converting vessel, and allowing the fluid malleable iron to flow into the iron ingot moulds placed there to receive it. The masses of iron thus formed will be perfectly free from any admixture of cinder, oxide, or other extraneous matters, and will be far more pure and in a more forward state of manufacture than a pile formed of ordinary puddle bars. Thus it will be seen that by a single process, requiring no manipulation or particular skill, and with only one workman, from three to five tons of crude iron pass into the condition of several piles of malleable iron in from thirty to thirty-five minutes, with the expenditure of about one-third part the blast now used in a finery furnace with an equal charge of iron, and with the consumption of no other fuel than is contained in the crude iron. To those who are best acquainted with the nature of fluid iron, it may be a matter of surprise that a blast of cold air forced into melted crude iron is capable of raising its temperature to such a degree as to retain it in a perfect state of fluidity after it has lost all its carbon, and is in the condition of malleable iron, which in the highest heat of our forges only becomes softened into a pasty mass. But such is the excessive temperature that I am enabled to arrive at with a properly shaped converting vessel and a judicious distribution of the blast, that I am enabled not only to retain the fluidity of the metal, but to create so much surplus heat as to re-melt the crop ends, ingot runners, and other scrap that is made throughout the process, and thus bring them without labor or fuel into ingots of a quality equal to the rest of the charge of new metal. For this purpose a small arched chamber is formed immediately over the throat of the converting vessel, somewhat like the tunnel head of the blast furnace. This chamber has two or more openings on the sides of it, and its floor is made to slope downwards to the throat. As soon as a charge of fluid malleable iron has been drawn off from the connecting vessel, the workman will take the scrap intended to be worked into the next charge, and proceed to introduce the several pieces into the small chamber, piling them up around the opening of the throat. When this is done he will run in his charge of crude metal, and again commence the process. By the time the boil commences the bar ends or other scrap will have acquired a white heat, and by the time it is over most of them will have been melted and run down into the charge. Any pieces, however, that remain may then be pushed in by the workman, and by the time the process is completed they will all be melted, and ultimately combined with the rest of the charge, so that all scrap iron, whether cast or malleable, may thus be used up without any loss or expense. As an example of the power that iron has of generating heat in this process, I may mention a circumstance that occurred to me during my experiments. I was trying how small a set of tuyères could be used; but the size chosen proved to be too small, and after blowing into the metal for one hour and three-quarters, I could not get up heat enough with them to bring on the boil. The experiment was therefore discontinued, during which time two-thirds of the metal solidified and the rest was run off. A larger set of tuyère pipes were then put in, and a fresh charge of fluid iron run into the vessel, which had the effect of entirely re-melting the former charge, and when the whole was tapped out it exhibited as usual that intense and dazzling brightness peculiar to the electric light. One of the most important facts connected with the new system of manufacturing malleable iron is, that all the iron so produced will be of that quality known as charcoal iron; not that any charcoal is used in its manufacture, but because the whole of the processes following the smelting of it are conducted entirely without contact with, or the use of any mineral fuel; the iron resulting therefrom will, in consequence, be perfectly free from those injurious properties which that description of fuel never fails to impart to iron that is brought under its influence. At the same time, this system of manufacturing malleable iron offers extraordinary facility for making large shafts, cranks, and other heavy masses; it will be obvious that any weight of metal that can be founded in ordinary cast iron by the means at present at our disposal, may also be founded in molten malleable iron, and be wrought into the forms and shapes required, provided we increase the size and power of our machinery to the extent necessary to deal with such large masses of metal. A few minutes' reflection will show the great anomaly presented by the scale on which the consecutive processes of iron making are at present carried on. The little furnaces originally used for smelting ore have, from time to time, increased in size, until they have assumed colossal proportions, and are made to operate on 200 or 300 tons of materials at a time, giving out ten tons of fluid metal at a single run. The manufacturer has thus gone on increasing the size of his smelting furnaces, and adapting to their use the blast apparatus of the requisite proportions, and has, by this means, lessened the cost of production in every way; his large furnaces require a great deal less labor to produce a given weight of iron than would have been required to produce it with a dozen furnaces; and in like manner he diminishes the cost of fuel blast and repairs, while he insures a uniformity in the result that never could have been arrived at by the use of a multiplicity of small furnaces. While the manufacturer has shown himself fully alive to these advantages, he has still been under the necessity of leaving the succeeding operations to be carried out on a scale wholly at variance with the principles he has found so advantageous in the smelting department. It is true that hitherto no better method was known than the puddling process, in which from 400 to 500 weight of iron is all that can be operated upon at a time, and even this small quantity is divided into homœopathic doses of some 70lbs. or 80lbs., each of which is moulded and fashioned by human labor, carefully watched and tended in the furnace, and removed therefrom one at a time, to be carefully manipulated and squeezed into form. When we consider the vast extent of the manufacture, and the gigantic scale on which the early stages of the process are conducted, it is astonishing that no effort should have been made to raise the after processes somewhat nearer to a level commensurate with the preceding ones, and thus rescue the trade from the trammels which have so long surrounded it.

Comments and Thoughts on the Discovery of Mr. Bessemer.—It will be obvious that one principal feature in the process is, that the operator deals with the metal in a state of perfect fluidity—a desideratum hitherto unattainable with iron containing only a small quantity of carbon. Hence it cannot merely be procured in masses of any size (whereas the puddler can only produce 60 or 70 lbs. in a lump), but it will possess the distinguishing character of all fluids—it will be perfectly homogeneous. The texture, composition, and quality will be the same throughout every part of the mass. That the fluidity is really greatly increased, notwithstanding the subtraction of the carbon, is shown by the fact that it is found desirable to diminish the power of the blast from nine or ten pounds to about five pounds during the latter part of the process, as well as by the rapidity with which the metal runs out of the furnace, and its brilliant whiteness. It is impossible to overrate the advantage of having a really homogeneous product. In large masses of malleable iron, procured in the ordinary way by welding together a number of the puddler's *blooms*, there often occur small knobs and fragments of metal much harder than the rest; and many manufacturers consider soft malleable iron quite as trying to their tools as hard steel, from the unexpected increase of resistance suddenly offered by particular parts of the mass, and the consequent unequal strain upon different portions of the machinery. The greater the mass required, the greater the difficulty of obtaining a metal upon all parts of which equal reliance can be placed; and hence, where a very heavy strain, in a direction different from that of the fibre, is expected, strength is often obliged to be sought in an enormous thickness of material. The prodigious weight of anchors is rendered necessary by the impossibility of calculating accurately the strength of the metal in any particular part, so that the size of the whole must be increased to meet the chance of a bad piece of metal occurring here and there. One of Mr. Bessemer's numerous patents is for the application of his invention to the construction of anchors, in which he hopes to attain equal strength with a greatly diminished weight.

One of the results of the invention will be the curious anomaly that steel will be produced at a little less risk, and therefore at a little less cost, than malleable iron; for it is obvious that, by tapping the furnace *before* the complete combustion of the carbon has taken place, steel will be produced instead of iron. Practice and experience will, no doubt, in time enable the workman so to regulate the operation as to produce to a nicety any particular quality of iron or steel required; but until this practical knowledge has been gained, there will be some difficulty in calculating the exact length of time to be occupied in the conversion. If, therefore, the process should be continued a little too long for steel, malleable iron will be obtained—if it be continued a little too long for malleable iron, the metal will be set in the furnace. The "boil" appears to be the critical period. Whatever be the time occupied in arriving at the boil, it is found that from 12 to 15 minutes are requisite to produce malleable iron, and from 7 to 12 minutes to produce the different qualities of steel.

How effectually the carbon can be removed is shown by an analysis of a chance specimen of Mr. Bessemer's malleable iron, made by Dr. Henry, who, we believe, was strongly inclined to doubt whether the process could really be as successful as it was stated to be. He found the quantity of carbon present to be less than 1-30th per cent.—or less than 1-3000th part of the weight of the metal. Of silica, a trace merely was found. By the application of means already well understood, the sulphur and phosphorus will be as completely removed. A considerable portion of both is driven off without the use of any means for that special object; and by treating the melted metal with proper substances, these impurities will be withdrawn. The difficulty which Mr. Bessemer has applied himself to solve, and which he has solved, is the complete separation of carbon and the earthy bases. Apart from the cheapness and facility of his process, he has been able successfully to grapple with the half per cent. of carbon which puddling can never get rid of.

The process, as described above, is open to a serious objection. The blast must be kept up to the last, or the melted metal would run into the tuyères, and spoil the blast apparatus. Hence the air is being driven through the metal up to the very moment that it ceases to run out of the vessel; and the ingots produced are consequently very porous and full of air bubbles. With malleable iron, this is of no importance, as it would always be rolled while in a state not far from fusion, and the air would be completely squeezed out, as the slag is squeezed out of the puddled ball. But cast steel would be useless if porous—a difficulty which is met by an ingenious modification of the converting vessel. It is slung horizontally at the end of two cranks, which, by means of a counterbalancing weight, can easily be turned through any angle. The blast is admitted by a pipe passing through the axle of one of the cranks, and thus revolving with the converting vessel. The tuyères enter the converting vessel by a series of apertures forming a horizontal row. The cylinder can thus be made to revolve round the axis of the crank without turning upon any axis of its own; and thus the apertures of the tuyères may be raised till they are brought above the surface of the metal. The blast can then be turned off and the agitation of the metal allowed to subside. Iron melted by existing processes sets in about three or four minutes, but Mr. Bessemer finds that he can allow it to stand for ten or twelve minutes—a period quite sufficient to allow all the air bubbles to escape—and the cylinder may then be raised still further, and the metal poured off as gently as may be requisite, through a spout at the top or in the side of the vessel.

Mr. Nasmyth tried some years ago to decarburize cast iron by blowing steam into the melted metal. This attempt failed, as the separation of the oxygen from the steam exhausted so much of the heat of the metal that the heat evolved in the combination of the oxygen with the carbon in the iron was insufficient to compensate the waste; and the iron was cooled instead of being heated. With the freedom from jealousy which marks a truly great mind, Mr. Nasmyth paid, at the last meeting of the British Association, a graceful tribute to the importance of the invention, and spoke in terms no less honorable to himself than to Mr. Bessemer, of the ingenuity of the process and the vastness of the results to which it would unquestionably lead.

Uchatius' Process for Manufacturing Steel.—We would, in this connexion, also call attention to a new process for producing cast steel, which is now exciting considerable attention in Europe. It is the invention of Captain Uchatius, an artillery officer in the Austrian service. He states, as the result of his experience, that the quality of the steel is influenced greatly by the size of the pieces of iron employed in its manufacture, the goodness of the cast steel being in proportion to the smallness of the lumps of iron. In order to reduce the iron, therefore, to the proper size, Captain Uchatius conducts the mass of molten metal directly from the blast furnace, into cold water, which is kept in motion by mechanical means; the iron is formed into fragments or grains, varying from 60 to 2000 to the kilogramme. The finest steel is made from the pieces of which 2000 go to the kilogramme. These bits of iron are then placed in crucibles and mixed up with a certain per-centage of finely powdered, sulphurless spathose iron ore and brown iron ore. The metal thus prepared is subjected to the requisite heat, and drawn off into ingot moulds. This steel, it is asserted, is of the finest and purest quality, varying, according to the pleasure of the manufacturer, from the most flexible steel for springs to the hardest double shear or file steel.

One of the characteristic features of the process of M. Uchatius, is not only to have introduced the atomic system by fusion, but also to have done this in the preparation of the material. Before fusion, the cast iron is mixed as much as possible with the metallic oxides, and the application of heat only terminates what the preparation has commenced. Among other advantages which appear to be derived from this new method, is economy in material; for, from numerous experiments made by the French Government, the loss is stated to be only 4 to 5 per cent. upon the cast iron submitted to the atomic treatment, and as the metallic oxides will part with what they have taken, the loss will even be less. The theory of the operation is of easy explanation, based as it is upon well known chemical facts. On surrounding the cast iron with oxygenated bodies, and applying heat, the grains part with their carbon, and this element combines with the oxygen of the metallic oxides, and is liberated under the form of carbonic acid and carbonic oxide. Another very important advantage attributed to this invention is, that the metallurgist is enabled to regulate his proportion of oxygen in such a manner that, by adding a certain quantity of forged iron, he can produce ten different kinds of steel. If this is so, it is a most essential point; for, to be able to undertake the manufacture of steel with a certainty as to the quality to be produced, would be of vast importance. All persons familiar with the business know that little dependence can, in this respect, be placed upon the usual methods. M. Uchatius' manner of tempering is the same as that employed in making English cast steel. It is said that the expense of producing 1,000 kilogrammes (about 2,187 lbs.) will not exceed $92, whereas to make that quantity of ordinary steel costs, in France, $200, and of the best quality $500. These prices would be materially diminished by establishing the works in the vicinity of coal mines, where a supply of fuel could be obtained cheaply. If the price of steel could thus be reduced it would undoubtedly replace iron in many cases; a great economy would also result from its employment in making pieces of artillery, where cast steel would have the immense advantage of being lighter, less costly, and more solid than copper. Experiments are now being made at the arsenal of Vienna to determine this point. A committee appointed by the French Government to examine the discovery report that the cast steel produced by his method is calculated to replace iron with great advantage in the manufacture of piston rods, axle trees, and connecting rods; also that the process is simple, and can be employed without great outlay; and lastly, that cast steel of various degrees of hardness can be obtained by modifying the proportion of the materials first employed. These materials being cast iron, and other substances of no great cost, it follows that the cast steel produced by this method will cost less than any other.

An exhibition of the process of Captain Uchatius was recently made in London, before a company of manufacturers and scientific men. While the preparations for the process were going on, Mr. Lenz, a partner of Captain Uchatius, read a paper descriptive of the invention. He commenced by explaining that he had labored under many disadvantages in being compelled to contrive substitutes for the regular furnaces, and other proper appliances peculiar to steel works, but, nevertheless, an opinion could be there formed of the merits of this important invention, for all the melting operations in cast steel manufacture were necessarily a series of operations on a small scale, the size of a steel crucible limiting the magnitude of the furnaces. The method heretofore adopted for making the best description of cast steel, was to convert Swedish or Russian bar iron, by a lengthy, uncertain, and costly process, first into what is called blister steel, which product was then melted down in crucibles and cast into ingots for the manufacture of the bar steel of commerce. Mr. Lenz proceeded to say that the present invention would render England quite independent of Sweden and Russia for steel iron making, as East India pig iron, now very plentiful and cheap, could be converted into steel in as few *hours* as Swedish and Russian bar iron would take *weeks* to manufacture; besides which, numerous descriptions of ordinary English pig iron would answer equally well, judging from the limited experiments in English iron he had performed. He expected that nearly all the iron works would soon make steel as regularly as they now make iron; and did not hesitate to assert that fully two-thirds of the cost of producing cast steel might be saved by using the present instead of the old process.

Mr. Lenz then proceeded to explain that the invention of Captain Uchatius was founded on the well known fact, that cast iron surrounded by any oxygenized materials, and subjected to a cementing heat for a given time, would yield up a portion of its carbon, which would combine with the oxygen driven off from the surrounding materials, forming carbonic oxide or carbonic acid gas. If this process were interrupted before completion, a partially decarbonized iron would result, the surface of which would have been converted into a pure iron, while the inner parts remained unchanged; or in other words, the progress of decarbonizing action would depend on the amount of metallic surface brought into contact with the oxygen-yielding material with which the iron was surrounded. In order, therefore, to expedite this operation, the pig iron was first reduced to a granulated state, which was accomplished by simply running the molten iron from the cupola (a blast furnace in some cases) into cold water, agitated by mechanical means. This granulated iron was mixed with a proper proportion of pulverized oxygen-yielding materials of a very cheap description, such as sparry iron ore (spathose ore), and adding, if requisite, a small quantity of manganese, which mixture was put into common crucibles, and subjected to heat in a cast steel blast furnace of ordinary construction. By thus subjecting the granules of iron in presence of the sparry iron ore to a melting heat, the surrounding oxides would first effect a partial decarbonization of the granulated iron, which decarbonization would be limited in amount according to the size of the granules operated upon, and by reason of the continued application of heat, the iron would melt and separate (with the assistance of the melting residue of sparry iron ore) from the impurities with which it was mixed, and also bring down with it a portion of the iron contained in the sparry iron ore, thereby increasing the yield of cast steel by 6 per cent. The manipulations of melting and casting were the same as those commonly employed by cast steel manufacturers. The quality of steel made by this process could be considerably modified. Thus, the finer the pig iron was granulated, the softer would be the steel made therefrom. The softer sorts of welding cast steel might be obtained by an addition of good wrought iron in small pieces, and the harder qualities by adding charcoal in various proportions to the above-mentioned mixture. Thus crude iron might be converted into steel ingots in the incredibly short space of about two hours.

Mr. Lenz then proceeded to exhibit the preliminary process of granulating, by running a crucible of melted pig iron into a vessel of water, when it was instantaneously converted into shot-like particles. A weight of twenty-four pounds of crushed ore and peroxide of manganese, in the proportion of about four pounds of ore and two pounds of peroxide of manganese, to which was added a small quantity of fire clay, was filled into the crucible in the temporary furnace, and allowed to melt in the usual manner. In the meantime the company proceeded to witness the operation of hammering down into a bar of an ingot of this new steel, which had been made a few days since; and although the steam hammer used was not at all adapted for steel, nevertheless, the bar steel produced from the ingot then hammered, was pronounced to be of excellent quality, and tools made from a fellow ingot were tried, and found to possess the qualities of fine English cast steel. About two hours and three-quarters had elapsed since the filling—some defect in the blast a little retarding the melting—the contents of the crucible were poured into the iron mould, from which, when opened, an ingot of steel weighing twenty-five pounds, being one pound more than the iron used, was exhibited, which bore every external evidence of being perfect in quality. It was intended to be properly tilted into bar steel, for further tests as to its qualities and properties. The simplicity and rapidity of the new process, as well as the quality of steel shown, elicited much admiration. The importance of the process in reducing the cost of steel can scarcely be overrated, when the innumerable new uses to which it will inevitably be turned in preference to iron are considered; the expense of steel tires, axles, piston rods, shafts, and other important working parts of machinery, being estimated as not exceeding the price now paid for first-class iron.

New Cast Steel Process.—Mr. R. A. Brooman, of London, has lately secured a patent, as agent for a foreign inventor, for the following new method of manufacturing cast steel:—

The basis of the invention consists in the introduction into crucibles, along with the pieces of wrought or malleable iron, of certain chemicals in which cyanogen is contained. As for example, cyanide of potassium and ferrocyanide of potassium, are to be used in connexion with some form of sal-ammoniac. The usual furnaces and melting pots suitable for melting blister steel may be employed. The malleable iron (which may be of any description, such as bar, scrap, blooms, &c.) is prepared by cutting or breaking it up into small pieces. In a 50lbs. charge of iron in a crucible are introduced ten ounces of charcoal, six ounces of common table salt, half an ounce of brick dust or oxyde of manganese, one ounce of sal-ammoniac, and half an ounce of ferrocyanide of potassium. The pot is to be covered and introduced into the furnace, and the contents thoroughly melted, the heat being maintained for the space of three hours or thereabouts. The mass is then to be poured off into iron moulds in the ordinary way of pouring cast steel, and with the usual care required for producing a solid ingot. This may then be rolled into sheets, or hammered or tilted into bars, after the common method. In this process the employment of table salt, manganese, or brick dust, is for the formation of scoriæ upon the top of the melted mass, to keep out the air. The proportions of ingredients given may be varied, and some may be omitted altogether, or others substituted. The essentials are the sal-ammoniac, some substance affording cyanogen, and charcoal. Fine cast steel may be produced with ferrocyanide of potassium and charcoal, also with sal-ammoniac and charcoal. The hardness or brittleness, as well as firmness of grain and degree of malleability, may be varied by altering the proportions of the several ingredients, especially of the charcoal, sal-ammoniac, and cyanogen. No particular character or quality of iron is necessary. Steel, it is stated, can be produced by this process from common English iron equally as well as from the best Swedish.

This process, which is undoubtedly a great improvement, has recently been put in practical operation near New York. It is, however, questionable whether any patent on such a process could be maintained, the operation being substantially the same as that of case-hardening; and it has also been applied before to the manufacture of steel. EDITOR.

Improved Method of Refining Iron.—Charles Sanderson, of Sheffield, Eng., has taken out a patent for the employment of copperas or sulphate of iron by adding to it cast iron while in a molten state, which he states acts as a reagent uniting with the silicon, phosphorus, arsenic, and other impurities in the iron, and carrying them off in the form of a scoria, thereby producing iron castings of far greater strength and purity.

Improvement in the Manufacture of Pig Iron and Steel.—The following improvement in the preparation of pig iron is highly spoken of in England:—

A small quantity of common salt (say 1½ or 2 per cent.) is introduced into the coke ovens, along with the small coals. The salt removes the sulphur from the coke, and hence the iron made with this coke in the blast furnace is materially improved. Bars made from this iron have broken like crown iron, and it makes capital rails. It is very likely that the process will be generally adopted with coals of an inferior description. An invention which has lately been patented in England by Mr. J. B. Howell consists in the manufacture of ingots or blocks of cast steel, for ordnance and other purposes, with an iron centre. The inventor places a bar of hot iron covered with a deoxydizing agent, in the centre of the mould, previous to pouring in the melted steel, and, by the use of this oxydizing agent, removes or dissolves the oxide from the iron, and by thus removing the oxide, the steel, while in a fluid state, comes in direct contact with the iron, insuring perfect cementation between the steel and the iron.

The correspondent of the London *Mining Journal* in Rhenish Prussia, expresses surprise that some of the capitalists in England do not turn their attention to puddling pig steel, which in Prussia is making rapid strides. Puddling both iron and steel with gas is very general in Prussia. In some instances the gas is obtained from the blast furnace, but in most cases it is generated in small ovens, attached to each furnace. Dry wood, charcoal, lignite, and turf are employed as fuel. At one of the iron works where wood is used for gas the charges are 8 cwt. of white mottled iron each furnace, bringing out 20 to 21 tons of puddled bars per week at a loss of only 4 or 5 per cent. and with a consumption of 4 cubic feet of timber per cwt. of puddled bars. At another works they charge with 10 cwt. of grey pig, and bring out the charge in 2½ hours with 8·70 cubic feet of wood per cwt. of puddled bars. A large rolling-mill is arranged to puddle steel with gas from iron lignite, to be converted into railway wheels and tires, for which there is an increasing demand. These are forged under the hammer to nearly the required form, and then passed through a pair of rolls to finish them.

The following is the description of a method of making cast steel, for which a patent has been recently granted to G. Brown of Swinton, England.

"The patentee puts into a common melting pot charcoal bar iron, clipped in pieces, of about one and a half inches long, and adds thereto good charcoal pig iron, in the proportion of one part, more or less, by weight of pig iron, to three parts more or less, of the clipped bar iron. This combination of metals is melted in the usual manner, and then run into ingot moulds. By this process cast steel is obtained suitable for any purpose to which cast steel made on the old plan can be applied,—the various qualities of steel required being obtained by slightly varying the proportions of bar and pig iron. Taking 40 pounds weight as the standard of an ingot, from seven to twelve pounds of pig metal are used, and the remainder is made of bar iron; these proportions would produce a cast steel suitable for most purposes. Thus, for cast steel to be manufactured into edge tools, ten pounds of pig metal are added to thirty pounds of bar iron. For table knives, eight pounds of pig metal are combined with thirty-two pounds of bar iron; and for hard steel, twelve pounds of pig metal are added to twenty-eight pounds of bar iron. But as almost all irons differ in hardness and quality, these proportions must, to a slight degree, be modified according to the judgment of the melter."

ON THE MANUFACTURE OF IRON.

The following is an abstract of a paper read before the London Society of Arts, by Prof. Calvert:—

After pointing out what were believed to be the causes of inferiority of iron, in many works, apart from the varying qualities of the ores, the injurious action which an impure fuel had upon the quality of the iron was particularly alluded to; and the necessity of removing the sulphur from the coal or coke, when employed in the blast furnaces, before it could be imparted to the cast iron during the process of smelting, was strongly enforced.

Prof. Calvert then referred to several instances in which the quality of iron, after the application of the chloride of sodium in the blast furnace, had been greatly improved. These improvements were described to have been effected at a very small cost, by the following simple process. If the blast furnace was worked entirely with coal, chloride of sodium was added, with each charge, in proportion to the quality of the ore and flux employed; but a better result was produced if the coal was previously converted into coke, and an excess of the chloride was used in its preparation, in order to act on the sulphur of the coal and of the ore should any be found therein; and a greater improvement was manifested in the quality of the iron, when only coke so prepared was used in the blast furnace. The coke, so purified, emitted no sulphurous fumes when taken out of the coke oven; nor when extinguished with water did it give off the unpleasant odor of sulphuretted hydrogen, nor was there any sulphurous acid gas liberated, during the operation of smelting iron in the cupola, or in raising steam in the locomotive boiler, by coke so prepared; and it was stated that these decided advantages were gained, in some cases at an additional cost of only one penny per ton of fuel. Prof. Calvert then gave the results of a series of experiments which had been made upon trial bars one inch square, cast from iron melted in the cupola, with coke prepared by his process. He exhibited specimens of the iron so prepared, when the closeness of texture and the absence of the "honeycomb" appearance prevailing in the iron cast with the ordinary coke, was clearly demonstrated.

The mode of experimenting was described, and the results were given very elaborately, and it was shown that the average increase of strength was from 10 to 20 per cent.

Taking the mean of the whole experiments, the following conclusions were arrived at:—The mean breaking weight of the bars, 1 inch square, smelted with the improved coke, was 515·5 lbs.; ditto, with extraordinary coke, 427·0 lbs.—equal to 88·5 lbs. in favor of the castings produced from the improved coke, or in the ratio of 5 to 4.

The experiments on the bars smelted with the improved coke, indicated iron of a high order as to strength, and might be considered equal to the strongest cold blast iron. The metal appeared to have a run exceedingly close, and exhibited a compact granulated structure, with a light grey color.

IMPROVEMENTS IN PLATING, GILDING, AND SILVERING.

Liebig's Process.—The following are the details of a process recently published by Liebig, by means of which glass can be plated without heat, thus forming faultless optical mirrors. The bath which gives the desired result is a solution of ammoniacal nitrate of silver, with the addition of potassa or soda, which deposits the silver at the ordinary temperature when put in contact with an aqueous solution of sugar of milk in the following proportions:—Fused nitrate of silver, 10 grs.; distilled water, 200 c.c.; ammonia, sufficient to obtain a limpid solution; to which is added by degrees potash ley of 1·05 density 450 c.c., or soda ley of 1·035 density 450 c.c. When the ley is added, a dark-colored precipitate is formed, which disappears on the addition of a further quantity of ammonia. When all the ley has been added, it is diluted with water to 1450 c.c., after which a dilute solution of nitrate of silver is carefully added until a permanent grey precipitate is produced. Sufficient water is then added to bring the quantity up to 1500 c.c., or a litre and a half of liquid, so that each cubic centimetre contains rather more than 6·66 milligrammes of nitrate of silver, corresponding to 4·18 milligrammes of metallic silver. The liquid should not contain any free ammonia; this alkali should be completely saturated by the oxide of silver. To get a complete saturation, a little of the silver solution should be added quite at last. In this case, 1 c.c. of liquid contains rather less than 4·18 milligrammes of silver in solution. The potassa or soda ley should be quite free from chlorides; to prepare it, carbonate of potassa, or preferably, of soda, should be used, quite free from chlorides, and decomposed in distilled water with lime which has been purified by sufficient washing. The ley must not be filtered, it must become clear by repose. When this ley is required for plating glass, add one-tenth or one-eighth of its volume of a solution of sugar of milk, containing 10 per cent. of sugar. To use these liquids, the glass must be supported by fastening a bar of tin at the back of the glass with wax, so that it can be suspended; under which is placed a glass or porcelain capsule, so that a space of half an inch is left between the bottom of the capsule and the surface to be silvered; the capsule is then filled with the liquid, to which the sugar of milk has just been added, and the whole is arranged so that the object to be silvered shall have its anterior surface quite immersed. It will be perceived that the silvering should take place at the surface of the bath, and not at the bottom, and that it is indispensable that the glass object should float and be supported in some manner upon the surface. It is necessary not to mix the sugar of milk with the bath until the moment of using, for the reduction commences immediately, as will be known by the brown color which it acquires; the object immersed becomes black in a few minutes;

after about a quarter of an hour it reflects objects, and the reduction may be considered as complete, when the bath is covered with a reflecting pellicle of metallic silver. In this operation all the silver is precipitated in the metallic state, and only a very small fraction of the reduced metal is fixed on the object which it has been proposed to plate. According to a very exact determination, the silver thus fixed on a glass surface of 226 square centimetres is 49 milligrammes. Consequently, to plate a square metre of glass surface, we should only require 2·210 grs. of silver, which is but a trifle. 280 cubic centimetres of liquid were required to plate those 226 square centimetres of superficies; now, 280 c.c. of liquid contain 1170 milligrammes of silver, consequently, in the interior of the vessel and the sides, were deposited 1170 — 49 = 1121 milligrammes of silver, which were collected and again converted into nitrate. When the operation is concluded, the object plated is removed, washed with hot distilled water, and dried in a warm place. Care must be taken not to touch the plated surface during these operations, or else the water will get in under the metallic layer, and cause it to fall off. After desiccation this layer adheres so strongly that it can scarcely be removed with the nail. If the plating has been performed on the surface of the bath, the layer will be of equal thickness all over, and with proper polishing, will have every quality of a silvered mirror. To attain unfailing success, several precautions are necessary: in the first place, the bottom of the vessel should be all over of an equal distance from the surface of the future mirror, otherwise some parts of this surface will be covered with a thinner plate of silver than others, and will consequently appear duller; for they will not reflect the light so well as the parts which are more thickly covered. Another important point is that the surface to be silvered should be perfectly clean; glasses simply wiped with a cloth will take a layer full of patches, on which will be plainly visible the streaks left by the cloth. Then the surface to be silvered must be wetted all over; the smallest bubble of air will produce a hollow in the layer. Before putting the glass on the bath it is better to wet it completely; the liquid used for this should be alcohol, in preference to water, as it drives off the air better. The glass would be plated as well at the bottom of the bath as at the top, only that in that case the whole of the silver would accumulate on the object, and the mirror would necessarily be so much the dearer. When the mirror is dry, the layer is covered with a colorless varnish composed of an alcoholic solution of gum dammar; it is then framed.

Gilding.—To gild glass permanently, heat is essential; gilding without heat is of a beautiful color and very brilliant, but it does not adhere strongly, and will strip off with washing. The gilding bath is prepared by means of a solution of gold in *aqua regia*, a solution to which is added 292 milligrammes of chloride of sodium per gramme of gold; it is evaporated to dryness, and heated until all the free acid is disengaged; after which the double salt is dissolved in water in sufficient quantity to make 100 c.c. of liquid contain 1000 milligrammes of gold. With this solution two others are prepared, one of which is composed of solution of gold, 50 c.c.; soda ley (density 1·035), 20 c.c.; water, 300 c.c. It is boiled in a flask until reduced to 250 c.c. The second solution is prepared with solution of gold, 50 c.c.; ley, 20 c.c.; water

200 c.c. The whole being put into a flask is placed in boiling water for an hour. The two liquids are then mixed, and may be used with success when recently prepared. To gild the inside of a glass vessel, a tenth part of its volume must be filled with a mixture formed of two parts of alcohol and one of ether, and then filled with the auriferous solution while still hot; the vessel must then be placed in water of the temperature of about 176° F. (80° C.) In less than 15 minutes the internal surface will be covered with a pellicle of gold; the vessel is to be removed when the sides are opaque, or, at any rate, when, seen by transparency, they have assumed a deep green color. The solution of gold is, of course, always reduced by the alcohol; but if we wish for a brilliant layer of metallic gold, we must arrange so that the affinity of gold for water should not be greater than that of gold for glass, and that the latter should be rather stronger than the other. It is difficult to hit upon the exact point, and the least variation in the proportions would injure the results. The above described bath will only gild when recently prepared; standing for 24 hours will destroy this property. When fit for gilding it possesses a slightly yellow tint; with time it loses this color, as well as the property of depositing a brilliant layer on glass; moreover, alcohol then reduces the gold with great difficulty.

Petitjean's Process.—The new process discovered by M. Petitjean for silvering glass is thus described by Prof. Faraday:—"It consists essentially in the preparation of a solution containing oxyd of silver, ammonia, nitric and tartaric acids, able to deposit metallic silver either at common or somewhat elevated temperatures. 1540 grains of nitrate of silver being treated with 955 grains of strong solution of ammonia, and afterwards with 7700 grains of water, yield a solution to which, when clear, 170 grains of tartaric acid, dissolved in 680 grains of water, are to be added, and then 152 cubic inches more of water, with good agitation. When the liquid has settled, the clear part is to be poured off; 152 cubic inches of water to be added to the remaining solid matter, that as much may be dissolved as possible, and the clear fluids to be put together and increased by the further addition of 61 cubic inches of water. This is the silvering solution No. 1. A second fluid, No. 2, is to be prepared in like manner, with this difference, that the tartaric acid is to be doubled in quantity.

"The apparatus employed for the silvering of glass plate consists of a cast iron table box, containing water within, and a set of gas burners beneath to heat it. The upper surface of the table is planed and set truly horizontal by a level. Heat is applied until the temperature is 140° Fah. The glass is well cleaned, first with a cloth, after which a plug of cotton, dipped in the silvering fluid and a little polishing powder, is carefully passed over the surface to be silvered, and when this application is dry it is removed by another plug of cotton, and the plate obtained is perfectly clean. The glass is then laid on the table, a portion of the silvering fluid poured on to the surface, and this spread carefully over every part by a cylinder of india rubber stretched upon wood, which has previously been cleaned and wetted with the solution. In this manner a perfect wetting of the surface is obtained, and all air bubbles, &c., are removed. Then more fluid is poured on to the glass until it is covered with a layer about one-tenth of an inch in depth, which easily stands upon it, and in that state its temperature is allowed to rise. In about ten minutes, by the heat of warm water in the hollow box of the table, silver begins to deposit on the glass, and in fifteen or twenty minutes a uniform opaque coat, having a greyish tint on the upper surface, is deposited. After a certain time, the glass employed in the illustration was pushed to the edge of the table, was tilted that the fluid might be poured off, then washed with water, and examined. The under surface presented a perfectly brilliant metallic plate of high reflective power, as high as any that silver can attain to; and the coat of silver, though thin, was so strong as to sustain handling, and so firm as to bear polishing on the back to any degree, by rubbing with the hand and polishing powder.

"The usual course in practice, however, is when the first stratum of fluid is exhausted, to remove it, and apply a layer of No. 2 solution, and when that has been removed and the glass washed and dried, to cover the back surface with a protective coat of black varnish. When the form of the glass varies, simple expedients are employed, and either concave, convex, or corrugated surfaces are silvered, and bottles and vases are coated internally. It is easy to mend an injury in the silvering of a plate, and two or three cases of repair were performed on the table."

SOME OBSERVATIONS ON DIVIDED GOLD.

The following is an abstract of a paper recently read before the Royal Institution of Great Britain, by Prof. Faraday:—

The author has been led by various considerations to seek experimentally for some effect on the rays of light by bodies which when in small quantities had strong peculiar action upon it, and which also could be divided into plates and particles so thin and minute as to come far within the dimensions of an undulation of light, whilst they still retained more or less of the power they had in mass. The vibrations of light are for the violet ray 59,570 in an inch, and for the red ray 37,640 in an inch; it is the lateral portion of the vibration of the ether* which is by hypothesis supposed to affect the eye, but the relation of number remains the same. Now a leaf of gold as supplied by the mechanician is only $\frac{1}{280,000}$ of an inch thick, so that $7\frac{1}{2}$ of these leaves might be placed in the space occupied by a single undulation of the red ray, and 5 in the space occupied by a violet undulation. Gold of this thickness and in this state is transparent, transmitting green light, whilst yellow light is reflected; there is every reason to believe also that some is absorbed, as happens with all ordinary bodies. When gold leaf is laid upon a layer of water on glass, the water may easily be removed and solutions substituted for it; in this way a solution of chlorine, or of cyanide of potassium, may be applied to thin the film of gold; and as the latter dissolves the other metals present in the gold (silver for instance, which chlorine leaves as a chloride), it gives a pure result; and by washing away the cyanide, and drying and draining the last remains of water, the film is left

* Analogous transverse vibration may easily be obtained on the surface of water or other fluids by the process described in the *Philosophical Transactions* for 1831, p. 336, &c.

attached to the glass: it may be experimented with, though in a state of extreme tenacity. Examined either by the electric lamp, or the solar spectrum, or the microscope, this film was apparently continuous in many parts where its thickness could not be a tenth or twentieth part of the original gold leaf. In these parts gold appeared as a very transparent thing, reflecting yellow light, and transmitting green and other rays; it was so thin that it probably did not occupy more than a hundredth part of a vibration of light, and yet there was no peculiar effect produced. The rays of the spectrum were in succession sent through it; a part of all of them was either stopped or turned back, but that which passed through was *unchanged* in its character, whether the gold plate was under ordinary circumstances, or in a very intense magnetic field of force. When a solution of gold is placed in an atmosphere containing phosphorus vapor the gold is reduced, forming films that may be washed and placed on glass, without destroying their state or condition; these vary from extreme thinness to the thickness of gold leaf or more, and have various degrees of reflective and transmissive power; they are of great variety of color, from grey to green, but they are like the gold leaves in that they do not change the rays of light. When gold wires are deflagrated by the Leyden discharge upon glass plates, extreme division into particles is effected, and deposits are produced, appearing by transmitted light of many varieties of color, amongst which are ruby, violet, purple, green, and grey tints. By heat many of these are changed so as to transmit chiefly ruby tints, relieving always the reflective character of gold. None of them affect any particular ray selected from the solar spectrum, so as to change its character, other than by reflection and absorption; what is transmitted still remains the same ray. When gold leaf is heated on glass, the heat causes its retraction or running together. To common observation the gold leaf disappears, and but little light is then reflected and stopped; but if pressure by a polished agate convex surface be applied to the gold in such places, reflective power reappears to a greater or smaller degree, and green light is again transmitted. When the gold films by phosphorus have been properly heated, pressure has the same effect upon them. If a piece of clean phosphorus be placed beneath a weak gold solution, and especially if the phosphorus be a clear thick film, obtained by the evaporation of a solution of that substance in sulphide of carbon, in the course of a few hours the solution becomes colored of a ruby tint; and the effect goes on increasing, sometimes for 2 or 3 days. At times the liquid appears clear, at others turbid. As far as Mr. Faraday has proceeded, he believes this fluid to be a mixture of a colorless transparent liquid, with fine particles of gold. By transmitted light it is of a fine ruby tint; by reflected light it has more or less of a brown-yellow color. That it is merely a diffusion of fine particles is shown by two results—the first is, that the fluid being left long enough, the particles settle to the bottom; the second is, that whilst it is colored or turbid, if a cone of the sun's rays (or that from a lamp or candle in a dark room) be thrown across the fluid by a lens, the particles are illuminated, reflect yellow light, and become visible, not as independent particles, but as a cloud. Sometimes a liquid which has deposited much of its gold, remains of a faint ruby tint, and to the ordinary observation, transparent; but when illuminated by a cone of rays the suspended particles show their presence by the opalescence, which is the result of their united action. The settling particles, if in a flask, appear at the bottom like a lens of deep-colored fluid, opaque at the middle, but deep ruby at the edges; when agitated, they may be again diffused through the liquid. These particles tend to aggregate into larger particles, and produce other effects of color. It is found that boiling gives a certain degree of permanence to the ruby state. Many saline and other substances affect this ruby fluid; thus a few drops of solution of common salt being added, the whole gradually becomes of a violet color; still the particles are only in suspension, and when illuminated by a lens, are a golden yellow by reflected light: they separate now much more rapidly and perfectly by deposition from the fluid than before. Some specimens, however, of the fluid, of a weak purple or violet color, remain for months without any appearance of settling, so that the particles must be exceedingly divided; still the rays of the sun, or even of a candle in a dark room, when collected by a lens, will manifest their presence. The highest powers of the microscope have not as yet rendered visible either the ruby or the violet particles in any of these fluids. Glass is occasionally colored of a ruby tint by gold; such glass, when examined by a ray of light and a lens, gives the opalescent effect described above, which indicates the existence of separate particles—at least such has been the case with all the specimens Mr. Faraday has examined. It becomes a question whether the constitutions of the glass and the ruby fluids described are not, as regards color, alike. At present, he believes they are; but whether the gold is in the state of pure metal, or of a compound, he has yet to decide. It would be a point of considerable optical importance if they should prove to be metallic gold; from the effects presented when gold wires are deflagrated by the Leyden discharge over glass, quartz, mica, and vellum, and the deposits subjected to heat, pressure, &c., he inclines to believe that they are pure metal.

REDUCTION OF METALS BY HYDROGEN.

St. Claire Deville states that the reduction of volatile metals depends very much upon the rapidity of the current of reducing gas. Thus, for instance, when oxide of zinc is ignited in a rapid current of hydrogen, the metal is reduced, while by ignition in a slow current of the same gas no metallic zinc is obtained, there is formed at another part of the tube, crystallized oxide of zinc.

He considers that in the latter case reduction does not take place, but that owing to the slowness of the current of the gas, the water vapor formed is not removed soon enough to prevent a further reaction between it and the vapor of zinc, reproducing oxide of zinc. In this way he accounts for the transfer of the oxide of zinc from one part of the tube to another, and is of opinion that the apparent volatilization of oxide of zinc in this experiment and in metallurgical operations, is owing to this reaction which takes place at a lower temperature, than the reduction of the oxide of hydrogen.—*Ann. de Chim. et de Phys.* xliii. 47.

ON THE FORMATION OF SALTPETRE IN CAVES.

At a recent meeting of the Boston Society of Natural History, Professor William B. Rogers remarked that, from his observations in the caves of the Middle and Southern States, he was satisfied that the earthy deposit containing the nitrates, known in some places as *Petre dirt*, was chiefly derived from the overhanging and adjacent rocks, and not from sediment brought into the cave by existing or former streams. The limestone, in which the nitriferous caverns are found, often contains a large amount of siliceous and argillaceous matter, and, in some instances, a marked proportion of organic substances. The more pervious layers, gradually deprived of their carbonate of lime by the leaching action of the water infiltering from above, are reduced to an earthy mass, the mere *caput mortuum*, as it were, of the original rock. In some cases this decomposition pervades the stratum for a great distance; the residuary, fine grained, ashy clay retaining the lamination and bedding which it had before the change. In course of time the earthy mass falls to the floor by its own weight, aided, perhaps, by occasional tremors of the ground, or is detached by the load of stalactites suspended from it below, and thus comes within the levelling and transporting action of the streams flowing through the cave.

As to the production of the nitrates with which the Petre dirt is more or less impregnated, Professor R. thought that it could not, in any large degree, be referred to the excretions and other remains of animals occasionally found in these caves; since the quantity of nitrogen required for this purpose would far exceed such a means of supply. Besides this, the nitrates are found in the earthy mass while it is still adhering to the roof or walls, and far removed from the organic matter supposed to be buried in the floor. Nor can we regard the nitrogen as chiefly derived from organic substances in the decomposing rocks. For in the case of some caves producing Petre dirt, the surrounding limestone contains only a trace of such ingredients. We must, therefore, refer the formation of the nitric acid, and ultimately the nitrates, to mutual chemical reactions between the porous calcareous earth and the contiguous atmosphere.

ANTIMONIAL VERMILLION.

M. E. Plessy has invented a process for preparing vermillion, of a beautiful color, of antimony and sulphur, and which process is sufficiently simple to admit of preparation on an extensive scale.

The first ingredient necessary for the manufacture, hyposulphate of soda, is prepared as follows:—In the upper part of a vessel, the bottom of which is broken out, a sieve containing large crystals of carbonate of soda is fixed. Into the lower part of the vessel projects a furnace pipe bent at right angles, which is attached to a small clay furnace. Into this furnace sulphur is thrown by little and little, and burns into sulphurous acid, which passes through the tube into the vessel, and there acts upon the carbonate of soda. The combustion of the sulphur may be regulated as occasion requires through the door of the furnace; the draft is quite sufficient, and in the course of three or four days the crystals of carbonate of soda are acted upon to a considerable depth. The very friable sulphite of soda may be readily separated from the unaltered nucleus, if any remains, and the latter may then be put back into the sieve. The sulphite of soda is dissolved in water so as to produce a solution of 25° B., and this is saturated whilst hot with crystallized carbonate of soda. When effervescence no longer occurs on the addition of this salt (which is the best criterion, as litmus paper gives no satisfactory indications), or rather when the dilute sulphite furnishes a slight effervescence of carbonic acid on the addition of muriatic acid, flowers of sulphur are added, and the mixture is heated in an earthen vessel for three hours on the water bath, stirring and replacing the water that evaporates. When the fluid is cool, it is filtered and diluted until it shows 25° B.

Perchloride of antimony is prepared by heating powdered black sulphuret of antimony with commercial muriatic acid. When the evolution of sulphuretted hydrogen begins to diminish at a gentle heat, the mixture is boiled for a few minutes. On cooling, the clear liquid is decanted. To avoid inconvenience from the sulphuretted hydrogen gas evolved during the solution of the sulphuret of antimony, it may either be passed into a solution of soda, or allowed to pass through a tube drawn out to a point at the extremity, close to which the flame of a spirit lamp is placed; by this the sulphuretted hydrogen is burnt, even when it is mixed with much aqueous vapor. The solution of chloride of antimony obtained is diluted with water to 25° B.

When the solutions of hyposulphite of soda and chloride of antimony are thus prepared, the antimonial vermillion is prepared in the following manner:—Four litres of solution of chloride of antimony and six litres of water are poured into a stoneware basin, and after these, ten litres of the solution of hyposulphite of soda. The precipitate which is produced by the water is rapidly dissolved by the hyposulphite of soda in the cold. The basin is now placed in a warm bath, which is heated to boiling; in this the temperature of the mixture gradually rises. Towards 86° F. the precipitate begins to form; it is at first orange-yellow, but gradually becomes darker. The temperature is allowed to rise to 131° F., when the basin is removed from the water bath, and the precipitate is allowed to settle, which takes place rapidly. The fluid is separated from the precipitate by decantation; the precipitate is washed first with water containing one-fifteenth of muriatic acid, and afterwards with common water, then collected on a filter and dried. In the moist state the antimonial vermillion has a shining red color, but in drying it loses a little of its lustre.

ON THE COMPOSITION OF MUSCLES IN THE ANIMAL SERIES.

From an article on the above subject, by MM. Valenciennes and Fremy, published in the *Journal de Pharmacie*, Dec. 1855, we make the following extracts:—

"The result of our researches in regard to the substance which gives acidity to the muscles of all the vertebrata, is that if, in some cases, the acidity of the muscles is due to lactic acid, that which makes the muscular fibre strongly acid is ordinarily a phosphate of potash, having, according to our analysis, the formula, KO, 2HO, PO. We obtained this salt in a crystallized condition by treating the muscles with weak alcohol and evaporating the liquor to a syrupy consistence.

While determining the proportion of this salt in the muscles of different animals, we observed evidence of some connection with the formation of the osseous system; that is, we always found it largely in animals in which the bones are very much developed, and very slightly in the Articulata and Mollusca. The part which this salt takes in the formation of bones is now clear; for we have directly ascertained that in reacting on carbonate of lime, the phosphate of potash from the muscles forms the basic phosphate of lime, which is so considerable a part of the bony substance. This phosphate of potash is not, perhaps, without effect in the production of a phosphuretted fatty matter that exists in the muscles which will be mentioned farther on; we think, however, that under these circumstances it deserves the attention of physiologists. The muscles of the vertebrated animals are impregnated with a considerable quantity of fatty bodies made up of varying proportions of olein, margarin, and stearin. Besides these neutral fatty bodies, another is always found, which differs from the substances properly called fat by a number of peculiarities, and presents some analogy to the cerebral fat. We have made a tolerably complete examination of this interesting substance. It was extracted easily by treating the muscles with weak alcohol, which dissolves it without altering the other fatty bodies. This liquid, when evaporated, gives a viscous amber-colored substance, which partly dissolves in water; treated with sulphuric acid, it decomposes like a soap, giving sulphate of soda and an acid heavier than water. This acid contains both azote and phosphorus; analysed, it afforded exactly the composition which one of us obtained from the cerebral fat, called oleophosphoric acid.

The phosphureted fat which exists in the muscles, is therefore identical with that which is found so plentifully in the brain, and is produced, like the latter, by the combination of soda and oleophosphoric acid. The substance can now be said to be found in every part of the animal organization. We have established that its proportion in the muscular tissue increases with the age of the animal, and it is as various as the different species of the vertebrute animals. Fishes, such as the whiting, the dab, the flounder, have only a very small proportion, while species having a compact body, with a strong taste, generally difficult to digest, like the mackerel, herring, trout, and most of all, salmon, have a large quantity. It is this phosphuretted substance which, by decomposing incompletely through the action of heat, gives to broiled fish its characteristic smell.

While studying this substance in the muscles of fish, we have been naturally led to examine the red matter which colors the muscles of salmon, that which, in trout and some other fish, produces the "*saumonage.*" This remarkable change of color is partly dependent on the phenomenon of reproduction. The salmon, for instance, is red skinned all the year, but its muscles become perceptibly paler at the time of spawning. This discoloration is still more distinct in trout, for when they spawn the skin becomes quite white. While the spawning does not occur at the same time, the female "salmons" itself a deeper red, and keeps this color longer than the male; and often in the same stream there are taken white trout and salmon trout. This shows, too, that the salmon trout is not the mongrel of the trout and salmon; besides, the fecundation of one of these fish by the other is out of the question, since the salmon spawns in July and rarely in August, while the trout spawns in December.

The coloring matter of the muscles of a salmon attracted the attention of Sir Humphrey Davy; in the work by this famous chemist, entitled Salmonia, it is said that the skin of a salmon can be discolored by ether. But even till now, this coloring matter has not been isolated. It is this which we attempt to accomplish. From our researches, we find this coloring matter to be of a fatty nature, presenting the characteristics of a weak acid, which we call salmonic acid, and that it dissolves in a neutral oil. In order to isolate salmonic acid, we used the following means: the red oil which is easily got from the muscles of a salmon by a press, was agitated cold with alcohol feebly ammoniated; the oil then becomes colorless, and the alcohol takes the coloring matter, which is separated by decomposing the ammoniacal salt with an acid. The acid thus obtained is viscous, red, and presents all the characteristics of a fatty acid; it is the same in the salmon-trout as in the muscles of a salmon. We have found it in considerable quantity and mixed with oleophosphoric acid in the eggs of salmon, which partly accounts for the discoloration and loss of smell in the flesh of a salmon when it lays. The female of the Salmo hamatus *Val.*, does not afford as much acid, either salmonic or oleophosphoric, as the common salmon (Salmo salmo *Val.*): the muscles of fish show therefore in species most nearly allied appreciable differences in their composition.

ON THE ORIGIN OF MALARIA.

Some interesting experiments have recently been instituted by MM. Savi and Passerini, of Pisa, Italy, on the noxious qualities of some plants supposed to be a source of malaria. The results of these we shall here briefly state.

The *chara*, a genus of plants which grows very plentifully in the marshes, exhales, especially during summer, a fetid smell, similar to that of the marshes themselves. This has led some to suspect that these plants, during their growth, decay, and decomposition, might be the cause of the malaria. To clear up this doubt, MM. Savi and Passerini undertook a series of observations on, and analyses of, the more common species, the *chara vulgaris* and the *chara flexibilis.*

They found these plants covered with an external crust of carbonate of lime, the quantity of which, always considerable, diminishes successively and gradually during the four months of May, June, July, and August, which are precisely those in which the influence of the malaria is most strongly felt. Among the other elements of the *chara* they detected also a fat volatile substance, hitherto unnoticed, which, containing azote, has an analogy with animal substances, and produces the fetid smell which gave rise to these researches. They named this substance *puterine*, from the vulgar name of *putera*, which the Italians give to the plant.

After examining the *chara* in its living and perfect state, they submitted it to putrefaction by steeping it in water. Decomposition began to show itself very soon. Acetic acid was formed, united with carbonate of lime, and disengaged the carbonic acid, which, rising into the atmosphere, produced a scum over the surface of the water. The smell of the plant began to exhale at the same time so powerfully as to cause serious accidents and violent headache to the persons exposed to it, even at a great distance. By degrees the plant assumed a dark color, became soft and soapy, and was finally reduced to a blackish mixture, formed of fragments of woody fibres and of very thin coal, unctuous to the touch, and with an intolerable stench.

In the last stage of putrefaction, the water in which the plant had been steeped became stinking, blackish, and mucilaginous; on its surface was formed a dark pellicle, sprinkled with yellowish stains, reflecting in some points the color of the rainbow, and emitting a disagreeable odor; when exposed to the action of fire it yielded azotic productions. The same experiments, carried on with covered vessels, under the action of solar heat, gave the same results. Repeated upon the *chara* of brackish waters, the saline principle of which is so powerful as to destroy all other plants, the observations presented the same phenomena, but with a greater degree of intensity.

MM. Savi and Passerini think themselves entitled to conclude, from these repeated experiments, that the *puterine*, or fetid principle of the genus *chara*, if not the only and general cause of the malaria, is, at least, one of the most powerful causes of its production in Italy. This mischievous principle, the odor of which is the same with that of marshy exhalations, extends its influence with still greater effect whenever the diminution or evaporation of the waters leaves the plants uncovered, and by its volatility it escapes, and is kept suspended in the atmosphere.

NEW VEGETABLE WAX.

The following description of a new variety of vegetable wax recently brought to this country, has been furnished to us by Dr. A. A. Hayes, of Boston. The commercial relations of our country, extending along the rivers of South America, are making known to us the products of the vast forests of the interior, many of which have a high value in the arts, and are new to commerce. The wax in question is obtained by boiling the deep green leaves of a shrub resembling laurel, abounding in the forests back from Para and Bahia, and is used to some extent as a substitute for wax in the manufacture of candles. It has a light tint of greenish-yellow color, transmitting nearly white light through thin portions; it is hard, the angles of the fragments scratching gypsum. Its fracture is slightly conchoidal, lustre more dull than that of ordinary wax. By rubbing it becomes electrically excited, and takes and retains a fine polish; it is brittle, without softening when compressed between the fingers. The average sp. gr., determined on many specimens, is at 60° F. 1·000, or the same as distilled water. When heated to 120° F. for some time, it loses moisture, and exhales a pleasant balsamic odor, not unlike that of pinks.

100 parts at 212° F. became a transparent fluid after frothing, having lost 2·10 per cent. of volatile matter this being mostly aqueous moisture due to

the process of manufacturing it, and the dry wax on cooling becomes slightly darker in color. Made into candles, it burns with a deep opaque yellow flame, a thin stream of smoke creeping from the apex; its decomposition in this way showing an excess of carbon, as the carbo-hydrogens burn in the air. This important character forbids its application as a substitute for wax, or for affording light in confined spaces; otherwise, its high melting point would render it very valuable in many situations when our ordinary materials fail. When mixed with tallow, the latter becomes harder, and the *apparent* melting-point of the mixture is higher than that of tallow. But the resulting mixed mass softens at a temperature of 100° F., and the new wax does not break up in the act of combustion, so as to unite with the carbo-hydrogens of the tallow with which it is mixed. Its application in this way does not, therefore, promise a valuable result.

Alcohol of sp. gr. 0·821, when boiled on the dried wax, dissolves a small portion, which separates in part by cooling, in the form of a hydrous mass, becoming white. The cold solution evaporated disengages a balsamic odor; the coating it leaves, when dry, has the characters of the original wax.

In sulphuric ether the same characters are preserved, the matter dissolved being identical with the original wax. Benzole is the appropriate solvent for this wax; it melts in it, dissolving largely, so that on cooling the solution becomes a soft mass. A more dilute solution allows the pure wax to deposit in beautiful snow-white granules, which, while wet, are transparent, becoming opaque on drying. These granules, when magnified, appear generally to be composed of aggregations of spherules, forming mamillary concretions; but in rare cases radiating lines occur within them, indicating the existence of a polarizing force too feeble to form a rectilinear solid. Chloroform dissolves the wax freely, and the results of cooling and evaporation are the same as occur with benzole. These characters sufficiently prove that this wax does not, like many other kinds, divide into a more fluid and a more solid body, when subjected to the action of solvents, and its unity in this respect is its most strongly marked peculiarity.

In alkaline solutions, by ordinary treatment, no saponification takes place, after long boiling. The wax retains a little alkali after it has been washed in water, and the compound is to a small extent soluble in water, but has not the characters of soap. This alkaline wax will absorb a considerable quantity of an alkaline solution in which it has been boiled; washing in water removes the excess of alkali, no definite compound being formed. When distilled from a nearly closed vessel, it leaves 0·44 per cent. of carbon and ash, the latter amounting to 0·10 only. This wax can be supplied, should a want exist commercially, at a price intermediate between that of tallow and the ordinary wax. The only application at present known in which it exhibits useful properties is in forming a basis for a preparation used in waxing furniture and polished wood work.

BRILLIANT AND CHEAP CARMINE.

The following economical method of making carmine has lately been patented in England by Mr. B. Wood:—Take 9 ounces of the carbonate of soda, and dissolve it in 27 quarts of rain water, to which are added 8 ounces of citric acid. When brought to the boiling point 1½ lb. of the best cochineal, ground fine, is added, and then boiled for 1¼ hour. The liquor is then strained or filtered and set by to cool. The clear liquor is then boiled again, with 9½ ounces of alum, for about ten minutes, and is again drawn off and allowed to cool and settle for two or three days. The supernatant liquor is then drawn off, and the sediment which has fallen to the bottom is filtered and washed with clean soft cold water, and is finally dried by evaporating all the moisture. The result is fine carmine, which can be made into the finest red ink by dissolving it in a caustic solution of ammonia, adding a little dissolved gum arabic.

By the old plan of making carmine, no citric acid was used; the cochineal was simply boiled in soft rain water for two hours containing a minute quantity of carbonate of soda, then allowed to settle, and treated by remainder of the process described above. An improvement in the brilliancy of the color is obtained by adding about one-ninth part of the crystals of tin to the alum, using for this purpose a ninth part less of alum than the amount given above.

USE OF BRINE IN FOOD.

In consequence of accidents caused by the use of the brine of herring or salt meat, the Council of Health in Paris has been charged with examining to what extent brine may be allowed in food. Numerous experiments have been tried at Alfort, which have led to the following conclusions:—

"The use of brine as a condiment or seasoning in the nourishment of man has hitherto had no injurious effect, and nothing authorizes the opinion that an economical process so advantageous for the poor should be proscribed. The same is not true of the abuse which is made of this substance in the nourishment and in the treatment of the diseases of certain animals, especially swine and horses. Authentic facts and recent experiments show that the mixture of brine in considerable quantity with food may produce real poisoning. In all cases, brine preserved too long or in contact with rancid meat should not be employed except with the greatest care, and after it has been purified by skimming all the scum which forms on the surface."

EFFECTS OF CHLOROFORM ON THE BLOOD.

At the Boston Society of Natural History, Dr. C. T. Jackson presented a statement relative to the effect of chloroform on the blood of a person who had died under its influence. The blood was found on examination to have lost the property of coagulation, was of a peculiar, dark cranberry red color, and quite uniformly liquid. The red blood globules, in a microscopic examination made by Dr. Bacon, were found to be a little shrunken and distorted; the white globules were also deformed. A chemical examination of the same blood showed that it contained *formic acid*, which was readily separable by distillation of the blood, by the heat of a chloride of calcium bath.

The formic acid, separated, had its peculiar odor, and instantly decomposed nitrate of silver, reducing the silver to its metallic state, so that large flakes of the metal were obtained. The observation that chloroform was decomposed by the blood, with the production of formic acid, he believed to be new; and it must be regarded as an important physiological fact of no small practical moment. Three atoms of chlorine leave the formyle to combine with the blood, while three atoms of oxygen are abstracted from the blood, to unite with the formyle in the production of formic acid. Thus the blood is not only deprived of its oxygen, but it is so altered as to be incapable of absorbing vital air, and the patient dies from asphyxia.

Such appears to be the probable theory of the cause of death in this case. It becomes us to inquire whether there is not always a partial decomposition of the blood, effected by the inhalation of chloroform, from which, in cases where it is not carried too far, the system recovers; while a more complete change results in death. There is still much to be done in the chemical and physiological investigation of this subject. Dr. Jackson was of the opinion that when chloroform must be administered, it should be largely diluted with ether; but the latter agent alone is a much safer anæsthetic and should always be preferred when it can be obtained; for no death is as yet known to have been produced by its proper administration mingled with air: while chloroform, in spite of all proper precautions in its administration, has destroyed life.

The chloroform inhaled in this case was found to be perfectly pure.

GLYCERINE.

Nature of Glycerine—Important to Soap Makers.—Dr. H. C. Jennings, of London, has addressed a communication to the Society of Arts, in which he maintains the ground that glycerine was an artificial product, arising from new atomic molecular arrangements, produced by chemical action upon fats, oil, or grease, during saponification, whether acid or alkaline. He states that he some time since "converted one pound of tallow, and on another occasion two pounds of palm oil, into glycerine, and will engage to do so at any time; any fatty matter from the animal or vegetable kingdom can be *wholly* converted into soluble glycerine—of course I do not undertake to operate upon Ol. Ricini, or a drying oil, such as linseed oil, &c., or rosin oil. I have operated upon glycerine, made by myself, and that sold; and have converted it into retro-glycerine—that is to say, *a most perfect oil.* Suppose two soap makers, or two candle makers, having different processes, A shall produce, through the want of chemical knowledge, 20 per cent. of glycerine, while B, by a better process, only produces 2 or 3 per cent. of glycerine, it will be evident that the amount of stearine, or soap, produced by B will exceed that produced by A.

"I have tried every means of ascertaining if there exists any affinity between pure glycerine and pure stearine and oleine, and find none to exist; in fact, a more absolute chemical revulsion of the atoms of these substances cannot be imagined."

Glycerine Dressings.—The value of glycerine surgical dressings is only beginning to be appreciated. Its antiseptic power renders it highly valuable in all ulcers which have a tendency to gangrene; while the favorable influence it exerts over healthy granulations, and the facility with which the dressings may be renewed, render it greatly superior to ointments in all other wounds and sores. In some European hospitals it has been substituted for the strong acids, and other caustic applications, with the happiest effects. It has been reported that wounds, submitted to this mode of dressing, have a florid color, and continue so clean that washing and the recourse to the spatula, to remove the cake of cerate and pus, which renders the present mode of dressing wounds so tedious and painful, can be dispensed with. Folds of linen, smeared with glycerine, are removed with the greatest facility, while they moderate suppuration, and repress redundant granulations. The dressings are soft, and agreeable to the patient, and admit of being made astringent, by the addition of tannin, in case of tendency to hemorrhage.

EXPERIMENTS ON WRITING INKS.

Some ingenious experiments to test the durability of writing inks have recently been made by Dr. Chilton, of New York City. He exposed a manuscript written with four different inks of the principal makers, of this and other countries, to the constant action of the weather upon the roof of his laboratory. After an exposure of over five months, the paper shows the different kind of writing in various shades of color. The English sample, Blackwood's, well known and popular from the neat and convenient way that it is prepared for this market, was quite indistinct.

The American samples, Davids's, Harrison's, and Maynard's, are better. The first appears to retain its original shade very nearly; the two last are paler. This test shows conclusively the durability of ink; and while, for many purposes, school and the like, an ink that will stand undefaced a year or so, is all that is necessary, yet there is hardly a bottle of ink sold, some of which may not be used in the signature or execution of papers that may be important to be legible fifty or one hundred years hence.

For state and county offices, probate records, &c., it is of vital importance that the records should be legible centuries hence. We believe that some of the early manuscripts of New England are brighter than some town and church records of this century.

In Europe, at the present time, great care is taken by the different governments in the preparation of permanent ink—some of them even compounding their own, according to the most approved and expensive formulas.

Manuscripts of the eleventh and twelfth centuries now in the state paper office of Great Britain, are apparently as bright as when first written; while those of the last two hundred years are more or less illegible, and some of them entirely obliterated.

MAUMENE'S PROCESS FOR EXTRACTING SUGAR FROM VEGETABLE SUBSTANCES.

M. Maumene, of Paris, in a paper descriptive of a new process for extracting sugar from vegetable substances, recently published by the French Academy, says:—That all the processes at present made use of are bad: for example, from 1000 kilogrammes of beet root, which contain really 100 kilogrammes of sugar, not more than fifty or fifty-five kilogrammes are extracted; and sugar cane, which should yield 200 or 210 kilogrammes to the thousand, gives from sixty to sixty-five only. The fault is shown to lie in the mode of treatment. Sugar exposed to the action of cold water undergoes a change known to chemists, which prevents its crystallization. A beet root dug up and stowed away is a cone of cold water, the longer it lies the more is the sugar diminished. Keeping it under shelter makes no difference. Manufacturers, however, have to store their stock of beets, as months elapse, according to the present process, before they can be passed through the mill.

The remedy proposed is to crush out the juice at once as fast as the roots are dug up, and discharge it into huge cisterns, and throw in a quantity of lime, whereby a saccharate of lime is formed which will keep undeteriorated for a whole year, and may be converted at the manufacturer's convenience. By adding carbonic acid, or others of similar action, to this saccharate, and treating it properly by evaporation, &c., it gives up the crystallizable sugar which it has held intact, and in full quantity.

THE NEW FACTS RESPECTING OZONE.

The following articles, gathered from various sources, embody all the recent information made public respecting ozone.

The first article is an abstract of a paper read before the American Association, Albany, by Prof. W. B. Rogers:

Prof. Rogers said, that the chief object in this communication was to call the attention of American observers to a branch of inquiry which, as yet, they had greatly neglected, and to indicate a change in the methods of observation which he thought essential to make the effects on the ozonometer a fair measure of the quantities of ozone in the atmosphere.

Prof. R. presented the results of two short series of observations, the first of which were made in the city of Boston, at a station on the eastern side of the extensive common; the second, on a hill fifty miles westward of the city, at a height about five hundred feet above tide, in the midst of an undulating rural district covered with verdure and removed from any collection of houses or manufactories. The ozonometer used was the ordinary test paper of Schoenbein, which was exposed freely to the outer air in such a way as to be sheltered from strong light and from rain.

The city observations extended from the first of February to the last of May. In these it was found that winds coming from any of the eastern points gave little or no indication of ozone, but those from western points, especially from the N. W., produced a strong impression upon the test paper. Thus for the four months of observations in the city the mean for E. winds was 0·6, that for W. winds was 3·9, the former showing no trace of ozone unless when the current was very strong.

At the country station, the observations extending from the first of June until late in August, when the report was drawn up, furnished very different results. Here the air, from whatever point it arrived, was more or less ozonized, rarely showing a less amount than that corresponding to 5 on Schoenbein's scale, often attaining 9, and occasionally even reaching the maximum or 10. In only a single instance, throughout the summer, was there an entire absence of effect. In this series the mean for E. winds was somewhat greater than that for the opposite currents, the former being 7·6, and the latter 6·7 of Schoenbein's scale.

The almost entire absence of ozone in easterly winds at the Boston station, and its presence in those from the west and north-west, Professor R. ascribed to the circumstance that the former, in order to reach the place of observation, had to traverse a wide extent of the densely built city, while those coming from westerly points reached the common with but little intermixture of air from streets or buildings.

In all these observations it was remarked as a general result, that the effect on the test, both as to rapidity and amount, was somewhat *in proportion to the velocity of the moving air.* Numerous instances were noted of a light breeze continuing for several hours, with but a small impression on the paper, while the strong wind which followed from the same quarter, produced, in a single hour, the most marked effect. Indeed, in very gusty days the impression was so quickly made, and so strong, as to render necessary the renewal of the test paper several times within the twelve hours.

This increase of ozonic effect with the velocity of the wind, Professor R. considered to be mainly due to the larger amount of air brought in contact with the test in a given time. In this view the fact becomes very important, as showing the great imperfection of the common mode of observation, even for purposes of rude comparison, since in observing successively, in a calm and in a high wind, we are in fact comparing the amount of ozone in vastly different quantities of air. To avoid this error, some means should be adopted for furnishing to the test equal quantities of air in equal times. Such a result would be secured by an aspirating apparatus, having a small chamber in the path of the current to receive the test. Such an arrangement, capable of bringing into action a large volume of air in a short time, would doubtless detect ozone in a multitude of cases, where the common observation in calm air would show none. It would also enable us to make hourly or even half-hourly observations, instead of waiting for the slow development of the action through half a day; a process which, instead of summing up the ozone actions of twelve hours, allows the effect of one period to be more or less obliterated by that which follows.

On Ozone and its Relation to Mushrooms.—It is well known that certain varieties of mushrooms possess the remarkable property of turning rapidly blue, when their head and stem happen to be broken and exposed to the air. This matter has attracted the attention of Schoenbein, who offers the following explanation. He considers oxygen, both in its free and bound state, to be capable of existing in two conditions—the ozonic or active, and the ordinary or inactive condition. All the oxy-compounds yielding common oxygen at a raised temperature he considers to contain ozonized oxygen, and he further believes that the disengagement of common oxygen from those compounds depends upon the transformation of the ozonized oxygen into the inactive one.

Now, a general fact is this, that the oxygen thus set free always contains traces of ozone, more or less according to the degree of temperature at which the oxygen happens to be disengaged from those compounds. The lower that degree, the larger the quantity of ozone mixed with the oxygen; though in all cases the quantity happens to be exceedingly small in comparison with that of the oxygen obtained at the same time. The best means of ascertaining the presence of ozone is the alcoholic solution of guiacum recently prepared. Oxygen does not in the least change the color of that resiniferous liquid, whilst ozone seems to possess the power of coloring it deep blue. The blue matter is nothing but guiacum plus ozone. Now, if we heat the purest oxide of gold, platina, silver, mercury, the peroxides of lead, manganese, &c., in fact any substance yielding oxygen, within a small glass tube, into which had been previously introduced a bit of filtering paper impregnated with guiacum solution, the paper will turn blue as soon as the disengagement of oxygen begins. All the circumstances being the same, the paper will be colored most deeply by the oxygen eliminated from that compound which requires the lowest temperature for yielding part or all of its oxygen.

Mr. Schoenbein further goes on to say that there cannot be any doubt that all the oxygen contained, for instance, in the oxide of silver, previous to that compound being decomposed by heat, exists in one state—be that state what it may. But how then does it happen that two different sorts of oxygen are generated at the same time from one compound? The answer to this seems to be, that one of the two kinds of oxygen eliminated must be engendered at the expense of the other; or to speak more correctly, that during the act of elimination of oxygen from the oxide of silver, part of that oxygen suffers a change of condition. Now, as the oxides of gold, silver, &c., possess the power of coloring blue the guiacum solution, just as free ozone does, it is considered that the condition of the oxygen contained in the oxides of gold, silver, &c., is the ozonic one; and it is further inferred, that by far the greatest portion of that ozone under the influence of heat is transformed into oxygen.

Now certain species of mushrooms contain a colorless principle easily soluble in alcohol, and in its relations to oxygen bears the closest resemblances to guiacum, as appears from the fact, that all the oxidizing agents which have the property of blueing the alcoholic solution of guiacum, also enjoy the property of coloring blue the alcoholic solution of the mushroom principle; and the deoxidizing substances which decolorize the blue solution of the guiacum, also discharge the solution of the mushroom principle.

The resinous principle of the mushroom does not seem to possess the power of coloring itself, except so long as it is in contact with the parenchyma of the plant. This has led Schoenbein to the discovery, that there exists in the mushroom a principle which possesses the property of exalting the chemical power of oxygen, and of causing it to combine in the ozone condition with the resinous principle. In many respects this compound appears to resemble the binoxide of nitrogen, and its existence confirms an opinion before expressed by Schoenbein, that the oxidizing effects of atmospheric oxygen (of itself inactive), which are produced upon organic bodies, such as blood, &c., are brought about by means of substances which possess the power both of exciting and carrying oxygen.

Conditions Influencing the Production of Ozone by Electrolysis.—M. Hozeau communicates the following as the result of recent investigations on this subject:—

1. The composition and temperature of the liquid being constant, the amount of ozone produced increases with the intensity of the pile, but not proportionately. Thus eight of Bunsen's elements produced 0·00195 grm., and eighty elements 0·00429 grm., in equal volumes of gas.

2. The intensity of the pile and the composition of the liquid being nearly constant, the amount of ozone produced decreases as the temperature increases.

3. The temperature of the liquid and the intensity of the pile being nearly constant, the amount of ozone produced increases with the amount of sulphuric acid, but does not seem to be proportionate to it.

It follows that in order to obtain the largest possible quantity of ozone by means of a given intensity, it is necessary to employ water with a very large proportion of acid. With eight of Bunsen's elements ozone is not generated from water containing $\frac{1}{20}$ its volume of acid, even after the addition of a little chromic acid; while it is produced by two elements from water mixed with five times its volume of acid. The amount of ozone in oxygen, produced under various conditions, was found to vary from 0·002 to 0·007 grm. in the litre.

Professor Van der Willigen states that he has observed the production of ozone, when a thin platinum wire, about two inches thick, is fixed between the arms of a Henley's discharger, which is included in the circuit of a Grove's battery of six cells. The wire soon becomes white hot, and the odor of ozone may be recognised along the whole length, but most distinctly at the positive end, at that pole where oxygen would be eliminated in the voltameter. —(*Compt. Rend.* xliii. 34.)

Observations and Experiments upon the Employment of Iodide of Potassium as a Reagent for Ozone.—A recent number of the *Comptes Rendus* contains the following paper on this subject by S. Cloëz:—

The experiments of Marignac, Fremy, and Becquerel, have done most to clear up the question of the nature of ozone; they prove completely the possibility of imparting to chemically pure oxygen all the properties of this mysterious substance.

Iodide of potassium being one of those substances upon which ozone is capable of acting, paper soaked in a solution of starch containing 0·002 of its weight of this iodide, has been prepared under the name of the *ozonometric reagent,* not only to indicate the presence of ozone, but also to measure the quantity contained in the air. If the coloration of this paper could only be produced by ozonized oxygen, its employment would leave nothing to be desired. But this is not the case; acid vapors act upon iodide of potassium in the same manner as active oxygen; the essential oils exhaled by plants have the same action, and prove that moist air, under the influence of the direct light of the sun, colors the *reagent,* although we cannot suppose the air to be ozonized. After a great number of trials, the author has not yet succeeded in establishing with certainty the part taken by ozone in the phenomenon of nitrification, effected in the absence of azotized or ammoniacal substances, but his experiments have convinced him that the numerous attempts to prove the presence of ozone in the air, and measure its quantity by means of iodized paper, are not of the least value.

It is an admitted fact, that the coloration of the paper takes place every day in the country, in places where there is an active vegetation, and especially in the neighborhood of resiniferous trees, whilst repeated observations prove that in the most populous parts of towns the paper is very rarely and very slightly colored. Resiniferous trees, aromatic plants, and all the parts of vegetables which contain volatile oils, act much more strongly than inodorous plants upon iodized paper in their vicinity. By passing moist air through a tubulated bell-glass covering the plants to be experimented on, and exposing the iodized paper to the air at its exit from the bell, it will be seen that whenever the plant is capable of producing odorous volatile substances, coloration takes place; in the other case the paper remains white.

From some experiments recently published, it would appear that the oxygen disengaged by the green parts of plants under the influence of light, is in the same state as the gas produced by the electrolytic decomposition of water, or the nascent oxygen prepared in the cold by the action of sulphuric acid upon binoxide of barium. The author has found that this oxygen has no effect upon iodized paper. He placed some aquatic plants in a bottle filled with rain water, containing about half its volume of carbonic acid, exposed the apparatus to the sun, and collected the gas under a test tube filled with water; the gas produced no coloration of iodized paper by contact for six hours. As it might be objected that the gas had lost its oxidizing power during the short space of time occupied in collecting it, he adapted to the neck of the bottle containing the plants, a glass tube of three decimetres in length, covering its lower half with black paper, and introducing a strip of test paper both into this and into the portion left exposed to the light. The apparatus was exposed for two days to the sun; 2·25 litres of moist gas were evolved, the whole of which passed over the iodized paper, of which the strip protected from the light was unchanged, whilst the other was strongly colored. This is the constant effect of the action of light upon iodized paper in the presence of moist oxygen.

It cannot be admitted, as advanced by Schoenbein, and lately repeated by Scouterten, that light ozonizes the air, for although the active modification of oxygen is not permanent, it may be kept for several hours; and if light possessed the property attributed to it, moist air exposed to the sun and removed for a short time from the action of the solar rays, ought to act upon iodized paper in the manner of ozone, but this is never the case. However long the air may be exposed to the sun, it is never ozonized.

STRYCHNIA AND ITS DETECTION IN CASES OF POISONING.

The frequent use of strychnia as a poison has attracted so much attention in Great Britain during the past year, that many careful reinvestigations of its properties and effects have been made by various experimentalists of reputation. The following are some of the most valuable of the contributions to our knowledge on this subject:—

On Several New Methods of Detecting Strychnia and Brucia.—The following is the *resumé* of a report made to the British Association, 1856, by Mr. T. Horsley on the subject of Strychnia, especial reference being due to the late Palmer poisoning case in England. Mr. Horsley observed that the circumstances attending Palmer's trial induced him to make a series of experiments on the subject, and he tried the effects of a precipitant formed of one part of bichromate of potash dissolved in fourteen parts of water, to which were afterwards added two parts in bulk of strong sulphuric acid. This being tried upon a solution of strychnine, the bulk was entirely precipitated in the form of a beautiful golden colored and insoluble chromate. The experiment, as performed by Mr. Horsley, was very interesting, and scarcely a trace of bitterness was left in the filtered liquor. He did not claim to have originated this discovery of the use of a chromic salt and an acid liquor; but the point to which he called attention was the essential difference in the mode of application, and he maintained that it was as much out of the power of any human being to define the limit of sensibility which he had attained, as it would be to count the sands or to measure the drops of the ocean. Taking thirty drops of a solution of strychnia containing half a grain, he diluted it with four drachms of water. He then dropped in six drops of a solution of bichromate of potash, when crystals immediately formed, and decomposition was complete. Splitting up the half grain of strychnia into millions of atoms of minute crystals, he said that each of these atoms, if they could be separated, would as effectually demonstrate the chemical characteristics of strychnia as though he had operated with a pound weight of the same. He then showed the chemical reaction with those crystals. Dropping a drop of liquor containing the chromate of strychnia into an evaporating dish and shaking it together, he added a drop or two of strong sulphuric acid, and showed the effect as previously noted. He next showed the discoloration produced in chromate of strychnia and chromate of brucia by sulphuric acid, the former being changed to a deep purple and then to a violet and red.

It had been asserted since the trial of Palmer that the non-detection of strychnine in the body of Cook was owing to the antimony taken by the deceased having somewhat interfered with the tests. Such a supposition was, in his (Mr. Horsley's) opinion, absurd. Nothing, he considered, could more incontestably disprove the fallacy than either of two new tests which he then performed. These he considered double tests, because they had first the obtainment of a peculiar crystalline compound of strychnine, which was afterwards made to develop the characteristic effects by which strychnine is recognised. Mr. Horsley next related a series of experiments which he had made on animals with strychnine, and entered into the probable reasons for its non-detection in certain cases, although (as he has just shown before) a method of detecting infinitesimal quantities of strychnia by tests. He procured three rats at seven o'clock P. M., he gave each rat a quarter of a grain of powdered strychnia, and two hours afterwards a quarter and half a grain more to one of the three. Next morning at four o'clock they were all alive, and had eaten food (bread and milk) in the night, but at seven or a few minutes after they were all dead. The longest liver was one of the rats that had had only a quarter of a grain. In about three hours afterwards he applied the usual test, but could not detect the least indication of strychnine in the precipitate. There was, moreover, a total absence of bitterness in all the liquor. He tried every part of the bodies of the rats with the like results. What, then, became of the strychnine? Had it been decomposed in the organism, and its nature changed, as Baron Liebig intimated? As to the non-detection of strychnine, he thought it not improbable that the strychnine might have become imbibed into the albumen or other solid matter, and so abstracted from the fluid, forming by coagulation (say, for instance, in the blood) a more or less insoluble albuminate. This idea had occurred to him from noticing the coagulation of the glairy white of egg with strychnine, and the fact of his not recovering the full quantity of the alkaloid whenever he had introduced it. At any rate, it merited consideration. In his second experiment he administered three-quarters of a grain of strychnia to a wild rat, but the animal evinced little of the effects of the poison, and it was purposely killed after five days.

His third experiment was with two grains of strychnia, administered as a pill wrapped up in blotting-paper to a full sized terrier dog. It was apparently quite well for five hours, when the operator went to bed, but was found dead next morning, but lying apparently in the most natural position for a dog asleep. When taken up blood flowed freely from its mouth. "On opening the animal, said Mr. Horsley, "I found the right ventricle of the heart empty of blood, whilst the left was full, some of the blood being liquid and some clotted. The stomach was carefully secured at both its orifices, and detached. On making an incision, I was surprised at not seeing the paper in which I had wrapped the pill, naturally expecting it would have been reduced to a pulp by the fluid of the stomach. I therefore sought for it, and lo! here it is, in precisely the same condition as when introduced into the gullet of the dog, and containing nearly all the strychnine. I have been afraid to disturb it until I had exhibited it to you, and now I will weigh the contents, and ascertain how much has been absorbed or dissolved. The experiment is important as showing the small quantity of strychnia necessary to destroy life; and, had I not been thus particular to search for the paper envelope, it might, possibly, have led to a fallacy, as I must have used an acid, and that would have dissolved out the strychnia, and the inference would have been that it was obtained from the contents of the stomach, whereas it had never been diffused. In this case, also, none of the absorbed strychnia was detectable in the blood or any part of the animal, although the greatest care was observed in making the experiments." The lecturer, who was listened to throughout with great attention, added that he had made further experiments, which he thought proved that it was highly probable a more or less insoluble compound of organic or animal matter with strychnia is found.

Dr. Marshall Hall, of England, has published the following new and apparently conclusive test for this subtile poison:—

"I dissolved one part of acetate of strychnia in one thousand parts of distilled water, adding a drop or two of acetic acid. I then took a frog, and having added to one ounce of water 1-100th part of a grain of acetate of strychnia, placed the frog in this dilute solution. No effect having been produced, 1-100th of a grain of the acetate was carefully added. This having produced no effect, in another hour 1-100th of a grain of the acetate was again added, making 3-100ths, or about the 33d part of a grain. In a few minutes, the frog became violently tetanic, and though taken out and washed, died in the course of the night. I thus detected, in the most indubitable manner, one thirty-third part of a grain of the acetate of strychnia. It appeared to me that had more time been given to the experiment, a much minuter quantity would be detectable. I placed a second frog in one ounce of distilled water, to which I added the 1-200th part of a grain of the acetate of strychnia. At the end of the first, second, and third hours, other similar additions were made, no symptoms of strychnism having appeared. At the end of the fifth hour, the frog having been exposed to the action of 1-50th part of a grain of the acetate of strychnia, tetanus came on, and under the same circumstances of removal and washing as in the former experiment, proved fatal in its turn. I thus detected 1-50th part of a grain of the poisonous salt by a phenomenon too vivid to admit of a moment's doubt; the animal, on the slightest touch, became seized with the most rigid general spasmodic or rather tetanoid rigidity. And this phenomenon, alternating with perfect relaxation, was repeated again and again.

"As the nerve and muscles of the frog's leg, properly prepared, have been very aptly designated as galvanoscopic, so the whole frog, properly employed, becomes strychnoscopic. In cases of suspected poison from strychnia, the contents of the stomach and the intestines, and the contents of the heart, blood vessels, &c., must be severally and carefully evaporated, and made to act on lively frogs just taken from the ponds or mud. I need scarcely say, that taken in winter, the frog will prove more strychnoscopic than in summer,—in the early morning than in the evening."

Professor Trail of Edinburgh has published the following paper on the detection of strychnine:—

1. The best method of eliminating this powerful poison from the contents of the stomach, is certainly by digesting these matters with alcohol, filtering and concentrating the filtered liquid by a gentle heat. To separate any animal matter taken up with the strychnine, boiling this liquid with a little acetic acid, and again filtering, will effect a clear solution of the strychnine, and this concentrated will afford the poison in a fit state for administering it to small animals, or for the application of chemical tests.

2. After many trials of various tests, that which seems one of the best is a neutral solution of chloride of gold, especially if a slight excess of acetic acid exists in the liquid, or be added with chloride. This addition throws down from the solutions of strychnine a gamboge yellow precipitate, which, if the quantity of the strychnine be considerable, shows a tendency to form minute crystals, while the chloride of platinum forms a less copious precipitate, of an orange-yellow color; but the chloride of gold is most to be depended on.

3. Experiments have been made with chloride of gold on all the vegetable alkaloids in the subjoined list, not one of which gives any precipitate at all with this test; therefore it will serve to discriminate strychnine from those other alkaloids—a point of considerable importance in the investigation of poisons:—1, Salacine; 2, quinine; 3, cinchonine; 4, codeine; 5, inuline; 6, lupuline; 7, veratrine; 8, picrotoxine; 9, solanine; 10, atropine; 11, delphine.

4. With regard to the delicacy of this test, six drops of a saturated solution of strychnine in alcohol, in which, however, it is not very soluble, even at a boiling heat, added to twenty minims of liquid, showed a slight yellow precipitate upon standing for some time.

5. Another good test of strychnine is obtained, as is well known, by adding a few drops of sulphuric acid to bichromate of potash. When this is added to a solution of strychnine, it produces no precipitate, but forms a pale blue liquid, that seems very characteristic of strychnine.

On the Detection of Strychnine in the Presence of Antimony.—Mr. C. W. Bingley, of Sheffield, in a communication to the Chemical Gazette, states that the characteristic reactions of strychnine in the presence of sulphuric acid and bichromate of potash are neutralized and prevented by the presence of tartarized antimony, or chloride of antimony.

A NEW GUN COTTON.

A correspondent of the American Journal of Pharmacy (Mr. Caldwell) describes a new kind of gun cotton, which is made as follows:—Newly prepared gun cotton is placed in a saturated solution of chlorate of potash, and allowed to remain for fifteen minutes. It is then gently pressed between folds of clean linen rag, and dried over a heat of 150 degrees. The cotton thus prepared explodes much quicker, and more like fulminating silver, than the ordinary gun cotton. From some experimental shots the result was as follows. A pistol loaded with nine grains by weight, of the ordinary cotton, sent a ball about half through a yellow pine door one inch thick, at the distance of twenty feet. It was then fired with two grains of the cotton, treated with chlorate of potash, when the pistol was shattered to pieces. Another pistol was loaded with one grain of the cotton, when the ball passed entirely through the door, making a perfectly smooth perforation.

RECENT PROGRESS OF AGRICULTURE IN GREAT BRITAIN.

Mr. Dennison, of England, a member of the agricultural jury of the great Paris exhibition, in concluding his report on the same, thus sketches the recent progress of agricultural science in Great Britain during the last five years:—

In speaking of the progress of agricultural chemistry, the name of Mr. Lawes must be placed by English farmers in the first place of honor. Without entering on the high controversy between Baron Liebig and Mr. Lawes, lately revived with increased animation, the English farmers have wisely accepted the teaching of Mr. Lawes, based on experiments, on the care and accuracy of which full reliance may be placed, and the results of which are open to the view of all. They have learnt that the approved artificial manures are not mere stimulants, but agents of fertility which, when properly applied, may be depended upon with certainty to produce a crop. The principles on which the growth of corn depends are better understood. The repetition of corn crops on the same soil can no longer be considered as necessarily faulty in principle, and to be unconditionally condemned. It is rather a question of expediency, to be decided by the cost of manure and of produce.

These lessons the English farmers have learnt from Mr. Lawes. They have accepted them with becoming gratitude. They are practising them with increasing confidence, day by day, to their great and proved advantage. The department of agricultural chemistry is now attracting to itself the attention of able chemists in all countries; and the contributions to knowledge resulting from the various investigations have, during the last few years, been very considerable. To attempt anything like an account of these results in this place is obviously out of the question, and we content ourselves with little more than an enumeration of the principal and most interesting investigations.

In this country, Mr. Lawes has continued his experiments on the laws concerned in the feeding and fattening of animals, taking, for the objects of his trial, pigs and sheep. The number of animals experimented upon, the intelligence and care brought to bear upon every detail of the experiments, and the very considerable expenditure which has evidently accompanied them, place these investigations far in advance of any of a similar kind that have been undertaken elsewhere. Although the results are of a practical character, the experiments of Mr. Lawes must not be classed with the very numerous trials on the feeding of animals that are to be found dispersed through agricultural publications, and which are *merely* practical, being undertaken without reference to general principles. The results of Mr. Lawes' inquiries are too numerous to be stated here; but they seem to point out that a just balance of the different constituents of food is of more importance in the feeding and fattening of cattle than a predominance of any one; that neither the albuminous nor farinaceous elements of food have an exclusive value for the purposes to which they are applied; and that the classes of vegetables which are peculiar in containing a high proportion of nitrogenous matter, are not necessarily, from that circumstance, the most adapted in practice to produce that part of the animal body (muscle) which most resembles them in composition. According to Mr. Lawes, therefore, the valuation of foods in relation to their contents in nitrogen is attended with much fallacy.

Amongst other papers, Dr. Vœlcker, of Cirencester College, has published an account of experiments made with a view of ascertaining the cause of the fertility produced by burnt clay when used as manure. He has arrived at the opinion that the effects are partly mechanical, but principally due to the liberation of potash from silicates of that alkali existing in the soil, but only slowly available until released by torrefaction.

Mr. Way has published two further papers on the important subject of the absorption of manure by soils, in continuation of his first research on this subject, which was published in 1850. Mr. Way attributes the power possessed by soils to remove various alkaline bodies (as potash, ammonia, &c.),

from solution in water, to the existence of a class of double silicates of alumina and another base, which is generally lime or soda. Mr. Way has succeeded, for the first time, in producing this class of salts; and he argues, from the effects observed in soils, that these latter contain the silicates in question in small quantity, and hence their power to preserve soluble manures from loss by rain and drainage. His second paper on this subject refers to the action of lime on soils, and he endeavors to show, from the large quantity of ammonia existing in almost all soils, which, according to his experiments, very far exceeds the doses of this alkali usually applied in manure, that lime acts much in the same way as ammoniacal manures themselves, by furnishing indirectly a supply of nitrogen to plants. The effects of over-liming are accounted for in the same way.

The subject in the chemistry of agriculture, which has lately, however, attracted the greatest share of attention, both in this country and abroad, is that of the source from which plants derive their *nitrogen*. It has been satisfactorily proved that plants growing in the ordinary way often contain more of the element nitrogen than they can obtain from the soil in which their roots are placed; and it is obvious that in some way or other this accumulation is derived from the atmosphere. Now, the air surrounding the globe is composed of a mixture of nitrogen and oxygen gases in the proportion of about four parts of the former to one part of the latter; it also contains small quantities of other gases, such as carbonic acid, nitric acid, and ammonia. The question at issue is, as to whether plants can, under any circumstances, make use of the great bulk of the nitrogen of the air in building up their tissues, or whether they derive the observed excess from the ammonia and nitric acid of the air. This question, the interest of which, both in a purely scientific and agricultural point of view, can hardly be overrated, has enlisted the energies of chemists on both sides, and has given rise to some admirable researches. It has also involved the extended examination of air and rain water, in order to ascertain how much ammonia and nitric acid are usually contained in the one, and brought down by the other. The principals in this discussion in France are MM. Boussingault and Ville; both of these chemists have made extended series of experiments on plants grown in glass cases; their conclusions are, however, diametrically opposite: M. Boussingault contending that plants cannot make use of the atmospheric nitrogen, but must be indebted to the nitric acid and ammonia in the air for their supply in excess over that furnished by the soil: M. Ville maintaining that in the absence of both of these, an increase of nitrogen in plants still takes place. A Commission of the French Academy of Sciences, recently appointed to look into this matter, leans rather in its report to the side of M. Ville, but the question is still far from being set at rest.

M. Barral has determined the quantity of ammonia and nitric acid brought down by rain in Paris. M. Boussingault has repeated these experiments as regards ammonia in Alsace, and finds the quantity very much smaller than in the rains of the city, a circumstance which we should be prepared to expect. M. Boussingault has also examined, with the same object, the water of fogs, and dew, and of rivers and streams. M. Ville has carefully determined the ammonia existing in the air both in the interior and suburbs of Paris.

Mr. Lawes and Dr. Gilbert have published the results of an inquiry into the quantity of ammonia and nitric acid in rain falling at Rothamstead, in Hertfordshire. The methods of determining small quantities of nitric acid are at present so imperfect, that Messrs. Lawes and Gilbert have not thought it well to publish their results as to this substance, but they are led to believe that in quantity it exceeds that of ammonia in rain. Besides the names we have mentioned in connection with these researches, other continental and English chemists might be referred to, if circumstances admitted of greater amplification. It is, however, obvious, that in this hurried sketch we have omitted all notice of many investigations on this and other subjects of agricultural chemistry which might well claim attention in a more extended review.

Finally, we must not omit to mention, that the trade in artificial manures, which is rapidly rising into such national importance, especially in England, is receiving the most important aid at the hands of chemical science. Not only are the various waste substances of manufactures and of daily life worked up into available form, but the manures produced by chemical means, more especially the superphosphate of lime, are daily improving in character, mainly through the suggestions of chemists who have specially devoted themselves to this branch of science. Fresh sources of guano have also been discovered, and new supplies of substances useful to the farmer have in several places been obtained.

It is, therefore, not without reason that we congratulate ourselves on the progress which has within the last five years been made by that department of agriculture which is based upon chemical science.

ON THE EMPLOYMENT OF HYPOSULPHATE OF SODA IN ANALYTICAL CHEMISTRY.

Dr. W. Tofal recommends the more frequent employment of hyposulphate of soda in chemical analysis, instead of sulphureted hydrogen. According to him, it can be also used to evolve sulphureted hydrogen; if a piece of zinc is placed in dilute hydrochloric acid, and a few drops of a solution of hyposulphate of soda added, sulphureted hydrogen is evolved. If now to this mixture a solution of a salt of lead, bismuth, cadmium, &c., is added, the sulphurets of the corresponding metals are precipitated.—*Ann. der Chem. und Pharm.*

IMPROVEMENTS IN THE PRESERVATION OF ANIMAL SUBSTANCES.

Jean Wothly, of Zoffinger, Switzerland, has obtained a patent for the following method of preserving meat:—The meat is first cut into pieces of about ten pounds in weight, and separated from the bones. These are then dusted over with sugar and salt, and allowed to stand about two days, and are then subjected to pressure, in order that all the blood and serous matter may be forced out; or in place of being pressed, they are moderately cooked before packing. They are then placed in casks lined with melted fat.

Each piece is covered with a piece of white paper well greased, packed in the barrel, and fat is poured in to fill up the spaces between the pieces. This meat cask is then closed, and placed within a larger one, and the space between the two filled up with sand, which is a good non-conductor.

M. Demait, of Paris, has patented a peculiar method of treating meat to preserve it for use, like our common smoked beef. The meat to be preserved is cut into pieces and strung on a cord at a suitable distance apart from one another. These are then hung on rods and suspended in an air-tight chamber, which has a furnace at its bottom. The chamber is then heated up to about 100° Fah., and a preparation of four ounces of the flour of sulphur, two and a half ounces of lime, and a handful of green mint leaves, is thrown upon the fire, and the doors closed. An opening in the bottom of the chamber admits the gas from the furnace, to the action of which the meat is submitted for 18 hours. At the end of this time the meat is withdrawn, and suspended in a moderately warm room, where it is dried. This process is stated to make finely flavored dry meat, capable of keeping a long period. The pieces of meat are pressed to remove the blood before being strung on the cords.

Joseph Hand, of London, has also secured a patent for preserving meat by a process varying but little from the above. It consists in exposing the meat, in a close chamber, to the action of binoxyd of nitrogen, nitrous acid, and sulphurous acid, in a gaseous state, either singly or combined.

M. Martin de Lignac, of Paris, has also been granted a patent for preserving meat. It consists in cutting raw meat into cubes about an inch square, and subjecting them in close chambers, to currents of warm air at about 75° Fah., until the meat has lost half its weight. It is then powerfully compressed in cylindrical tin boxes to about one-fifth the space occupied before it was dried. The lids of the boxes are then soldered on and a small hole left in the top of each. The boxes are then submitted to a heat of 212°, to raise any moisture in the meat into a steam, when they are soldered up perfectly tight.

GEOLOGY.

ON THE PHYSICAL STRUCTURE OF THE EARTH.

THE following is an abstract of a paper read before the British Association, by Prof. Hennessy:—

After some preliminary observations as to the impossibility of accounting for the earth's figure, without supposing it to have been once a fused mass, the exterior of which has cooled into a solid crust, the process of solidification of the fluid was described. The influence of the connexion and circulation of the particles in a heterogeneous fluid was shown to be different from what would take place in a homogeneous fluid such as usually comes under our notice. As the primitive fluid mass of the earth would consist of strata increasing in density from the surface towards the centre, its refrigeration would be that of a heterogeneous fluid, and the process of circulation would be less energetic in going from its surface towards its centre. Thus, the earth would ultimately consist of a fluid nucleus inclosed in a spheroidal shell. The increase in thickness of this shell would take place by the solidification of each of the surface strata of the nucleus in succession. If the matter composing the interior of the earth is subjected to the same physical laws as the material of the solid crust coming under our notice, the change of state in the fluid must be accompanied by a diminution of its volume. The contrary hypothesis had been hitherto always assumed in mathematical investigations relative to the form and structure of the earth. The erroneous supposition that the particles of the primitive fluid retained the same positions after the mass had advanced in the process of solidification as they had before the process commenced, had been tacitly or openly assumed in all such inquiries until it was formally rejected by the author, who proposed to assume for the fluid similar properties to those exhibited by the fusion and solidification of such portions of the solidified crust as are accessible to observation. The results to which the improved hypothesis has led show that it fundamentally affects the whole question, not only of the shape and internal structure of the earth, but also of the various actions and reactions taking place between the fluid nucleus and the solid shell. If the process of solidification took place without change of volume in the congelation of the fluid, the strata of the shell would possess the same forms as those of the primitive fluid, and their oblateness would diminish in going from the outer to the inner surface. If the fluid contracts in volume on passing to the solid state, the remaining fluid will tend to assume a more and more oblate figure after the formation of each stratum of the shell. The law of density of the nucleus will not be the same as that of the primitive fluid, but will vary more slowly, and the mass will thus tend towards a state of homogeneity as the radius of the nucleus diminishes by the gradual thickening of the shell. The surface of the nucleus, and consequently the inner surface of the shell, will thus tend to become more oblate after each successive stratum added to the shell by congelation from the nucleus. This result, combined with another obtained by Mr. Hopkins, proves that so great pressure and friction exist at the surface of contact of the shell and nucleus as to cause both to rotate together nearly as one solid mass. Other grounds for believing in the existence of the great pressure exercised by the nucleus at the surface of the shell were adduced. If the density of the fluid strata were due to the pressures they support, and if the earth solidified without any change of state in the solidifying fluid, the pressure against the inner surface of the shell would be that due to the density of the surface stratum of the nucleus, and would, therefore, rapidly increase with the thickness of the shell. Contraction in volume of the fluid on entering the solid state would diminish this pressure, but yet it may continue to be very considerable, as the co-efficient of contraction would always approach towards unity. The phenomena of the solidification of lava and of volcanic bombs were referred to in illustration of these views, and their application was then shown to some of the greatest questions of geology. The relations of symmetry which the researches of M. Elie de Beaumont seem to establish between the great lines of elevation which traverse the surface of the earth appear to Prof. Hennessy far more simply and satisfactorily explained by the expansive tendency of the nucleus which produces the great pressure against the shell than by the collapse and subsidences of the latter. The direction of the forces which would tend to produce a rupture from the purely elevatory action of the pressure referred to would be far more favorable to symmetry than if the shell were undergoing a distortion of shape from collapsing inwards. The nearly spherical shape of the shell would also greatly increase its resistance to forces acting perpendicularly to its surface, so as to cause it to subside, while the action of elevatory forces would not be resisted in the same manner.

ON THE OCCURRENCE OF NUMEROUS FRAGMENTS OF FIR WOOD IN THE ISLANDS OF THE ARCTIC ARCHIPELAGO.

From a recent communication made by Sir R. I. Murchison to the London Geological Society, on the above topic, we derive the following abstract:—

My chief object, said Mr. M., is to call attention to the remarkable fact of the occurrence of considerable quantities of wood, capable of being used for fuel or other purposes, which exist in the interior and on the high grounds of large islands in latitudes where the dwarf willow is now the only living shrub.

Before I allude to this phenomenon, as brought to my notice by Capt. M'Clure and Lieut. Pim, I would, however, briefly advert to a few rock specimens collected by the latter officer in Beechey Island, Bathurst Land, Eglinton Island, Melville Island, Prince Patrick's Island, and Banks' Land.

From this collection, as well as from other sources to which I have had access, as derived from the voyages of Parry, Franklin, Back, Penny, Inglefield, and the recent work of Dr. T. Sutherland, I am led to believe that the oldest fossiliferous rock of the Arctic region is the upper Silurian, viz. a limestone identical in composition and organic contents with the well known rocks of Wenlock, Dúdley, and Gothland.

No clear evidence has been offered as to the existence of Devonian rocks, though we have heard of red and brownish sandstone, as observed in very many localities by various explorers, and which may possibly belong to that formation. But whilst in the fossils we have the keys to the age of the Silurian rocks, we have as yet no adequate grounds whereupon to form a rational conjecture as to the presence of the Old Red Sandstone, or Devonian group.

True carboniferous *Producti* and *Spiriferi* have been brought home by Sir E. Belcher from Albert Land, north of Wellington Channel; and hence we may affirm positively, that the true carboniferous rocks are also present. Here and there bituminous schist and coal are met with; the existence of the latter being marked at several points on the general chart published by the Admiralty. With palæozoic rocks are associated others of igneous origin, and of crystalline and metamorphosed character.

Of secondary formations no other evidence has been met with except some fossil bones of Saurians, brought home by Sir E. Belcher, from the smaller islands north of Wellington Channel. Of the old Tertiary rocks, as characterized by their organic remains, no distinct traces have, as far as I am aware, been discovered; and hence we may infer that the ancient submarine sediments, having been elevated, remained during a very long period beyond the influence of depository action.

Let us now see how the other facts, brought to our notice by the gallant Arctic explorers who have recently returned, bear upon the relations of land and water in this Arctic region during the quasi-modern period, when the present species of trees were in existence.

Capt. M'Clure states that in Banks' Land, in latitude 74° 48′ and thence extending along a range of hills ranging from 350 to 500 feet above the sea, and from half a mile to upwards inland, he found great quantities of wood, some of which was rotten and decomposed, but much of it sufficiently fresh to be cut up and used as fuel. Whenever this wood was in a well preserved state, it was either detected in gullies or ravines, or had probably been recently exhumed from the frozen soil or ice. In such cases, and particularly on the northern faces of the slopes where the sun never acts, wood might be preserved any length of time, inasmuch as Capt. M'Clure tells me he has eaten beef, which though hung up in his cold larder for two years, was perfectly untainted.

The most remarkable of these specimens of well preserved recent wood is the segment of a tree, which, by Capt. M'Clure's orders, was sawn from a trunk sticking out of a ravine, and which is now exhibited. It measures 3 feet 6 inches in circumference. Still more interesting is the cone of one of these fir trees which he brought home, and which apparently belongs to an *Abies* resembling *A. alba*, a plant still living within the Arctic circle. One of Lieut.

Pim's specimens of wood from Prince Patrick's Island is of the same character as that just mentioned, and its microscopical characters much resemble *Pinus strobus*, the American pine, according to Prof. Quekett, who refers another specimen brought from Hecla and Griper Bay, to the *Larch*.

In like manner Lieut. Pim detected similar fragments of wood two degrees farther to the north, in Prince Patrick's Land, and also in ravines of the interior of that island, where, as he informed me, a fragment was found like the tree described by M'Clure, sticking out of the soil on the side of a gully.

According to the testimony of Capt. M'Clure and Lieut. Pim, all the timber they saw resembled the present drift wood so well known to Arctic explorers, being irregularly distributed, and in a fragmentary condition, as if it had been broken up and floated to its present positions by water. If such were the method by which the timber was distributed, geologists can readily account for its present position in the interior of the Arctic Islands. They infer that at the period of such distribution large portions of these tracts were beneath the waters, and that the trees and cones were drifted from the nearest lands on which they grew. A subsequent elevation, by which these islands assumed their present configuration, would really be in perfect harmony with those great changes of relative level which we know to have occurred in the British Isles, Germany, Scandinavia, and Russia, since the great glacial period. The transportation of immense quantities of timber towards the North Pole, and its deposit on submarine rocks, is by no means so remarkable a phenomenon as the wide distribution of erratic blocks during the glacial epoch over Northern Germany, Central Russia, and large portions of our island when under water, followed by the rise of these vast masses into land. If we adopt this explanation, and look to the extreme cold of the Arctic region in the comparatively modern period during which this wood has been drifted or preserved, we can have no difficulty in accounting for the different states in which the timber is found. Those portions of it which happened to have been exposed to the alternations of frost and thaw, and the influence of the sun, have necessarily become rotten; whilst all these fragments which remained inclosed in frozen mud or ice which have never been melted, would, when brought to light by the opening of ravines or other accidental causes, present just as fresh an appearance as the specimens now exhibited.

The only circumstance within my knowledge which militates against this view, is one communicated to me by Capt. Sir Edward Belcher, who in lat. 75° 30′, long. 92° 15′, observed on the east side of Wellington Channel the trunk of a fir tree standing vertically, and which, being cleared of the surrounding earth, &c., was found to extend its roots into what he supposed to be the soil.

If from this observation we should be led to imagine that all the innumerable fragments of timber found in these polar latitudes, belonged to trees that grew upon the spot, and on the ground over which they are now distributed, we should be driven to adopt the anomalous hypothesis, that, notwithstanding physical relations of land and water similar to those which now prevail (*i. e.* of great masses of land high above the sea), trees of large size grew on such *terra firma* within a few degrees of the North Pole!—a supposition which I consider to be wholly incompatible with the data in our possession, and at variance with the laws of isothermal lines.

If, however, we adopt the theory of a former submarine drift,* followed by a subsequent elevation of the sea-bottom, as easily accounting for all the phenomena, we may explain the curious case brought to our notice by Sir Edward Belcher, by supposing that the tree he uncovered had been floated away with its roots downwards, accompanied by attached and entangled mud and stones, and lodged in a bay, like certain "snags" of the great American rivers. Under this view, the case referred to must be considered as a mere exception, whilst the general inference we naturally draw is, that the vast quantities of broken recent timber, as observed by numerous Arctic explorers, were drifted to their present position when the islands of the Arctic Archipelago were submerged. This inference is indeed supported by the unanswerable evidence of the submarine associates of the timber: for, from the summit of Coxcomb Range in Banks Land, and at a height of 500 feet above the sea, Capt. M'Clure brought home a fine large specimen of *Cyprina Islandica*, which is undistinguishable from the species so common in the glacial drift of the Clyde; whilst Capt. Sir E. Belcher found the remains of whales on lands of considerable altitude in lat. 78° north.

Reasoning from such facts, all geologists are agreed in considering the shingle, mud, gravel, and beaches in which animals of the Arctic region are imbedded in many parts of Northern Europe, as decisive proofs of a period when a glacial sea covered large portions of such lands; and the only distinction between such deposits in Britain and those which were formed in the Arctic Circle is, that the wood which was transported to the latter has been preserved in its ligneous state for thousands of years, through the excessive cold of the region.

ON THE GROWTH OF STALACTITES.

Professor W. B. Rogers, at a late meeting of the Boston Society of Natural History, gave the following brief sketch of facts which he had observed in the growth of stalactites:—

A drop of water, charged with carbonate of lime, is seen to form at a particular point of the roof, and after its descent, another drop, by the same mechanical causes, takes its place. It is not necessary to suppose a hole around which the concretion may collect. Usually there is none. At the margin of the drop where it thins away to a film, evaporation and the loss of carbonic acid combine to cause a precipitation of part of the dissolved carbonate, which, on separating, attaches itself to the rock in the form of a very delicate white *ring*, corresponding to the margin of the liquid. Each succeeding drop deposits a similar ring in contact with and beneath that already formed, until the whole is prolonged downwards in the shape of a *quill-like*

* Dr. Hooker informs me that all the specimens sent to him were collected in mounds of silt, rising up from the level of the sea to 100 feet or more above it; and he entirely coincides with me in the belief that the whole of this timber was drifted to the spots where it now lies.

tube. This, from its vertical position, invites the water of the adjoining part of the roof to descend along its outer surface, and now an exterior and more rapid growth begins. Usually, the former process continues to operate for a long time after the external growth has commenced: so that the stalactite, in some cases, retains its open central canal until it has reached a length of a foot or more, and a diameter at its base of two or three inches. As the water, which flows along the outside of the tube, parts at each step with a portion of its calcareous charge, and thus grows continually less capable of forming the deposit, the rate of deposition must diminish somewhat regularly from the upper to the lower end of the mass. Hence it is that stalactites, formed in positions where their growth on all sides is freely permitted, have always a *sharply conical or tapering form.*

The drops which fall from these pendants to the floor, still retain a portion of carbonate of lime in solution; but as the shock of the impact and the spreading of the liquid greatly favor the escape of its carbonic acid, a further deposit must be formed in this position, and thus the stalagmite grows upwards to meet the stalactite growing downwards, until in many cases they unite to form a column reaching from the floor to the ceiling of the cave.

As in general the infiltering water follows the joints and planes of stratification of the limestone rock, the *fashion or pattern of the stalactitic drapery will be more or less determined by the position and arrangement of these divisional surfaces.* Where, as in parts of Weyer's Cave, in Virginia, these planes of bedding are steeply inclined, and meet the roof in a series of parallel lines, the concretionary action seems to have commenced by forming parallel rows of stalactites along these lines. This process, in certain places, has gone on until, by lateral union of the adjoining pendants of each row, they have been transformed into *parallel sheets of stone,* which in some instances extend from the roof to the floor. From their great extent, and a degree of thinness which, in part, renders them translucent, these sheets are capable of being thrown into sonorous vibration by a blow from the heel near the ground, and under these circumstances they emit a musical sound of great depth and force.

BOILING SPRINGS IN UTAH.

The Placerville (Cal.) *American* gives the following description of ten curious Springs situated about ten miles north of Wash-ho Valley, Utah, upon a tributary of the Truckee, and called "Steamboat Springs," appearing to derive their name from the fact that they are like so many boilers generating steam. "For a distance of three-fourths of a mile do these remarkable springs pour their waters, rushing, boiling, and foaming, through innumerable fissures in the rocky formation in which they are found. The entire of one bank of the stream on which they are situated, a distance of from thirty to eighty rods in width and three-fourths of a mile in length, and rising backwards from the river in places from sixty to eighty feet, the whole seems one vast deposit from the water that for ages has been ejected therefrom. It is not that boiling hot water is ejected throughout this whole extent from well defined springs, but the surface is filled with innumerable cracks or fissures from four to eighteen inches in width, communicating with subterranean cavities or chambers, through which the boiling water is forced with great velocity, and producing a noise closely resembling that produced by the wheels of a powerful steamer upon the water. A singular feature is, that in large tracks but a few feet from each other, the boiling water is seen flowing in opposite directions; and in others changing from one direction to another at intervals of a few minutes. In many places the waters overflow the surface, but more generally traverse the crevices at various depths from the surface, generally in view, but sometimes so deeply within as not to be distinguished, whilst the ceaseless roaring, splashing, and hissing is heard in every direction. And jets of steam that will scald the hand instantly on application, are here and there forced through the openings and fissures, high above the surface of formation, and with great violence. There is one place more remarkable, if possible, than others; it is where the surface of the rocky deposit is unbroken, yet loudly distinct beneath is heard the roaring as of a strong blast furnace. Not a drop of water is visible here, but the rock or deposit on which the spectator stands, is actually burning hot; the bare hand can scarcely be held upon it for a moment. Morning and evening, when the air is cold and still, the whole is shrouded with steam and vapor. In many places there are small deposits of sulphur that will ignite by the application of a match; in others the strongest alum was found; and yet others, an alkaline substance so concentrated as to destroy in a short time a linen handkerchief in which a specimen had been wrapped. The country in the immediate vicinity bears unmistakable evidence of the effect of powerful volcanic action—masses of vitrified rocks, cinders, the ordinary coarse conglomerate scoria of extinct volcanic craters; and not a few specimens were obtained of the lightest, pumice stone ever seen."

ON THE ORIGIN OF GREENSAND, AND ITS FORMATION IN THE OCEANS OF THE PRESENT EPOCH, BY PROF. J. W. BAILEY.

As an introduction to the subject of this paper, it is proper to refer to various observations which have been made of facts intimately related to those which I wish to present. That the calcareous shells of the Polythalamia are sometimes replaced by silica, appears to have been first noticed by Ehrenberg, who says:—

"I may here remark that my continued researches on the Polythalamia of the Chalk have convinced me that very frequently in the earthy coating of flints, which is partly calcareous and partly siliceous, the original calcareous shelled animal forms have exchanged their lime for silex without undergoing any alteration in figure, so that while some are readily dissolved by an acid, others remain insoluble; but in chalk itself, all similar forms are immediately dissolved."

The first notice of *casts* of the cells and the soft parts of the Polythalamia was published by myself in the Am. Jour. of Science for 1845, where I stated as follows:—

"The specimens from Fort Washington presented me with what I believe have never been before noticed, viz. distinct *casts* of Polythalamia. That these minute and perishable shells should, when destroyed by chemical changes, ever leave behind them indestructible memorials of their existence was scarcely to be expected, yet these casts of Polythalamia are abundant and easily to be recognized in some of the Eocene Marls from Fort Washington."

Dr. Mantell also noticed the occurrence of casts of Polythalamia and their soft parts, preserved in flint and chalk, and communicated an account of them to the Royal Society of London. To Ehrenberg, however, appears to be due the credit of first distinctly announcing the connection between the Polythalamia and the formation of Greensand, thus throwing the first light upon the origin of a substance which has long been a puzzle to geologists. In a notice given by this distinguished observer upon the nature of the matrix of the bones of the Zeuglodon from Alabama, he says:—

"That Greensand, in all the numerous relations in which I have as yet examined it, has been recognized as due to the filling up of organic cells, as a formation of stony casts mostly of Polythalamia, was stated in July of the preceding year." He then refers to the Nummulite Limestone of Traunstein, in Bavaria, as rich in green opal-like casts of well-preserved Polythalamian forms, and mentions them as also occurring, but more rarely, in the Glauconite Limestones of France. He then proceeds to give an account of his detection of similar casts in the limestone adhering to the bones of the Zeuglodon from Alabama, and states that this limestone abounds in well-preserved brown, green, and whitish stony casts of recognizable Polythalamia. This limestone is yellowish, and under a lens appears spotted with green. These green spots are the Greensand casts of Polythalamia, and they often form as much as one third of the mass. By solution in dilute chlorohydric acid, the greensand grains are left, mixed with quartzose sand, and with a light yellowish mud. The latter is easily removed by washing and decantation. The casts thus obtained are so perfect that not only the genus, but often the species of the Polythalamia, can be recognized. Mingled with these are frequently found spiral, or corkscrew-like bodies, which Ehrenberg considers as casts of the shells of young mollusks.

With reference to the perfection of these casts of the Polythalamia, and the light they throw upon the structure of these minute animals, Ehrenberg remarks:—

"The formation of the Greensand consists in a gradual filling up of the interior space of the minute bodies with a green-colored, opal-like mass, which forms therein as a cast. It is a peculiar species of natural injection, and is often so perfect, that not only the large and coarse cells, but also the very finest canals of the cell walls, and all their connecting tubes, are thus petrified, and separately exhibited. By no artificial method can such fine and perfect injections be obtained."

Having repeated the experiments of Ehrenberg upon the Zeuglodon Limestone, I can confirm his statements in every particular, and would only add, that besides the casts of Polythalamia and small spiral mollusks, there is also a considerable number of green, red, and whitish casts of minute anastomosing tubuli, resembling casts of the holes made by burrowing sponges (Cliona) and worms. In the Berlin Monats-Bericht, for July, 1855, Ehrenberg gives an account of very perfect casts of Nummulites, from Bavaria and from France, showing not only chambers connected by a spiral siphuncle, but also a complicated system of branching vessels. He also gave at the same time an account of a method he had applied for the purpose of coloring certain glass-like casts of Polythalamia, which he had found in white tertiary limestone from Java. This method consists in heating them in a solution of nitrate of iron, by means of which they can be made to assume different shades of yellow and brownish red, still retaining sufficient transparency when mounted in balsam to show the connexion of the different parts. The interesting observations of Ehrenberg which are alluded to above, have led me to examine a number of the cretaceous and tertiary rocks of North America in search of Greensand and other casts of Polythalamia, &c. The following results were obtained:—

1st. The yellowish limestone of the cretaceous deposits of New Jersey occurring with Teredo tibialis, &c., at Mullica Hill, and near Mount Holly, is very rich in Greensand casts of Polythalamia and of the tubuliform bodies above alluded to. 2d. Cretaceous rocks from Western Texas yielded a considerable number of fine Greensand and other casts of Polythalamia and Tubuli. 3d. Limestone from Selma, Alabama, gave similar results. 4th. Eocene limestone from near Charleston, S. C., gave abundance of similar casts. 5th. A few good Greensand casts of Polythalamia were found in the residue left on dissolving a specimen of marl from the Artesian Well at Charleston, S. C.; depth 140 feet. 6th. Abundance of organic casts, in Greensand, &c., of Polythalamia, Tubuli, and of the *cavities of Corals*, were found in the specimen of yellowish limestone, adhering to a specimen of Scutella Lyellii from the Eocene of North Carolina. 7th. Similar casts of Polythalamia, Tubuli, and of the *cavities of Corals*, and species of Encrinitis, were found abundantly in a whitish limestone adhering to a specimen of Ostrea sellæformis from the Eocene of South Carolina. The last two specimens scarcely gave any indications of the presence of Greensand before they were treated with dilute acid, but left an abundant deposit of it when the calcareous portions were dissolved out. All the above-mentioned specimens contained well-preserved and perfect shells of Polythalamia. It appears from the above, that the occurrence of well-defined organic casts, composed of Greensand, is by no means rare in the fossil state.

I come now to the main object of this paper, which is to announce that the formation of precisely similar Greensand and other casts of Polythalamia, Mollusks, and Tubuli, is now going on in the deposits of the present ocean. In an interesting report by Count Pourtales, upon some specimens of soundings obtained by the U. S. Coast Survey in the exploration of the Gulf Stream, the sounding from Lat. 31° 32′, Long. 79° 35′, depth 150 fathoms, is mentioned as "a mixture in about equal proportions of Globigerina and black sand, probably greensand, as it makes a green mark when crushed on paper." Having examined the specimen alluded to by Mr. Pourtales, besides many others from the Gulf Stream and Gulf of Mexico, I have found that not only is Greensand present at the above locality, but at many others, both in the Gulf

Stream and Gulf of Mexico, and that this Greensand is often in the form of well-defined casts of Polythalamia, minute Mollusks, and branching Tubuli; and that the same variety of petrifying material is found as in the fossil casts, some being well-defined Greensand, others reddish, brownish, or almost white. In some cases I have noticed a single cell, of a spiral Polythalamian cast, to be composed of Greensand, while all the others were red or white, or *vice versâ.*

The species of Polythalamia whose casts are thus preserved, are easily recognizable as identical with those whose perfectly preserved shells form the chief part of the soundings. That these are of recent species is proved by the facts that some of them still retain their brilliant red coloring, and that they leave distinct remains of their soft parts when treated with dilute acids. It is not to be supposed, therefore, that these casts are of extinct species washed out of ancient submarine deposits. They are now forming in the muds as they are deposited, and we have thus now going on in the present seas a formation of Greensand by processes precisely analogous to those which produced deposits of the same material as long ago as the Silurian epoch. In this connection it is important to observe that Ehrenberg's observations, and my own, establish the fact that *other* organic bodies than Polythalamia produce casts of Greensand, and it should also be stated that many of the grains of Greensand accompanying the well-defined casts are of wholly unrecognizable forms, having merely a rounded, cracked, lobed, or even coprolitic appearance. Certainly many of these masses, which often compose whole strata, were not formed either in the cavities of Polythalamia or Mollusks. The fact, however, being established beyond a doubt, that Greensand does form casts in the cavities of various organic bodies, there is a great probability that all the masses of this substance, however irregular, were formed in connexion with organic bodies, and that the chemical changes accompanying the decay of the organic matter have been essentially connected with the deposits in the cavities, of green and red silicates of iron, and of nearly pure silica. It is a curious fact in this connection, that the *siliceous* organisms, such as the Diatomaceæ, Polycistineæ, and Spongiolites, which accompany the Polythalamia in the Gulf Stream, do not appear to have any influence in the formation of casts.

The discovery by Prof. Ehrenberg of the connection between organic bodies and the formation of Greensand, is one of very great interest; and is one of the many instances which he has given to prove the extensive agency of the minutest beings in producing geological changes.

HEIGHT OF THE HIMALAYAS.

It appears from a late survey made of the Himalaya range, by Colonel Waugh, that the Khanchinjinga, which has been hitherto supposed to be the highest summit, is in fact not so—a higher mountain having been discovered, situated between Katamandoo and Khanchinjinga. This last named is 28,156 feet above the level of the sea; but the new summit reaches the enormous height of 29,002 feet. It has been proposed to call this Mount Everest, after a former surveyor-general of India.

NEGATIVE ARTESIAN WELLS.

The London Society of Arts have recently published a paper by M. Bruckmann, on "Negative Artesian Wells," that is, wells which take instead of giving out water. Such wells serve as permanent drains; they are sunk in loose strata, or where communications exist with fathomless fissures or with deep-lying streams. M. Bruckmann, who is a native of Würtemberg, states that they may be established "in all the so-called normal or sediment formations; diluvium; tertiary deposits; chalk, Jurassic rocks," and others. And he brings forward examples of the benefits that have followed the sinking of negative wells in towns or in swampy country districts. The drainage becomes at once perfect and constant; fluid matters of all kinds find their way to the mouth, and flow away, while solid matters may be stopped, and used in fertilization.

ON THE RELATIVE AGE OF DIFFERENT PORTIONS OF THE MOON'S SURFACE.

At the Albany meeting of the American Association, Professor Alexander presented a paper on the above topic, in which he stated that a map of the Eastern hemisphere, taken with the Bay of Bengal in the centre, would bear a striking resemblance to the face of the moon presented to us. The dark portions of the moon he considers to be continental elevations, as shown by measuring the average height of mountains above the dark and the light portions of the moon. He recently had seen the bearing of newly-observed phenomena on the question, the character of the ridges in the neighborhood of Pico. These ridges are shown by their tints to be of the same geological character as the tops of the mountains. They show themselves to be recent disturbances or upheavals by the manner in which they cross other formations, as though ejected through cracks in a previous crust. The superior thickness or elevation of crust in the dark portions, is shown by the fact that some of these white lines, running through everything in the bright portions, cease at the entrance into the darker regions. A close scrutiny of the white portions shows a great subsequent inundation of the white rock flowing over the ocean beds (if that term be allowed) and raising their level. He thought that these facts threw some light on the inhabitants of the moon. Might not this flow into the ocean bed have absorbed, by some chemical action (as water of crystallization or otherwise), the ocean and atmosphere? If so, the moon might have been formerly inhabited and been rendered desolate by this change.

ON THE POSSIBLE ORIGIN OF VEINS OF GOLD IN QUARTZ AND OTHER ROCKS.

Mr. Ibbotson, in a communication to the London Geological Society, stated, that having mixed a solution of gold in nitro-muriatic acid with five times its weight of water, and placed it in a Berlin evaporating dish on a thick sheet of copper over a gas lamp, the author observed a crack in the basin, which was increasing. On transferring the solution to another basin, he found that the crack presented a vein of gold; the pure gold forming small nodular masses along the fissure, both inside and out, and resembling veins of gold in auriferous quartz rocks. Under the circumstances of the low temperature at which the solution was being evaporated, the diluted state of the solution still left unevaporated, and the difference of the appearance of the nodular form of the gold vein from the usual appearance of the metallic gold obtained by evaporation from such a solution, the author thought it worth while to describe and exhibit the specimen.

ON A POSSIBLE ORIGIN OF INCLINED STRATA.

At the Albany meeting of the American Association, Mr. J. D. Whitney gave a description of a remarkable instance of inclined stratification near Lake George, where fine white sand containing small quartz pebbles has been deposited over a considerable extent, and with a thickness of 25 feet vertical, having a dip of 30 degrees. This fact, thus established, that strata may be deposited at a high angle, led to the development of a theory of the formation and dip of the sandstones of the Connecticut valley and other similar deposits on the Atlantic slope of the Appalachian chain. The main point of the theory was this: that these beds of sandstone were originally deposited in an inclined position in a basin of subsidence by currents of water carrying detritus, which currents were produced by the subsidence itself. If a fault originated in a valley, at one side or the other, and there should be a subsidence on that side, a current of water would be produced, of greater or less violence, which current would set across the valley and carry with it the material abraded from the adjacent region, which would be deposited in strata dipping, at a considerable angle, at right angles to the line of direction of the fault, as in the Connecticut valley. According as the subsidence was to the east or the west, the dip of the strata would be in the opposite direction. Thus the origin of limited basins of sandstone, having a dip transverse to the direction of the basin, would be fully explained by a cause lying within the basin itself—a phenomenon which had not as yet been satisfactorily explained by geologists.

ON THE MOUNTAIN CHAINS OF WESTERN AMERICA.

At the Albany meeting of the American Association, W. P. Blake, Esq., in a paper on the Orography of the Western portion of the United States, thus delineated and named the three chains of mountains, crossing the country between the Mississippi and the Pacific; the deductions being made from a careful examination of all the recent Government surveys:—First, the Rocky Mountains, extending from the table land of Mexico to and beyond the northern boundary. Second, the Sierra Nevada and its prolongations north and south; and third, the Great Basin range and other broken ranges between the first and second groups. He then proceeded to describe these chains. The length of the first, he said, was 1,400 miles, and its general direction NN.W. and SS.E. The second chain is formed of many and nearly parallel ranges, which enclose elevated valleys. The third extends from Snake River on the north to the parallel of 40 degrees. Mr. Blake proposed new names for these three ranges. The first he proposes to call the Anahuacian; the second, the California Chain; the third, the Aztecian Chain.

ON THE AGENCY OF THE GULF STREAM IN THE FORMATION OF THE PENINSULA AND KEYS OF FLORIDA.

The following paper was read before the Albany meeting of the American Association for the Promotion of Science, by Mr. J. Le Conte:—

Until the explorations of Agassiz and Tuomey, the geology of Florida had not been known, it being supposed to consist of a prolongation of that of Georgia and Alabama; but these gentlemen made known the remarkable fact that the keys and most of the Peninsula are of recent origin, and, so far as they examined, are the work of corals, still living in the vicinity and still at work. The object of the present paper was to show that coral agency alone was not sufficient to account for the phenomena, but that another and more powerful agent has been at work preparing the foundation for the builders, and that this agent was the Gulf Stream. A section was drawn upon the blackboard, dividing the lower part of Florida into three sections—the more northerly bounded by a line from Tampa Bay north-easterly to the Atlantic; a second from Charlotte's Harbor, parallel to this; and a third, also parallel, from Chatham Bay.

These lines are also parallel to the line of coast at the extremity of the peninsula. Parallel also is the line of islands, the keys, separated from the shore by a ship channel, and still further outside the line of living coral reef, just on the edge of the Gulf Stream. The living reef is some five to ten miles from the keys, and the keys some forty miles from the coast, the water here being very shoal and dotted over with small mangrove islands. The shore is some twelve or thirteen feet above the sea, but inland the so called Everglades sink, and are but a few feet above water, varied by fresh ponds and hammocks. Outside the living reef the sea bottom slopes rapidly to almost unfathomable depths. This description being kept in mind, the theory to be presented will be clear. That the Southern coast, the keys, and the Everglades are the work of coral agency there is no doubt. But as corals cannot grow above the surface of the water, their agency alone is not sufficient—the violent action of the winds and waves is necessary to break off masses of the coral and bear them within the line of the reef. Here these coral boulders become the nuclei around which smaller pieces of coral, sand, and other substances collect, become cemented by the carbonate of lime in the sea water, and so at length the whole becomes an island clothed with vegetation. All these processes may be seen going on at the keys and reefs of Florida. There is the solitary boulder, that already is the centre of a mass of coral debris, and so on up to the inhabited island. The coral sand in these islands is found always affected by that kind of stratification caused by the action of violent waves. The idea of Prof. Tuomey that the masses of coral exposed above the sands and soils of some of the islands are the tops of ancient coral trees elevated by igneous agency, is found to be an error when excavations are made, as they are then revealed to be but boulders. The conclusion from this reasoning follows inevitably that the line of keys is a former coral reef changed by the action of the waves as above described. In this manner, as Tuomey pointed out and Agassiz has proved, was the present Southern coast formed. Here also Tuomey supposed he saw evidence of upheaval, while Agassiz saw nothing but the effect of the waves. The line of the shore was once a reef, then became keys, finally a continuous coast line, behind which the shoal water rapidly filled up, and the Everglades were formed. Of course, during the reef period, the elevated line from Chatham Bay was the coast. The coast also must have been begun as a coral reef, which went through the same changes, at a time when the line from Tampa Bay was still the limit of the peninsula. It is clear that all this portion of southern Florida was *superficially* formed by coral agency; and we can hardly doubt that this is equally true of the country much further to the northward, for specimens of precisely the same coral have been collected as far north as St. Augustine. This opinion Mr. Le Conte fortified by various other facts and arguments. Thus far we have Prof. Agassiz's views upon the mode of formation of this region. That the coral agency, however, was not alone sufficient, the speaker now proceeded to show:

First: It is a well known fact that the reef-building corals of those seas cannot grow at a greater depth than sixty to seventy feet; nor can they grow above the surface of the water at low tide—being thus confined vertically to limits of ten or twelve fathoms. Unless there be a subsidence of the sea-bottom, therefore, we can have no reef of greater extent than this; in case of coral *islands*, we may add ten or fifteen feet for materials thrown up by the waves, which, where there is no subsidence, limits the extremes to some eighty feet.

Second: It is certain that no subsidence of the sea-bottom has here taken place, as that would preclude all possibility of the increase of the peninsula by coral agency. It follows then that the coral formation of Florida can be nowhere beyond eighty feet in thickness. Now if coral agency alone is to be admitted, it follows that the ocean, for the enormous distance from St. Augustine to the present reef, was nowhere above sixty or seventy feet in depth; and Florida was originally represented by a tongue-formed shoal three hundred miles in length! Suppose this to have been the case, why did not the corals grow over the whole extent, and form a coral field, instead of appearing in a succession of reefs? This proved conclusively to the speaker that the conditions of coral growth were progressively more and more southwardly. The facts in the case prove that the sea-bottom has been gradually rising from north towards the south.

Third: The gradual rising of the sea-bottom may be occasioned either by igneous agency or by sedimentary deposit. Prof. Tuomey supposed that he had found evidences of the former, but Agassiz has satisfactorily explained those appearances on which the deception was based, and we may with full confidence say that there is no evidence of any such igneous action. It is inconceivable that a sufficient elevation could have taken place to have afforded the coral a foothold and not have raised the recently formed land. The rising by sedimentary deposit, on the other hand, can affect nothing but the sea-bottom, and to this cause the speaker referred that uprising which forms the necessary condition of the horizontal extension of the coral reefs.

Now to proofs that such deposits have actually taken place: It is a law of currents that if their velocity is checked they deposit a portion of their sediments upon the bottom; if it is increased, they wear away their beds and banks. If the velocity of the stream be greater on one side than on the other, they abrade one bank and deposit the abraded matter on the other. Such a current, in making a curve, necessarily has a greater velocity on the outside than on the inner; the outer bank will then be abraded, and a tongue of land be formed on the other side. If instead of the tongue of land you have a body of still water around which the current sweeps, deposition of sediment will begin and go on until you have the tongue again; and this is necessarily true under all circumstances. It is of no consequence whether the limits of the current be solid banks or banks of still water. A sediment bearing stream making a sweep or curve in still water must deposit its sediment principally upon the inner side of the curve, thus forming shoal water. The curve will extend, and the shoal in proportion. The Gulf Stream is such a current, making a strong sweep around the point of Florida. The result of this reasoning is, that the sweep of the curve of the Gulf Stream has been extending for ages, and the peninsula has kept pace with it by means of sedimentary deposit. Or suppose Florida was once represented by a shoal of the same form and extent, this shoal must become constantly shallower from the same cause. If, then, the Gulf Stream carries sediment, the above conclusions must follow. This stream is supposed to be a continuation of the great Equatorial current crossing the Atlantic, dividing at Cape St. Roque, the northern branch uniting with the waters of the Amazon and Orinoco running along the coast of South America, through the Caribbean Sea into the Gulf of Mexico, emerging between Florida and Cuba, and running off to the north. This stream we know carries the sediment of the Amazon and Orinoco in a visible form for several hundred miles. Much of this is no doubt deposited along the South American coast, but according to Humboldt much is carried into the Gulf. Into the Gulf is also poured the vast amount of sediment of the great Central North American Rivers, especially of the Mississippi, and those turbid waters form the Gulf Stream; for Lyell has proved that all these currents and streams mingle their waters in this great basin. It was here shown that all this sediment could not be deposited in the Gulf itself, by calculations based upon the depth and velocity of the stream and the distance (500 miles) from the mouth of the Mississippi to the Tortugas. It was also shown that such a sinking of the sediment from the surface would take place that the Stream would have a clear and transparent stratum of water at the top of some 60 and 70 feet in depth, at the close of the seven days required for it to pass from the mouth of the Mississippi to the point of Florida. In this respect the Gulf Stream, flowing between the banks of still water, differs from a river broken by a rough bottom and impinging upon irregular sides. The lower strata of the Stream may then be filled with sediment, though the upper be clear. One other fact in relation to the habits of the coral must be noted in this connection—namely, that it only exists in clear water.

To sum up the foregoing in a few words, the theory under consideration is this—which was illustrated at length by a diagram. When the stream, in sweeping around the point of Florida, had parted with so much of its sediment as to bring the bottom within 60 or 70 feet of the surface, it became possible for the coral to exist, providing it could find water of sufficient purity. This would be the case at any point so far from the shore as to be beyond the influence of the surf's disturbance of the mud deposited along the coast, as the shoal has risen into the clear surface stratum of the stream. As the bottom formed by deposit is necessarily formed upon a slope, the coral would find a line parallel to the shore, along which none of the conditions of its existence would be wanting. This line would be that of a reef. How the reef would become a line of keys, and the keys in turn become the coast, and the shoal water within become the Everglades, has already been shown. Did not the island of Cuba interpose, this extension of Florida might go on indefinitely, but as the passage narrows, the force of the current necessarily increases, and there is therefore no hope that in this manner Cuba will be annexed. The laws regulating the deposition of sediment also afford an explanation of the long parallel ridges on the sea bottom of the coast of South Carolina, in the bed of the Gulf Stream. Suppose that two or three submerged peaks in the line of the Bahama Islands stand within the Stream. Behind these peaks there must be still waters, or at least an eddy. Here matter will be deposited by the waters passing over and beside them, and the matter thrown down will in turn offer an obstacle which will continue to cause the effect further and further away from the original point. Again, while the Gulf Stream is moving in a curve around the point of Florida, nearly all its deposits will be made on the river side of the curve, that is upon this point; but after passing into the open sea, it takes a straight course and begins to deposit upon both sides alike. Hence, by this theory, the origin of the Bahama Banks. Another very curious result of all this reasoning remains to be mentioned. As the limits of a channel narrow, the current necessarily increases its velocity. The heat of a warm current is therefore retained to a far greater distance from the point of departure. It is well known that the Gulf Stream affects favorably the climate of the north-western portions of Europe. There is nothing then absurd in the idea that during the decrease of the breadth of the Gulf Stream between Cuba and the main land opposite, a decrease of hundreds of miles, the temperature of the water carried across the ocean to the coasts of Ireland, Scotland, and Norway, has been constantly rising, and that from this cause an increasing amelioration of the climate of that part of the Eastern continent has resulted.

ON THE PERMIAN AND TRIASSIC SYSTEMS OF NORTH CAROLINA.

At the Albany meeting of the American Association, an interesting and valuable paper was presented by Dr. Emmons, State Geologist of North Carolina, on the Permian and Triassic systems as developed in that state. The Permian rocks in North Carolina are sandstones, slates, and shales, which occupy a trough nearly in the central portion of the state, and extending from Oxford, near the northern boundary, to a point some six miles across the boundary of South Carolina. There is another small belt, similar in structure and conformation, in the north-western part of the state. Red, grey, and drab sandstones alternate with calcareous shales, bituminous slates, and coal seams. Beginning at the lowest in the series they occur in the following order:—The stratum on which they rest is a bed of conglomerate so hard that it is used for mill stones. The pebbles of which this is composed are mostly of quartz, derived from the Taconic series below. In the county of Chatham this bed of conglomerate attains a thickness of at least sixty feet. Upon this immediately rests the first of the Permian rocks, a red sandstone occurring in belts from one to three feet thick, separated by marls. The aggregate thickness of this stratum reaches in some spots 1,800 feet. The next series consists of shales, calcareous and bituminous, interspersed with belts of softer materials. Among these shales are found beds of bituminous coals of a very fine quality. This coal has 4½ per cent. of volatile matter, makes 2 per cent. of ash, and forms excellent coke. The thickness of this series was given at 800 feet. The third series consists of beds of hard and soft sandstone—the latter properly called marls. His object was now to state facts which will show the position of these rocks. They rest upon sandstones which contain carboniferous fossils, and must, therefore, be more recent than these. There is evidently a great hiatus between the rocks underlying and the series now in contemplation. Now, what are the ages of this series? The Permian and Triassic. What is the evidence of this? Facts derived from the peculiar characters of the fossils found in them. The most important of these fossils are Saurians, and that type which is considered characteristic, namely, the Thecodent Saurians of Europe—those which are found in the Bristol conglomerate of England, belonging to the lower part of the Permian system. The teeth of these Saurians are in sockets, the vertebræ are peculiar in being concave at both ends, and constricted at the sides, which are characteristic of the Bristol Saurians. The ribs are double headed; and in the specimens now exhibited of the vertebræ, the impression of this double head of the rib was distinctly visible. It is clear that these Saurians were highly organized, though this was matter not now to be considered. He called attention again to the fact that the teeth were in sockets, and of these teeth he had three or four species, all of which he considered as being the same with the Clepsyossurus Pennsylvanicus, first discovered and named by Isaac Lea, Esq. These specimens were found, some imbedded in the coal and some in rock, so hard that acids were necessary to extract them. In one of the specimens two vertebræ are in their natural position. One tooth he considered that of the Palæosaurus; another specimen he considered to be plates of the head of the Archægosaurus, now found for the first time in this country. The only specimens found hitherto are from the Saarbruck beds. This, though of the same genus, is probably of a different species. The other fossils are of a minute Cypris, which occurs in the slates of Saxony, similar in character and age. Drawings of a variety of plants found in these coal measures were shown. Leaving this series of shales, we come to drab-colored sandstone, variable in thickness, but attaining a maximum of one thousand two hundred feet. Above this is another belt of conglomerate, marking the commencement of another era. Above this, again, is another plant bed, entirely without animal remains, consisting mainly of ferns and Cycades. One of these is a true Cycas, and the first, he thought, which had been found in the United States, though it existed as a living species in New Holland. He mentioned also specimens of Voltzia and Walchia. Next comes another sandstone, in color red, and containing Posidoma, and at the top some very remarkable bones, which he exhibited, but which he was unable to name. With these bones were found coprolites, containing scales of fishes. This sandstone is eight hundred or one thousand feet thick, and was referred by him to the age of the Keuper of Europe. A bone was also exhibited encased in rock, from a position below the plant bed. He spoke of the difficulty of making out all these strata, owing to the great quantity of debris; but he trusted that he had proved that the upper conglomerate is separate from the lower, and should be recognized as different, both for paleontological and lithological reasons. The new red sandstone of Connecticut, New Jersey, and Pennsylvania probably belongs to one of these series, and that the upper, for the lower sandstone he could prove disappears upon advancing north, while the upper can be traced. Thus the Richmond coal field is separated from that of Deep River in North Carolina, which he considers as of the Permian age, while that at Richmond he refers to the Triassic.

Professor Agassiz said that there was not in any of our geological cabinets a series of fossils so important as that laid before them by Professor Emmons. His conclusions were formed from but a few moments' examination, but certainly we had here fossils all the way from the Upper Jura to the Lower Triassic. He did not see anything which he could refer to the Permians. There were fossils here which he recognized as occurring only in Portland stone and on the Purbeck beds. He had found also a well authenticated Labyrinthodon.

ON THE ORIGIN AND ACCUMULATION OF PROTO-CARBONATE OF IRON IN THE COAL MEASURES GENERALLY.

The following paper on the above subject, has been presented to the Boston Soc. Nat. History, by Prof. W. B. Rogers:—

This compound of iron, as we know, where mined in the coal measures, presents itself in courses of lenticular nodules and interrupted plates, usually included in the carbonaceous shales and in the fire-clays which underlie the seams of coal, and in such cases it often forms a heavy ore, containing but little earthy or organic matter, mixed with proto-carbonate. But it is also frequently met with in a *diffused condition*, pervading thick strata of shale and shaly sandstone, and causing these rocks to present in their different layers, all the gradations of composition from a poor argillaceous and sandy ore, to beds of sandstone and shale, with little more than a trace of the ferruginous compound.

On comparing the different subdivisions of a system of coal measures, we may remark certain general conditions connected with the abundance or with the comparative absence of the proto-carbonate in the strata.

One of these is seen in the fact that the lenticular ores and strata, impregnated with proto-carbonate of iron, are in a great degree restricted to such divisions of the carboniferous rocks as include beds of coal, or are otherwise heavily charged with carbonaceous matter. This is well shown on comparing together the four subdivisions of the carboniferous rocks of the great Trans-Alleghany coal region, as classified under the head of the Seral coal series of the Pennsylvania and Virginia Geology. In the first of these, designated as the Older coal measures, the proto-carbonate is found in large amount both in the shape of layers and lenticular ore, and diffused through the substance of the shaly strata. In the next division above, distinguished as the Older barren shales, and which, as the name implies, is comparatively devoid of carbonaceous matter, much less of the proto-carbonate is met with. In the third group, that of the Newer coal measures, the ore again abounds, and in the uppermost division, or Newer barren shales, it has a second time almost disappeared.

The connection between the development of the proto-carbonate in the strata and the presence, either now or formerly, of a large amount of carbonaceous or vegetable matter, becomes even more striking on a detailed examination of particular heads. Thus, in the coarse sandstones of the coal measures which are comparatively destitute of vegetable remains, we find little admixture of the proto-carbonate. On the other hand, the fine grained flaggy argillaceous sandstones, which are often crowded with the impressions and carbonized remains of plants, are at the same time more or less impregnated with this ferruginous compound. So, again, the soft argillaceous shales, in the midst of which the lenticular ore so frequently presents itself, show, by their dark color and included impressions of plants, as well as by actual analysis, that they are richly imbued with vegetable matter. Nor do the nearly white fire-clays, which in many cases enclose thick courses of the lenticular ore, form any exception to this law. For, although in their present state they contain little or no carbonaceous matter, the marks of innumerable roots of Stigmaria and parts of other plants which everywhere penetrate the mass, show that at one time they must have been crowded with vegetable remains.

A further and yet more striking proof of the influence which the contiguous vegetable matter has had in the formation of the proto-carbonate, is seen in the fact that the most productive layers of the ore are commonly met with quite near to the beds of coal, and that frequently crowds of the nodules are found in the carbonaceous shales or partings which lie in the midst of the seam itself.

While the strata, including the proto-carbonate, are thus distinguished by the admixture of more or less carbonaceous matter, they are *also remarkable for seldom exhibiting a distinctly red tint.* Presenting, where not weathered, various shades of greenish-grey and olive, and bluish-black, they only become brown or red where, by exposure to air, the proto-carbonate has been converted into the sesquioxide of iron. On the other hand, those divisions of the coal measures which have been but slightly charged with vegetable matter, as, for example, the barren shales of the Seral Coal Rocks, before alluded to, contain much red material, both in distinct strata and mottling the general mass, and are throughout more or less impregnated with the sesquioxide.

A like general law, as to color, would seem to apply to the other great groups of sedimentary rocks which include in particular beds accumulations of vegetables, or other organic exuviæ. Thus, in the New and Old Red Sandstone formations, which generally include so large a proportion of sediment colored by the red oxide of iron, organic remains are of comparatively rare occurrence, and when present, are met with almost exclusively in the grey and olive and dark colored strata, which are interpolated in certain parts of the great masses of the red material. This relation is beautifully shown in the middle secondary rocks of the Atlantic slope, which extend in a prolonged belt from the Connecticut Valley into the State of South Carolina. In strata of *red* sandstone and shale, which form the chief part of the mass, vegetable or animal exuviæ are almost entirely absent. But the remains of the fish and impressions of carbonised parts of plants occurring in this group of deposits are found embedded in layers of greenish and olive sandstones, and dark bituminous shales. So in the southern parts of the belts in Virginia and North Carolina, where these rocks include seams of coal and extensive beds of sandstone and shale, containing the remains of plants, the usual red color is found to give place to the grey, olive, and dark tints of the Old Coal Measures, and layers of proto-carbonate of iron show themselves in the vicinity of the coal seams.

Taken in mass, the red and mottled strata of the unproductive coal measures, or of the other groups of red rocks above alluded to, would no doubt be found to contain, in an equal thickness, as large an amount of iron as the coal-bearing strata, which include the layers of carbonate, the difference being that in the former case the metal remains for the most part diffused through the rocks as a sesquioxide, while in the latter, having assumed the condition of proto-carbonate, it has to some extent been concentrated in particular layers or strata.

In attempting to explain the origin of proto-carbonate under the conditions above described, it is important to keep in view the fact of the diffusion of this compound through many of the strata as a general constituent, and the frequent preservation, even in layers of the ore, of the lamination of the contiguous rock. The supposition of its being a chemical deposit formed from springs charged with carbonic acid, and holding proto-carbonate in solution, is evidently inconsistent with these conditions, and not less so with the fact of the great horizontal extension of individual beds of ore and impregnated shaly rocks.

In view of these various considerations it may be concluded—

First. That throughout the coal measures and other groups of rocks above mentioned, as well as in the portions containing coal and diffused vegetable and animal matter, as in the barren parts, the original sediment was more or less charged with sesquioxide of iron, and

Second. That this sesquioxide, in the presence of the changing vegetable matter with which certain of the strata abounded, was converted into proto-carbonate, which remained in part diffused through these beds, or by process of filtration and segregation was accumulated in particular layers.

It is well known that during the slow chemical changes by which vegetable matter, enclosed in moist earth, is converted into lignite or coal, both light carburetted hydrogen and carbonic acid are evolved, and that these gases are even eliminated from coal seams and their adjoining carbonaceous strata. The reducing agency of the carbon and hydrogen, as they separate in their nascent state from the organic matter, is capable, as we know, of converting certain sulphates into sulphurets, and even more readily of transforming the sesquioxide of iron into protoxide. The latter change would doubtless be favored by the affinity of the carbonic acid present in the mass for the protoxide, as formed, and in this way the sesquioxide would be entirely converted into proto-carbonate of iron.

Conceiving a like process to have operated on a large scale in the coal-measures or other strata, containing, when deposited, a mixture of sesquioxide of iron and organic matter, we have a simple explanation of the general conversion of this oxide into carbonate, and of the loss of the reddish coloring in which these materials more or less participated. As these actions must be supposed to have commenced in each stratum as soon as the organic matter contained in it began to suffer chemical change, we may conclude that the formation of the proto-carbonate was already far advanced in the earlier strata when only beginning in those deposited at a later period. Each layer of vegetable matter, as it was transformed into coal, would not fail to impregnate the adjoining beds of shale and sandstone with the proto-carbonate, and thus the development of this compound was, as it were, coeval with that of the coal.

The gathering of the diffused proto-carbonate into bands and courses of ore began, no doubt, as soon as the production of this compound had made some progress, but it probably continued until long after the completion of the chemical changes above described, and, indeed, it is possible that in some strata it is not yet entirely finished. In this process, which finds a simple explanation in *the combined action of infiltration and the segregating force*, it can hardly be questioned that *the carbonic acid*, pervading the mass of sediment, acted *a very important part*. The large amount of this gas evolved from the beds of vegetable matter, undergoing change, would impart to the water of the adjoining strata the power of dissolving the diffused proto-carbonate, which, being then carried by infiltration through the more porous beds, would accumulate above and within the close argillaceous or shaly layers, forming, in some cases, bands of rock ore, in others, courses of nodular and plate ores. Of these, the former would seem to have resulted from the accumulation by *gravity* of the dissolved carbonate in the substance of sandy shales, near the upper limit of the more impervious beds, while we may regard the latter as having been collected in all directions from the general charge of proto-carbonate accumulated in the argillaceous mass, its mobility in the dissolved condition greatly aiding the gathering process of the *segregating force.*

Dr. Hayes remarked that he had long been aware that the conditions belonging to deposits of proto-carbonate of iron in the coal measures, are such as to forbid the supposition that the compound had been deposited from waters holding the carbonate of iron in solution. The view presented, which refers the production of the carbonate, from the peroxide, by the reducing action of organic matter undergoing changes in contact with it, harmonizes with a mass of chemical facts and observations already accumulated. The native hydrated peroxides of iron can be thus reduced to protoxide, and in fact converted into proto-carbonate of iron, in the laboratory, by the aid of decomposing vegetable matter. In observing this change it is always found that the reducing action on the peroxide commences at the time that the first steps in the decay of the organic matter are observed. Carbonic acid gas, with carburetted hydrogen gas, appears at a later stage; the protoxide of iron formed being insufficient in quantity to combine with all the carbonic acid which is produced. It is an essential condition in this change that water, or moisture, is present; as the organic decomposition—a kind of putrefaction—would not otherwise take place. It is proper in this connexion to state the fact that the ferruginous springs of this country rarely contain carbonate of iron dissolved. The iron salt which is present, is a *crenate*, originating from the decomposition of organic matter, in contact with ferruginous earth. The crenate of iron exists only as a proto-salt; it is soluble in water, and when brought into contact with air, hydrate of peroxide of iron falls, usually containing some humus, or coaly matter, resulting from the decomposition of the crenic acid. It is not probable that the crenate can produce the carbonate of iron, if oxygen is present; but, when protected from oxidation, and especially in presence of an excess of carbonic acid, the crenate *may* form a proto-carbonate of iron, as the crenate of lime, even in the atmosphere, forms carbonate of lime.

In referring the production of carbonate of iron deposits in strata to the solvent action of carbonic acid dissolved in mineral waters, any theory should point out the source from whence the protoxide of iron is taken, to form the dissolved carbonate, as protoxide of iron does not naturally exist. If a previous reduction of other oxides of iron, by organic matter, is necessary to ensure this solution, it will probably be found that crenic acid, instead of carbonic acid, is the solvent.

The explanation, as given by Prof. Rogers, becomes, therefore, not only the simpler view, and strictly accordant with known facts, but it seems to be necessary as a basis for the theory generally received.

There is a point of geological interest in connection with the manner in which the proto-carbonate of iron is included in the coal series, and often in contact with beds of coal. This compound, as before stated, is a hydrate compound, and its varieties generally lose their carbonic acid, and become peroxide by a moderate elevation of temperature; its presence, therefore, in contact with alternating beds of coal, may be considered as indicating that such beds have not been subjected to heat above the temperature at which the carbonate is decomposed.

NEW SALINE DEPOSIT FROM SOUTH AMERICA.

At a recent meeting of the Boston Society of Natural History, Mr. N. H. Bishop presented some samples of a peculiar crystalline salt which he had brought from South America, with the following account of the same:—It is found mixed with the soil in greater or less abundance, from San Luis de la Punta (a town on the western side of the pampas of the Argentine Republic, where the grass plains properly end and the *travesia* or desert commences) to the foot of the Andes.

San Luis lies in lat. 33 deg. 16 min. S., long. 66 deg. 27 min. W., and is the capital of the province of the same name. From this town, westward, the soil is almost worthless, until the river Mendoza is reached, where irrigation commences.

The soil is very light and dry, not compact in the least. This is probably caused by the dryness of the atmosphere and absence of water; for when Mr. Bishop crossed that part of the country, they were obliged to purchase water that had been caught in holes for the use of cattle. Stones are rarely met with; where they do exist, at the base of the Andes, he did not observe the existence of this salt. There are several spots on the *travesia*, between San Luis and Mendoza, furnishing a poor quality of grass, which is fed upon by the cattle which are driven across the continent to the coast. With the exception of these spots, the country between the above named towns, and extending many leagues to the north and south, is a dreary desert, covered with a low growth of thorn bushes and a few species of gnarled trees, some of which bear pods.

This substance penetrates the earth from a few inches to a couple of feet. It is particularly abundant at certain places east of the town of San Juan, where the ground is covered with a thin incrustation. It is here exceedingly painful to the eyes from the reflection of the sun's rays, and the inhabitants are constantly affected with inflammation of the eyes.

The method of treating the soil by the natives is very simple. The water is conducted from the rivers Mendoza and San Juan (which take their rise in the Cordillera) through a sequia or canal, around squares of level land, at irregular intervals of time, and, to use their own expression, they *wash off the salitre.* Then a plough, constructed of two pieces of wood, is brought into service, and turns up from six to eight inches of the soil, which goes through the same washing process as the first. After two or three repetitions of this operation, a shallow soil is obtained, partially free from *salitre*, in which wheat, clover, pumpkins, melons, etc., are raised. The remaining *salitre*, according to the belief of the natives, is exhausted by successive crops, and after several years of tillage, the soil is suitable for the vine. Oranges, peaches, quinces, olives, figs, etc., flourish. Within a few years large tracts of land have been made exceedingly fertile by the process above described, and could the New England plough be introduced there, the process would be far more valuable.

Dr. A. A. Hayes communicated the following as the results of his analyses of the saline mineral presented by Mr. Bishop.

The specimen was a white crystalline solid, formed by the union of two layers of salt, as often results from the evaporation of a saline solution, when the pellicle formed on the surface falls to the bottom. Along the line of junction crystal facets are seen, but the forms are indistinct. These crystals readily scratch calc spar and dissolve without residue in water, affording a solution, which, by evaporation at 150 deg. F., leaves the salt, with some of the original physical characters. In this climate, the specimen attracts moisture, and therefore has not a fixed amount of water constituent.

It consists of water, sulphuric acid, soda, magnesia, chlorine; mixed with it, are traces of crenate of iron and lime, with sand and grains of earth.

Three fragments from different masses were taken, and the following substances found:

	I.	II.	III.
Water	16·42	18·84	19·60
Sulphate of Soda	48·00	45·82	45·74
" Magnesia	34·20	33·19	33·31
Chloride Sodium	1·21	1·79	1·16
Crenates Lime and Iron with Silicic Acid	0·17	0·30	0·13
Sand	0·00	0·06	0·06
	100·	100·	100·

The varying amounts of water given are illustrative of the absorptive power of the salts, in the atmosphere of this place. Dried at 90° F., the amount of water was 15·20 in 100 parts, which exceeds by 4 parts the proportion necessary to form proto-hydrates of the two salts present.

Analysis does not show the two sulphates to be in definite proportions in the masses, but the crystals may be a double salt, composed of one equivalent of sulphate of soda and one equivalent of sulphate of magnesia; each retaining an equivalent of water. In the masses, the closest approximation is 42 parts of sulphate of magnesia found, instead of 46 parts, required.

The communication of Mr. Bishop embraces interesting facts. These saline deserts cover extended areas in different parts of South America, and so far as he has been able to learn, the saline matter differs in kind at the different points. The tendency of saline matter contained in any soil is to rise through the aid of moisture to the surface, when, the water escaping, the salt is deposited. This effect, contrary to the gravitating influence, is the most common cause of deserts, and may be exerted everywhere, when the evaporation of water from a given surface becomes much greater in amount than that surface received in the form of rain and dew. The cultivation of saline deserts by washing down the saline matter, exhibits the opposite action of water in restoring fertility, and it is by no means essential that the water should contain organic matter to ensure the full effect, as the soil of deserts generally contains all the organic matter of many years' accumulation.

ON THE DISCOVERY OF VOLCANIC CINDERS AT THE BOTTOM OF THE ATLANTIC.

The specimens from the bottom of the Atlantic obtained by the U. S. steamer Arctic, in her recent deep-sea sounding expedition, between the coasts of

Newfoundland and Ireland, having been submitted to microscopical examination by Prof. Bailey of West Point, show evidence of the existence of a volcanic deposit on certain portions of the ocean-bed. In reference to these Prof. Bailey says:—

The occurrence of what appear to be volcanic products in the bed of the ocean for a distance of about twenty-two degrees of longitude, or about a thousand miles, is an extraordinary fact, and one which deserves careful scrutiny. That any one familiar with the microscopic appearance of volcanic ashes, &c., would pronounce these matters to be of volcanic origin I have no doubt. These volcanic products consist of pumice, obsidian, crystals of hornblende—single and in groups—and other igneous products penetrated by crystals. As, however, the ingenious suggestion was made to me that these igneous products might be derived from the fires of the ocean steamers, along or near whose pathway these soundings were made, it became important that these furnace products should also be studied. An examination was accordingly made of specimens of such matters as are thrown overboard from the ash pits of the steamers Asia and Baltic. Careful examination of the specimens showed that they contained a group of products which could not possibly be confounded with the supposed volcanic matters. In fact, there was no relation between the two classes of bodies, except that both were evidently the results of intense heat upon different mineral matters. Among the furnace products of the steamer Baltic, were numerous single and aggregated glass spheres of minute, or even microscopic size, which, if they should ever be found in the ocean soundings, would be very puzzling without this clue to their origin. The question of the original source of these volcanic products is one of great interest. How far these plutonic tallies may have travelled, and in what direction—whether from the Azores, the Mediterranean, or from Iceland—involves a study of currents and an examination of soundings which have yet to be made.

In regard to this discovery, Lieutenant Maury, in his report to the Secretary of the Navy, thus comments:—The Gulf Stream seems to have strewed the bed of the ocean for more than a thousand miles across with these "plutonic tallies," as Professor Bailey styles them. They enable us to mark better than any means heretofore afforded have done the extreme limits of the annual vibrations made by the channel in which the waters of the Gulf Stream flow. The fact that nothing of the kind has been detected in the specimens brought up by the Coast Survey from the bottom of the Gulf Stream further to the south, seems to indicate that these cinders could not have come from the volcanoes of Central America, which have been known to cast their ashes as far as Cuba. The drift of the ocean would not have brought them from Iceland or any of the British Islands, and lodged them where Brooke's lead found them. It appears to be most probable that they came from the extinct volcanoes of the Western Islands. The size of the vitreous particles appears to warrant the conclusion, that they are too heavy to be carried far by the winds, or to be borne long by the water.

It is barely possible they may have come from Ætna and Vesuvius, and been brought out by the under currents from the Mediterranean. Specimens from the deep sea of the Straits of Gibraltar would at once settle this question.

DEEP SEA SOUNDINGS IN THE ARCTIC OCEAN.

From a recent report of Lieutenant Maury to the Secretary of the Navy, we derive the following extract relative to some observations made last year by Com. Rodgers, in the U. S. ship Vincennes, on the temperature and specific gravity of the water at the surface, midway, and at the bottom of the Arctic ocean. These observations are highly interesting. He passed up through Behring's Straits into that sea during the summer of 1855, and, though he remained in it but a few days, he availed himself of the opportunity to try the temperature and specific gravity of the water at various depths and places; and his observations show uniformly this arrangement or stratification in the fluid mass of that ocean—warm and light water on top, cold water in the middle, and warm and heavy water at the bottom. These observations, if extended, would go far towards the final settlement of the question of an open sea in the Arctic ocean. It is likely that this warm water went in as an under current; that though warmer it was salter, and for that reason it was heavier. It was made salter, we conjecture, by evaporation; and while it was subjected to this process it was in some latitude where it received heat while it was giving off fresh water vapor. This substratum of heavy water was, therefore, probably within the tropics and at the surface when it received its warmth. Water, we know, is transported to great distances by the under currents of the sea without changing its temperature but a few degrees by the way. Beneath the Gulf Stream, near the tropic of Cancer, and in the month of August, with the surface of the ocean above 80 degrees, the deep sea thermometer of the Coast Survey reports a current of cold water only 3 degrees above the freezing point. That cold current or the water that it bore must certainly have come from the polar regions.

We know of numerous currents flowing out of the Polar basin and discharging immense volumes of water into the Atlantic; we know of but one surface current, and that a feeble one, around the North Cape, that goes into this basin. All these out-coming currents are salt water currents; therefore we cannot look for their genesis to the rivers of hyperborean America, Europe, and Asia, and the precipitation of the Polar basin—for all the water from these sources is fresh water. The salt that these upper currents bring out is sea salt; hence we should be forced to conclude, were there no other evidence to warrant the conclusion, that there must be one or more under currents of salt and heavy water flowing into the Arctic basin. A considerable body of water at the temperature of 40 degrees rising to the surface there—as come to the surface it must, in order to supply the outgoing upper currents—would tend mightily to mitigate the severe cold of those hyperborean regions.

This discovery of Rodgers furnishes the only link that seems to have been wanting in the chain of reasoning to complete from known facts the theory of an open water in the Arctic ocean; and this discovery, taken in connection with what northern voyagers tell us concerning the migration of animals in those regions; with what Dr. Kane saw and De Haven says; with the fact that harpoons fastened in whales on the shores of Greenland have been taken out of whales along the shores of Kamtschatka and Japan—these facts, taken in connection with the discovery which my own researches have fully developed, that the right whale of Greenland and the right whale of the North Pacific are the same fish, and that to it the torrid zone is as a sea of flame which it cannot pass; I say these facts, linked together, and taken in connection with other facts and circumstances, seem to form a chain of faultless circumstantial evidence, showing the existence of an open water in the Polar basin.

Deep sea soundings, with specimens of the bottom, have also been returned to this office from that expedition. They were taken in the North Pacific with Brooke's apparatus, and have been studied through the microscope of Professor Bailey at West Point.

They all tell the same story. They teach us that the quiet of the grave reigns everywhere in the profound depths of the ocean; that the repose there is beyond the reach of wind; it is so perfect that none of the powers of earth save only the earthquake and volcano can disturb it.

The specimens of deep sea soundings, for which we are indebted to the ingenuity of Lieut. Brooke, are as pure and as free from the sand of the sea as the snow flake that falls when it is calm upon the sea is from the dust of the earth. Indeed, these soundings suggest the idea that the sea, like the snow cloud with its flakes in a calm, is always letting fall upon its bed showers of these microscopic shells; and we may readily imagine that the "sunless wrecks" which strew its bottom are, in the process of ages, hid under this fleecy covering, presenting the rounded appearance which is seen over the body of the traveller who has perished in the snow storm. The ocean, especially within and near the tropics, swarms with life. The remains of its myriads of moving things are conveyed by currents, and scattered and lodged in the course of time all over its bottom. This process, continued for ages, has covered the depths of the ocean as with a mantle, consisting of organisms as delicate as the macled frost, and as light as the undrifted snow-flake on the mountain.

Wherever this beautiful sounding rod has reached the bottom of the deep sea, whether in the Atlantic or Pacific, the bed of the ocean has been found of a downlike softness. The lead appears to sink many feet deep into the oozy matter there which has been strained and filtered through the sea water. This matter consists of the skeletons and casts of insects of the sea of microscopic minuteness.

CURIOUS FACT IN RELATION TO COAL.

Mr. J. P. Leslie, in a communication to the American Association, stated, that it is a generally received opinion among the coal districts of Pennsylvania, that sulphuret of iron abounds in the synclinal strata of the coal series. Miners and engine drivers insist upon its truth, that where the bed is inclined steeply the coal is purer, and where it lies flat the coal is soft and comparatively rich in sulphur.

ON THE COMPOSITION OF SERPENTINE ROCKS AND ALLIED SPECIES.

Some papers on this subject, read before the Nat. Hist. Soc. of Boston, by Dr. A. A. Hayes, have thrown light on the chemical composition of the rocks heretofore called serpentine:—

The research commenced on the ornamental mineral, which introduced into the arts under the name of "Verd Antique Marble," was found to be a composite rock, containing an assemblage of minerals, known as talc, compact asbestos, and actinolite, with occasionally fragments of silicious slate and cour argillite, *cemented* by *anhydrous carbonate of magnesia.* This aggregate receives a fine polish, and resists exposure to atmospheric agents as well as the syenites, and is a remarkably beautiful and valuable mineral, largely developed at Roxbury and Cavendish, in Vermont, the best quarries being at Roxbury.

Finding the anhydrous carbonate of magnesia acting as a cement, to possess an unlooked for resistance to the action of acids, and the rock to lose its combined water on exposure to heat very slowly, it was at once apparent that the analyses of serpentine rocks as published, might be incorrect in the water determination. The experiments carefully conducted on specimens of serpentine from the larger known localities, confirmed the conclusions in regard to their composite character generally. The specimens yielded carbonic acid and magnesia as anhydrous constituents, while often the bulk of the mineral was made up of talc, and compact asbestos in a more or less finely divided state. The coloring matter was proved to be a silicate of proto-peroxide of iron, belonging to the green minerals aggregated, while the analyses often showed the presence of nickel. In all cases the water, which was variable in amount, belonged to the *basis minerals*, or those which the anhydrous carbonate of magnesia had cemented. The modern and the ancient serpentines which have been celebrated, did not yield by the exact proximate method of analysis any constituent which could be properly called a hydrous silicate of magnesia. They all presented carbonic acid, magnesia, and talc, while finely divided magnesia minerals, more or less hydrous, make up the basis. It is well known, from the researches of Prof. Rogers and others, that the magnesian minerals of the harder kinds, such as asbestos, yield to carbonic acid, dissolved in water, a portion of magnesia. The experiments of Dr. Hayes harmonize with the conclusion, that the cementing material of the serpentine rocks may be thus derived, and the research has an important bearing in a geological view, as it proves that the serpentine rocks, so far as they have been observed, are of aqueous or hot water origin, a heat above that of 500° F. being inconsistent with their composition chemically.

ON THE ORIGIN OF THE GAS CURRENTS IN SALIFEROUS DEPOSITS.

At the German Association for the Promotion of Science, M. Schübler, of Stuttgard, presented some details of the facts ascertained in the mining explorations in the Saliferous deposits, on effluvia of gas and subterraneous gas currents, and on the formation of Rock-salt nests. This distinguished geologist concludes, from observation, that the carbonic acid gas is formed without elevation of temperature in the dolomitic strata of the saliferous deposits, including gypsum and rock-salt, and that silica combined with alkalies must be operative in separating a carbonic acid from its combination with lime and magnesia. M. Schübler ordered experiments to be made for the confirmation of this theory. Phials filled with a pulverized mixture of gypsum, dolomite, quartz, and rock-salt, and placed with the orifice downwards in glasses filled with mercury, to exclude the ingress of the surrounding air, were sunk in bored holes to the depth of 500 to 600 feet; care had been taken to expel every vestige of atmospheric air by exposing the phials so prepared to a temperature of 100°. Eight days after the commencement of the experiment the phials were again taken out, and the pulverised mixture in them was analysed. It contained bicarbonate of lime, and a substance similar to dolomite in hardness and its resistance to the action of acids. The vacated portion of the phials was filled with gaseous carbonic acid.

ARTESIAN WELLS ON THE PLAINS.

With a view of facilitating the overland intercourse with California, the War Department some two years since despatched Captain Pope, of the Engineers, with a party, to endeavor to procure water by means of Artesian wells on the great plain of Llano Estacado, on the thirty-second parallel of latitude, between New Mexico and the Mesilla Valley.

Captain Pope went out to the scene of his labors in the spring of 1855, from Indianola, by the way of San Antonio, and formed his camp on the banks of the Pecos river, where it is intersected by the thirty-second parallel of latitude. From this point he proceeded with his working parties due east a distance of fifteen miles, and there sunk the first well. From the Pecos river the country seems to the eye to be a perfect level, but instrumental observation shows that there is a rise of about six hundred feet in a distance of thirty-five miles; and from that point, which may be termed the summit of the plain, it continues with a gradual descent eastwardly, to the hills from which run the head waters of several of the forks of the Colorado river.

In sinking the wells Captain Pope found no difficulties in the geological formation. This is entirely composed of alternate strata of indurated clay and cretaceous marls, of every variety of color, easily bored through, but sufficiently hard to prevent the walls of the boring from falling and incommoding the labor.

The first stream of water was struck at a distance of three hundred and sixty feet, and it rose to a height of seventy feet in the tubing. Continuing the labor through the same formation, the second stream of water was struck at the depth of six hundred and forty-one feet, which rose four hundred feet in the well, or about fifty feet higher than the first stream. These labors demonstrated the existence of water streams beneath the surface, but as winter was approaching, and the material which he had brought having been exhausted, Captain Pope went into winter quarters on the banks of the Rio Grande.

Having received fresh supplies in the spring of last year, he returned to the Llano, and in April last resumed his labors there. His former attained results having demonstrated the existence of abundant water beneath the surface, he went five miles eastward from the first well, and there sank the second. In the prosecution of this work he struck the same streams that he had found in sinking the first well, and on reaching a depth of eight hundred and sixty feet, he encountered another which rose seven hundred and fifty feet in the tubing. At this point the material was again exhausted, and the small appropriation made by Congress for the experiment had been expended. Captain Pope was therefore obliged to suspend his labors, and await further orders from the government.

The results of this work have been eminently successful, for they demonstrate the feasibility of the plan of procuring water on this great plain by the sinking of Artesian wells, and it is much to be hoped that Congress will make another appropriation to continue and perfect the work. Through the absence of water the Llano Estacado forms a complete barrier to travel between the western towns of Louisiana and Arkansas to New Mexico and the Mesilla valley, along the line of the thirty-third parallel, by a route which is some hundreds of miles shorter than any other. It is covered throughout with grama grass, which is one of the most nutritious of the grasses for cattle, and which has the greater advantage that it is not killed by the cold of winter, affording abundance of pasture all the year round.

GENERALITIES OF THE GEOLOGY OF NORTHERN CALIFORNIA AND OREGON.

At the Albany meeting of the American Association, Dr. Newberry gave a general view of the geology of Oregon and that part of California lying north of San Francisco, and of the age and structure of the three ranges of mountains which, he said, gave character to the topography of the Far West, and of the valleys which lie between them. These "valleys," he said, were rather plains or plateaus than valleys. The Sacramento Valley was a plain lying between the Coast Range and Sierra Nevada—for the most part destitute of trees—through which the river ran with tortuous course, like a brook in a meadow. In the lower part of the Sacramento Valley, there were no rocks older than tertiary; but at the head of the valley he had found the carboniferous limestone—clearly marked by its characteristic basalts, on which were lying the cretaceous and tertiary strata, precisely as on the Upper Missouri.

Crossing the volcanic spur of the Sierra Nevada connecting Mount Shasta with that great chain of mountains, he had descended into the Klamath Basin, which he said formed an appendage to the great basin of the Salt Lake and was a plain somewhat cut by subordinate ranges of mountains, lying at a considerable elevation and containing a large number of lakes, of which the Klamath were the most important. This basin was drained through the cañons of Pit river, the largest tributary of the Sacramento, which, like the Klamath river, had forced its way through the mountain ranges which lay between the basin and the sea; Pit river flowing through an impassable cañon nearly an hundred miles in length. The Klamath basin was once to a much greater extent covered by water than now; and before it was so perfectly drained as now, its waters deposited a variety of strata, some of which were as white and fine as chalk, though having a very different composition.

He said further, that the basin or plateau of the Des Chutes was not separated by any barrier from that of the Klamath lakes, and exhibited all its peculiar features still more strongly marked. The Des Chutes basin was a plateau lying between the Cascades and the Blue Mountains, and, with the Klamath basin, belonged, from its topography, geology, fauna, flora, and climate, to the great central basin. Like the Klamath basin it was once covered with water—was a lake drained by the Columbia, as now, but not so perfectly drained. The Columbia had been gradually deepening its bed. The Des Chutes lake, as it then was, had deposited sediments to the depth of 2,000 feet or more, for the streams which now traverse it have cut cañons in this plateau to that depth. These sediments were covered by a floor of trap which had been poured evenly over the whole surface—which had not been subsequently disturbed, and when broken open, exhibited a columnar structure—the columns being quite perpendicular and sometimes one hundred feet in height. Below the trap was a series of strata exhibiting all possible varieties of volcanic tufa, some very fine and chalky, others coarser; and the different layers, which were from two to ten feet in thickness, and perfectly parallel, were colored with all the hues of the rainbow—red, green, yellow, blue, orange, pink, white, &c., and as highly colored as a geological chart for a lecture room. It had often happened to him, travelling over this plateau, to come suddenly and without any warning to the brink of one of these cañons two thousand feet deep, at the bottom of which a stream was flowing.

The Cascade Mountains, he said, were not a simple chain, but a broad belt of mountain peaks, sometimes fifty miles or more in width, many of the summits being covered with perpetual snow, the passes being generally about 7,000 feet in height. He had found extensive proofs of the existence, at a former period, of glaciers capping the Cascade range, and extending far below the present limit of perpetual snow. The Cascade range was eminently volcanic, abounding in craters, lava fields, and congealed lava streams, all as fresh and ragged as though just poured out from some volcano; indeed, Mount Hood and Mount St. Helens may still be considered as active volcanoes, giving off gases and steam continually, and within a few years have emitted showers of ashes.

Professor N.'s theory of the excavation and filling of the valleys of California and Oregon was, that at one time, probably at a period corresponding with that of the drift in the Eastern States, all that portion of the continent was raised to such an altitude as to produce a degree of cold which covered the mountains and filled the valleys with ice. By this ice the surfaces of rock were worn down, and the marks of glacial action which now abound produced. The valleys were excavated in part by this process. As the continent was depressed the valleys were occupied by water, in which the ashes from ranges of active volcanoes were discharged, and arranged in strata of sediment.

As the drainage of these basins progressed by the cutting down of the outlet, they were gradually converted to the dry plains which they now are.

Among other points of interest in the geology of the West which were touched upon, was the geological age of the coal deposits of Oregon and Washington territories, all of which Prof. N. said were tertiary, and were associated by unmistakable tertiary fossil plants.

THE GOLD AND SILVER WEALTH OF THE WORLD.

The following paper is translated from a recent work by Narcès Tarassenko Otreschkoff, Russian Councillor of State:—

The amount of gold and silver annually taken from the mines of Europe, including Russia, is 26,805 kilogrammes of gold (2 7-10 pounds to the kilogramme), and 161,444 kilogrammes of silver, valued together at $25,000,000.

In America, including California, the annual product is 169,834 kilogrammes of gold, and 755,180 kilogrammes of silver, worth in all $146,000,000.

In Asia, the annual product is 2,700 kilogrammes of gold, and 110,000 of silver, amounting in value to $22,000,000.

In Africa no silver mines are wrought, and only 4,200 kilogrammes of gold are produced, valued at $2,600,000.

Australia, too, yields no silver, but the annual product of gold amounts to 290,360 kilogrammes, valued at $200,000,000.

Sum total in all parts of the world, 510,199 kilogrammes of gold, and 1,026,624 kilogrammes of silver, valued together at 1,988,000,000 francs, or over $397,000,000. The whole sum extracted from the earliest times up to the present amounts to 15,314,653 kilogrammes of gold, and 254,410,170 of silver, worth together something more than $20,536,000,000.

Of this sum, there had been extracted at the birth of Jesus Christ, 2,245,265 kilogrammes of gold, and 63,630,123 kilogrammes of silver, valued at $4,328,000,000.

The increase in the production of gold and silver is enormous, and we shall at present rates gain more in this respect in fifty years, than our ancestors did in fifty centuries.

The following table shows the amount of gold and silver that has been extracted during various periods, from the birth of Christ down to the year 1855:—

	Gold. Kilo.	Silver. Kilo.	Value. Francs.
From A. C. to 1492	6,123,711	13,662,107	23,459,000,000
" 1492 to 1810	3,856,487	137,096,830	40,523,000,000
" 1810 to 1825	270,190	6,237,414	2,288,000,000
" 1825 to 1848	863,514	16,715,923	6,598,000,000
" 1848 to 1851	339,535	3,013,411	1,803,000,000
" 1851 to 1855	1,615,654	4,054,362	6,375,000,000

The gold product has steadily increased to swell the amount. The yearly gain increased, from the first period (from the birth of Christ until 1492) until the second period (1492 to 1810), from 4,106 to 12,477 kilogrammes. In the next period of fifteen years (1810 to 1825), it increased nearly 50 per cent., viz. 18,012 kilogrammes. In the fourth period, the annual gain was 37,544, and in the fifth, 113,178 kilogrammes. For several subsequent years the annual product was 403,912 kilogrammes.

It will be seen how much the silver gain has increased from the first to the second period. It fell short in the third period 415,827 kilogrammes, and increased again in the fourth, 726,779, and in the fifth, 1,004,470 kilogrammes. The increase in the yield of silver during the sixth period was only 9,120 kilogrammes.

The annual value of the gold and silver extracted during the first period was barely 16,000,000 francs. It increased in the second period to 130,500,000, and in the third to 152,500,000 francs, while it nearly doubled from 1825 till 1848—increasing as it did to 280,000,000. In the next period it more than doubled, amounting to 601,000,000 francs, and in the last four years it has increased nearly 150 per cent., and now amounts to 1,592,631,651 francs, or $318,526,350.

The following table will show the amount of the precious metals hitherto extracted from the different countries on the globe:—

	Gold. Kilo.	Silver Kilo.	Total value. Francs.
Europe........	929,444	23,896,106	8,414,000,000
Asia...........	7,058,938	72,366,362	42,708,000,000
Africa.........	2,104,694	1,259,220	7,292,060,000
America.......	3,599,295	146,591,473	41,646,000,000
Australia......	762,282	....	2,625,000,000

So that the total amount of gold and silver extracted in America up to the close of the year 1855, is only about $20,000,000 less than the entire produce of the Asiatic mines since the beginning of the world, while it is already more than double the entire past yield of all the mines of Europe, Africa, and Australia put together.

Gold Product of the Quartz Mining of California for 1855.—A late report of Dr. Trask, State Geologist of California, gives the whole number of mines now in operation as 52. Eleven quartz mines produced in 1854, $777,790; eighteen produced in 1855, $2,239,161. Total in two years, $3,016,951. Of some other mines he had obtained the product confidentially, and estimates that the aggregate products of the whole fifty-two would fall but little short of six millions.

ON THE FORMATION OF CANNEL COAL.

The following is an abstract of a paper communicated to the American Association, by Dr. Newberry of Ohio, on the origin of cannel coal:—

These coals, as a class, compared with ordinary bituminous coals, are characterized by greater homogeneity of physical structure and chemical composition, having a more laminated and slaty fracture—impure specimens, conchoidal across the plane of stratification—contain more earthy and more volatile matter (and of course less fixed carbon), and the gases which they evolve have a higher illuminating power. The fossils which they contain are either aquatic, or exhibit marks of the action of water. The origin of these differences between cannel and common bituminous coals has been the subject of considerable diversity of opinion among geologists, the peculiar characteristics of cannel having been ascribed to a peculiar and highly resinous vegetation, affected by the agency of heat. This theory being unsatisfactory, Dr. Newberry gave the subject especial attention in his investigations of the Geological Phenomena of the Ohio System of the Alleghany Coal Field. His observations upon the cannel coal beds of Ohio, the changes they exhibit in going from one front of outcrop to another, their physical and chemical characters, &c., have resulted in giving him the conviction that the peculiar characters presented by beds of cannel coal are due *to their deposition in water, and the commingling with macerated and dissolved vegetable tissue, which for the most part compose them,* and a *considerable portion of animal matter.* 1st. Cannel coal always exhibits a tendency to assume the foliated structure of slates and shells—a structure which it must have derived from aqueous deposition. It often is found shading into bituminous shale—into which it is converted simply by accessions of earthy matter. Bituminous shale and cannel coal may therefore be considered the same substance in different degrees of purity—that is, consolidated ligneous mud, deposited from aqueous suspension with different admixtures of carbonaceous matter; this carbonaceous matter; in bituminous shales, as in cannel coal, exhibiting a preponderance of volatile matter over fixed carbon, and the gas furnished by it contains a larger proportion of the more volatile hydro-carbon, and possesses a higher illuminating power than that derived from ordinary bituminous coal. The chemical composition of cannel coal, so rich in volatile ingredients, is such as would naturally follow the decomposition of vegetable matter while constantly submerged. What we call the decay of plants after the loss of their vegetable life is in fact a *combustion*—an oxidation of their hydrogen to form water of their carbon, to form carbonic acid. Under water these changes go on still more slowly, and a larger portion of the vegetable tissue becomes bitumenized. In such circumstances bitumenization is the oxidation of the carbon and escape of carbonic acid—with the combination and removal of a portion of the alkaline phosphates and carbonates, &c., which go to form the loss—the union of hydrogen with the carbon to form carburetted hydrogen and other hydro-carbons—a portion of which are given off and part combine mechanically or chemically with the oxygen, a portion of the alkalies and the earthy matter—to form an almost indestructible mass, destined to serve man for the generation of heat, and which we call coal. It is evident that the more ready the access of oxygen to the carbonaceous matter during the process of bitumenization, the larger the proportion of the products of the process will be those of combustion; and the more perfectly the oxygen is excluded, the larger proportion of the more volatile and combustible constituents of the wood will be retained. Of the conservative influence of water and vegetable matter we have ample evidence, not only in the almost incalculable durability of wood when constantly submerged, but in coal itself. In all beds of coal except those where the process of volatilization is complete, in plumbago, and perfectly gasless anthracites, the work of decomposition is constantly going on, and water is to this, as to ordinary combustion, an extinguisher. In this country coal is commonly mined from the outcrop, in some hill side, where it is not covered by standing water; in such circumstances a progressive change is noticeable both in the chemical and physical proportion of the coal from the surface to the point where atmospheric influence ceased. Near the surface it is friable and lustreless, and becomes harder and more brilliant as it is penetrated. Near the surface, too, it is nearly destitute of gases, the proportion of volatile matter increasing as the coal improves in appearance. Of this, Mr. N. was assured by personal examinations of specimens from the outcrop, and from deep in the mine. On the contrary, where the outcrop was covered by water, the coal will be found hard and light, and containing nearly its normal quantity of volatile ingredients. The higher illuminating power of the gases of cannel would naturally follow from the preservation of the volatile elements of wood by its continual submersion in a hydrogenous liquid, and the presence of a portion of animal matter. That a resinous vegetation could have given its inflammable character to cannel he thought improbable. He had found unchanged resin in bituminous coal, but never in cannel. The greater relative proportion of earthy matter in cannels would be an almost necessary result of covering the vegetable matter with a fluid heavier than air, and of greater power of transporting sediment. The appearance of the fossils previously noticed also seems to prove the aqueous nature of the origin of cannel. Pieces of cannel from England correspond with those in which these fossils are found. Shells, too, are not unfrequently found in the middle of a stratum of cannel. Among the vegetable remains found in this coal by Mr. Newberry are *stigmariæ*, roots, and rootlets of trees which grow in coal-producing marshes, roots so characteristic of the under class of the coal seams, and others. Strata of ordinary bituminous coal usually consist of layers of greater or less thickness of brilliant bitumen, having a conchoidal fracture, alternating thin layers of what is generally cannel, sometimes containing so much earthy matter as to become bituminous shale; at times these layers of cannel are of considerable thickness, and form an important part of the stratum. This arrangement is attributed to the variable quantity of water covering the coal marshes—the cannel-like layers being deposited during the prevalence of higher water, when the fishy remains could naturally have become a portion of the stratum.

ON THE MANUFACTURE OF COAL OILS.

We should fail in an essential part of our record of modern improvements did we neglect to notice an extensive business which has developed within a few years,—viz. the manufacture of illuminating and lubricating oils from bituminous coals. An interesting paper on the subject of "Kerosene" oil, manufactured in New York from Cannel coal, was presented to the American Association at its last meeting by Prof. Clum. This oil promises to be of great importance to the manufacturing interests of the country, both as an illuminating and lubricating agent. The same may be said also of the mineral oils manufactured by the Breckenridge Coal Co. of Kentucky, which have been accepted for trial by the General Government for lighthouse purposes. The introduction of these oils has already greatly reduced the prices of fish and sperm oils. and for many purposes the latter are entirely superseded.

NEW METEORITE IN TENNESSEE.

Within a few months, another small meteoric mass has been added to the list of those extra-terrestrial bodies which have fallen within the limits of Tennessee. This is a stone, weighing, when first obtained, three pounds. It fell two miles west of Petersburg, and fifteen north-west of Fayetteville, in Lincoln county, about half-past three o'clock P.M., August 5th, 1855, during or just before a severe rain storm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five lesser reports; these were heard by many persons in the surrounding country. Immediately after, it approached from the east, and appeared, while falling, to be surrounded by a milky halo, two feet in diameter. It buried itself about eighteen inches in the soil, and when first dug out was too hot to be handled.

This specimen has an edge broken off, revealing the character of the interior. Within it is of an ashen-grey color, varied by patches of white, yellowish, and dark minerals. When first obtained it was entirely covered, as most meteorites of this kind are, with a very thin "black, shining crust, as if it had been coated with pitch;" this was doubtless formed by the fusion of its outer surface in its rapid passage through the air.

One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging $2\frac{3}{4}$ by $2\frac{1}{2}$ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form roughly approaching an oblique pyramid. The length from the base to the apex is $4\frac{1}{2}$ inches. Three adjacent sides are rough, being covered with cavities and pits. It is likely that the stone has been torn off from a larger mass, or from other fragments along these faces. The other sides are smoother and rounded, and appear to have constituted a portion of the surface of the larger mass.

The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3·20. It weight, in its present condition, 3·83 lbs.

Fragments of this meteorite have been analysed, and found to contain the following minerals:—Pyroxene—principal portion of the mass; Olivene and orthoclase—disseminated through the mass; nickeliferous iron—forming about one half per cent. of the mass. In addition to these, there are specks of a black shining mineral, not yet examined.

The general analysis is as follows:—Silica 49·21, alumina 11·05, protoxyd of iron 20·41, lime 9·01, magnesia, 8·13, manganese ·04, iron ·50, nickel, *trace*, phosphorus, *trace*, sulphur ·06, soda ·82.—*Safford's Geological Reconnoissance of the State of Tennessee.*

METEORIC LEAD.

Mr. Gleig, of England, has recently found in a mass of meteoric iron received from Tarapaca, Chili, small globules of meteoric lead in a metallic state. Small quantities of iron and alumina, with pieces of magnesia and phosphorus, were found combined with it; this, we believe, is the first instance in which metallic lead, or any of its compounds, have been found in meteoric masses.

PROOF OF THE PROTOZOIC AGE OF SOME OF THE ALTERED ROCKS OF EASTERN MASSACHUSETTS, FROM FOSSILS RECENTLY DISCOVERED. BY PROF. W. B. ROGERS.

It is well known that the altered slates and gritty rocks which show themselves interruptedly throughout a good part of Eastern Massachusetts, have, with the exception of the coal measures on the confines of this state and Rhode Island, failed hitherto to furnish geologists any fossil evidences of a paleozoic age; although, from aspect and position, they have been *conjecturally* classed with the system of rocks belonging to this period. Indeed the metamorphic condition of these beds generally, traceable no doubt to the sienitic and other igneous masses by which they are traversed or enclosed, would naturally forbid the expectation of finding in them any distinguishable fossil forms.

I have lately been led to examine a quarry in the belt of silicious and argillaceous slate, which lies on the boundary of Quincy and Braintree, about ten miles south of Boston, and to my great surprise and delight I found it to be a *locality of trilobites.*

It appears that for several years past the owners of the quarry have been aware of the existence of these so-called images in the rocks which, from time to time, they have quarried as a ballasting material for wharves, but *until now the locality has remained entirely unknown to science.*

The fossils are in the form of casts, some of them of great size and lying at various levels in the strata. So far as I have yet explored the quarry they belong chiefly, if not altogether, to one species, which, on the authority of Prof. Agassiz, as well as my own comparison with Barrande's descriptions and figures, is undoubtedly a *Paradoxides.* Of its specific affinities I will not now speak farther than to remark that the specimens agree more closely with Barrande's Par. spinosus than with any other form.

The rock in which these fossils occur is a compact, dense, rather fine-grained, bluish grey or olive silico-argillaceous slate or slaty sandstone, containing little or no carbonate of lime. The fossiliferous belt is actually included in a part of its course between great masses of igneous rock, and it is not a little surprising that, under conditions so favorable for metamorphic action, the fossil impressions should have been so well preserved.

In regard to the distribution of the genus Paradoxides, Barrande, in his great work, the Système Silurien de la Bohème, has the following important observations:

"In Bohemia the genus Paradoxides characterizes exclusively the primordial fauna, and does not extend beyond our protozoic schist. The twelve species which have been determined divide themselves almost equally between the two slaty belts of Ginetz and Skrey, and two are common to them both. In these we find the Paradoxides spinosus in all the localities which have afforded fossils, while each of the other species is restricted to a few points, principally those of Ginetz and Skrey.

"In Sweden the Paradoxides belong exclusively to the local formations designated by Angelin as regions A and B, representing jointly our protozoic slate formation above mentioned. The region A is the lowest fossiliferous belt of Sweden, as it rests directly on the azoic rock.

"In Great Britain we know, according to the papers of Mr. Salter, that Paradoxides has been found in the Trappean group (Lingula flags of the Survey) which is the oldest fossiliferous rock of Wales, resting on the azoic sandstones of Harlech and Barmouth. There is, therefore, a perfect agreement in these three regions as to the geological horizon of the genus now under consideration. This agreement acquires still further importance from the affinities displayed equally and everywhere by the other types which accompany the Paradoxides; for instance, in Sweden we have olenus and conocephelites, in England olenus, as recognised in the Trappean group."

As thus the genus Paradoxides is peculiar to the lowest of the paleozoic rocks in Bohemia, Sweden, and Great Britain, marking the primordial division of Barrande and the Lingula flags of the British survey, we will probably be called upon to place the fossil belt of Quincy and Braintree on or near the horizon of our lowest fossiliferous group, that is to say, somewhere about the level of the primal rocks, the Potsdam sandstone, and the protozoic sandstone of Owen, containing dekelocephalus in Wisconsin and Minnesota. Thus, for the first time, are we furnished with data for fixing conclusively the paleozoic age of any portion of this tract of ancient and highly altered sediments, and what is more, *for defining, in regard to this region, the very base of the Paleozoic column, and that too by the same fossil inscriptions which mark it in various parts of the old world.*

Referring to the occurrence of Paradoxides in the protozoic rocks of Europe, Barrande observes: "The presence of this genus has not been satisfactorily proved in any other Silurian region, although this generic name has been applied to North American forms, such as Paradoxides Boltoni, and Par. Harlani, &c. The first of these is known to be P. Lichas, and we know nothing of the others. The care with which the geologists of New York have described the Trilobites of the lower Silurian rocks of the country in question, is sufficient proof that they have not discovered any trace of Par."

I may add to this, that in no subsequent publication have I seen any reference to the finding of fossils of this genus in the rocks of North America.

One of the most curious facts relating to the Trilobite of the Quincy and Braintree belt, is its seeming identity with the Par. Harlani, described by Green in his monograph of North American Trilobites. This description, which is quite imperfect, was made out from a specimen of *unknown locality* procured some twenty-five years ago, by Dr. Harlan, from the collection of our well known mineralogist, Mr. Francis Alger. That it is the same with the more conspicuous of our Quincy fossils, is I think established by the comparison of the nearly complete specimen of the latter with the cast of Par. Harlani taken from Mr. Alger's specimen, the original never having been returned. Considering the perfect agreement in lithological characters of the matrix as described by Green, with that of the Quincy fossils, and the immediate recognition of this identity of mineral features by Mr. Alger on seeing my Quincy specimens, we can hardly doubt that the original specimen of Par. Harlani came either directly or through the drift scattered in the vicinity, from the same fossiliferous belt. Thus it appears that this vagrant fossil, so long without a local habitation although not without a name, has at length been restored to its native seat, where it takes a prominent place in the dynasty of ancient living forms that marked the earliest paleozoic history of New England.

In this connexion I find a remark in Barrande which, besides being historically curious, has an interesting bearing on the specific affinities of the fossil. He observes: "We see in different collections and especially in that of the School of Mines and the British Museum, under the name of Par. Harlani, from the United States, a cast of a Trilobite which appears to us to be identical with P. spinosus, of great size, such as found at Skrey, in Bohemia." The cast here referred to, like that used in my comparison with the Quincy fossil, was doubtless one of the series of plaster copies prepared by Dr. Green to accompany his monograph. Its agreement with P. spinosus harmonizes well with my own observation, already stated, of the close resemblance between the Quincy fossil and this Bohemic species.

The occurrence of well preserved fossils among rocks so highly altered, and so contiguous to great igneous masses, as are the fossiliferous slates of Quincy, may well encourage us to make careful search in other parts of New England, where heretofore such an exploration would have been deemed useless. Although we cannot hope to build up the geological column of New England from the protozoic base just established to the carboniferous rocks, supposing all the intervening formations to be represented in this region—we may at least succeed in determining by fossils hereafter discovered, some of the principal stages in its structure, and in thus relating its strata definitely to the great paleozoic divisions of Appalachian Geology.

FOSSILS FROM THE NEW RED SANDSTONE OF PENNSYLVANIA.

At a meeting of the Philadelphia Academy of Natural Sciences, April, 1856, Mr. Lea read some notes from a paper on the new red sandstone formation of Pennsylvania, and stated that he had, during an excursion last summer, found in the dark shales of that formation, near Phœnixville, on the Schuylkill, the tooth of a sauroid reptile.

On comparing this tooth with *Clepsysaurus Pennsylvanicus*, which he had described from the same red sandstone formation in Lehigh county, it will be found to differ very widely. The edge is not serrate on any part like that genus, nor is it so large or so attenuate. The form, too, is more compressed. It differs from the teeth of *Bathygnathus borealis*, Leidy, from the new red sandstone of Nova Scotia, in size, being smaller and being more attenuate, as well as having a trenchant smooth edge and not a serrate edge. It is about the size and approaches the form of Professor Owen's figure of *Labyrinthodon.*

Mr. Lea also stated, that in the greenish and blackish shales of the same locality he found two species of *Posidonia*, which genus is so characteristic of this portion of the formation and existing in immense quantities. As they seem to differ from that figured by Sir Charles Lyell, in his Elementary Geology, as coming from the oolitic coal shale of Richmond, Virginia, Mr. Lea proposed the names of *P. ovata* and *P. parva*, the first being about seven-twentieths of an inch in transverse diameter. The latter is more rotund, and about three-twentieths of an inch in transverse diameter, both being covered with numerous minute concentric costæ over the whole disc.

Near to this locality and superimposed, Mr. Lea obtained a specimen of impure dull red limestone, which contained, on a partially decomposed surface, impressions presenting the appearance of *foot-marks*, somewhat like *Chelichnus Duncani*, Owen, figured by Sir Wm. Jardine in his Ichnology, for which Mr. Lea proposed the provisional name of *Chelichnus Wymanianus*, after Professor Wyman, of Cambridge, Mass.

From the same formation and locality were procured the impressions of plants.

In the black Posidonia shales was found a single ganoid scale, which is more like *Pygopteris mandibularis*, Agas., from the marl slate (lower permian), than any other which had come under Mr. Lea's notice. There were other obscure forms observed, which have not yet been satisfactorily found to be analogous to any known forms, but which Mr. Lea hoped to be able to make out.

NEW AMERICAN FOSSIL FISHES.

At the Albany meeting of the American Association, Dr. Newberry exhibited a series of fossil fishes of great beauty and perfection of preservation, which he said were derived from the carboniferous strata of Ohio—from a locality which he had discovered nearly two years since—and which would rival in the variety and beauty of its fossils the famous fish beds of Solenhofen or Monte Bolca. These fishes were, however, truly carboniferous, occurring near the centre of the Ohio portion of the Alleghany coal field, both geographically and stratigraphically. It was, therefore, to be compared with the deposit of fossil fishes at Burdee House in Scotland, so fully illustrated by Dr. Hibbert—that in the Ohio deposit were represented with every genus found in the limestones of Burdee House, with a single exception, while in addition there were several genera not yet found in Scotland. The number of species was greater in the American than the Scotch deposits, and all were different. Nearly all the species had, however, a character common to those of Burdee House in the elaborate ornamentation of their scales and plates, in which they differed from most of the fossil fishes of the coal series. He said the similarity of all, and the identity of many, of the fossil plants from the coal strata of Europe and America had been noticed, and now the general similarity of the fossil fishes still further indicated the synchronism of the coal period on the two continents. Dr. Newberry said these fish remains were found in a thin stratum of cannel coal lying at the base of a thick bed of bituminous coal; that there was every reason to conclude that these fishes had inhabited a lagoon or space of open water in the coal-producing marsh, as within a mile or two in any direction the cannel coal and the fish remains ceased to be found; that in this lagoon the smaller fishes lived in great numbers, and, as their teeth proved, lived on vegetables; on these, which were of the genera *Palæoniscus*, *Amblypterus*, *Mekolepis*, &c., the *Cœlacanths*, which were carnivorous, subsisted; these in turn becoming the prey of the great *Megalichthys* and of the sharks. These facts he inferred from the great abundance of the coprolites of the larger fishes, composed almost entirely of the scales and bones of the smaller species which had served them for food. Probably, this lagoon communicated with the open ocean, where the sharks and rays, &c., lived—that it was evidently favorite feeding ground with them—that by some means the entrance was stopped—the lagoon dried up, partially at least—and their dying in great numbers about the same time furnished us with so many beautiful, unmutilated specimens of old and young—that subsequently the surface was occupied by a growth of marsh vegetation, and the bituminous coal was formed without a trace of fishes.

Mr. A. H. Worthen also read a paper upon the occurrence of fish remains in the carboniferous limestones of Illinois. The occurrence of these remains has up to the present time been considered extremely rare in the mountain limestones of the Western States; and except in the thin bands of limestone about to be described, they are among the rarest of the several beds that compose the sub-carboniferous series of the region under consideration. Several years since, while engaged in collecting the fossils of this formation near Warsaw, Ill., Mr. W. observed a thin band of gray crinoidal limestone, which contained the palate bones of fish in considerable numbers, and subsequent research has revealed two more of these "platforms of death" lower down in the series, densely filled with these remains. The upper fish-bed is situate in the upper part of what Mr. W. calls, for want of a better name, the *Lower Archimedes Limestone*, since it is the lowest bed at present known to contain fossil corals of the genus Archimedipora. The remains from this bed, with one or two exceptions, consist entirely of palate teeth, associated with cyathophyllaforme corals, spirifer oralis and spirifer cuspidatus. The middle fish-bed is situate at the base of this Archimedes limestone and near its junction with the cherty beds below. This bed has proved by far the most prolific in these remains, and from it Mr. W. obtained more than five hundred well preserved teeth in a single locality, and on a surface not exceeding ten feet square. The fossils from this bed are mostly jaw teeth, with comparatively few palate teeth and spines. The matrix in which they are imbedded is a coarsely granular crinoidal limestone, not above four inches thick, and sometimes so friable as to be easily crumbled between the fingers. This character of the matrix enables the collector to obtain these delicate and beautiful fossils in a rare state of preservation. Beside the cyathophylla-formed corals in the upper bed, we have an interesting coralline form occurring in equal abundance and belonging to a genus which he did not know. He also obtained the head of one species of Actinocrinus from this stratum. This bed is separated from the one above by the limestones and marlites of the Keokuk quarries, from 25 to 30 feet in thickness. The lower fish bed is situate near the top of the Burlington and crinoidal limestone, and the stratum in which the fish remains occur does not differ materially either in its lithological or paleontological character, from the associated strata. This crinoidal limestone forms the base of the mountain limestone series in this region, and rests directly upon rocks equivalent to the Portage and Chemung groups of New York. This lower bed has yielded a great number of teeth, though they are usually of smaller size than in the upper beds. This stratum was first observed at Quincy, Ill., and has since been recognized in Henderson County in the same State, and at Augusta, in Iowa, points nearly one hundred miles distant from the one first named, showing that these fish beds are not local. This bed has also afforded one well marked bone nearly four inches long. From these specimens it seems that the fishes of the sub-carboniferous era increased in size from the beginning to the end of that period, and that by far the greater portion of them were cartilaginous, only two well marked bones having been obtained from at least one thousand well preserved teeth. The *Pentremitæ* and *Archimedes* limestones of southern Illinois have afforded several very fine specimens of fish remains, but a very careful examination has not yet revealed any strata in which they occur in such profusion as in the lower beds. Going south through Tennessee and Northern Alabama, though this formation attains a thickness of more than one thousand feet in the valley of the Tennessee river, these remains are exceedingly rare, and a careful research of several days yielded only three or four specimens of this class of fossils.

ON THE RELATIONS OF THE FOSSIL FISHES OF THE CONNECTICUT RIVER SANDSTONE, TO THE TRIASSIC AND LIASSIC PERIODS.

Mr. W. C. Redfield read a paper "on the relations of the fossil fishes of Connecticut and other Atlantic States to the Triassic and Liassic periods." He showed that so long ago as 1836, Mr. J. H. Redfield had made a careful examination of a portion of these fishes; and by the aid of the great work of Prof. Agassiz on the fossil fishes known in Europe, was able to point out the geological age of these American fishes, as of the period from the Triassic to the Liassic series; their affinities being as near to the latter as to the former. These results were published in the annals of the New York Lyceum of Natural History, with his first description of the genus Catopterus. In a report prepared at the request of the American Association of Geologists and Naturalists, and presented at the meeting in New Haven in 1845, Mr. John H. Redfield gave a more extended examination of these fishes, including the genus Catopterus from the coal rocks of Eastern Virginia, and confirming the results of the former examinations. Later researches by geologists do not appear to have altered these determinations. The value of fossil remains, as indicating the relative age of rocks, is well shown by the fact that a young man of twenty, without previous training, was thus able to point out the geological age of these strata, and within the same limits which seem to be established by all subsequent discoveries and examinations.

NEW CARBONIFEROUS REPTILE.

At the American Association, Albany, Prof. Jeffries Wyman presented a communication on the remains of an animal found by Dr. Newberry in the coal strata of Ohio. In adverting to these new fossils, Prof. Wyman remarked:—

As we descend through the strata of the earth the remains of fossils become ever fewer, downward to the coal formations. In America the remains of reptiles in the coal series are found by their footprints. Some have been discovered by Lee, and others are to be described by Rogers, but these are of the Batrachian order. Now it is of the highest necessity that great caution be used in deciding upon the character of animals thus made known to us, since they sometimes exhibit both reptilian and ichthyic characteristics. The Gar pike, for instance, might be taken for a reptile if only a part of its skeleton was found, and vice versâ. One part of a vertebra would lead the anatomist to judge it a fish, another part would give equal reason to suppose it a reptile. We must, therefore, have many parts of a skeleton. The fossil in question was undoubtedly reptilian. The cranium is so much like that of a frog as to give the impression upon first inspection that it is that animal; but, on counting the vertebræ, we find the number to be too great. The skull is that of the tailless Batrachia; the posterior parts those of one with a tail. He was sure it was not a fish; it looks like that of a serpent. There are in these remains two characters not found in existing reptiles. First, broad processes in the vertebræ, comparable to the *Miraponia* of the Western rivers, and thus far the animal was Batrachian; Secondly, ribs like those of a serpent, unlike any known Batrachian. Of existing Batrachians some are without limbs, and some with limbs. Some of these latter have two toes; some three, and others four and five. The footprints found in Pennsylvania exhibit five toes before and four behind. In this specimen appearances indicate the existence of a fifth toe on the forefoot, which may yet lead to the discovery of the connection of these footprints with Batrachian reptiles.

Prof. Agassiz said that this was very welcome evidence of reptile life, and of the difficulty of identifying animals from portions. He said that in dissection of turtles he had discovered the particular bones in the turtle's neck, which were supposed to be peculiar to birds, so that had a skeleton been found, the upper portion of it would have been referred to a bird, and the lower to a reptile. These discoveries forced upon science the necessity of reconsidering many cases which were now relied upon as furnishing reliable evidence of the existence of peculiar animals in past ages. He believed that the Batrachians did not belong to the class of reptiles, but that they formed a class of amphibians intermediate between reptiles and fishes, and comprising a large portion of what were called the large reptiles of the old ages.

FOSSIL INSECTS OF THE TERTIARY MARLS OF CROATIA, AUSTRIA.

At the recent Meeting of the German Association for the Promotion of Science, Prof. Heer presented a conspectus of the fossil insects found in the Tertiary Sulphuriferous Marls of Radobog, Croatia. The Professor determined 303 species distributed among 114 genera; of these, 39 are Coleoptera, 34 Gymnognatha (Orthoptera), 82 Hymenoptera, 8 Lepidoptera, 79 Diptera, and 61 Rhynchota. The Coleoptera offer but few striking forms; among the

Gymnognatha, Grasshoppers and Termites predominate. Fifty-five of the eighty-two species of Hymenoptera belong to the genus *Formicina.* Lepidoptera are of very rare occurrence; *Mycetophila, Sciura,* and other genera whose larvæ live in the fleshy substance of fungi, together with *Limnobiæ,* and spotted-winged *Tipulæ,* similar to those living in damp forests, prevail among the Diptera. The *Rhynchotæ* are represented chiefly by species of the groups *Cimecidæ, Cicadidæ, Cicadellinæ,* and *Aphides.* The whole insect fauna of Radobog is without any specific character, embracing mid-European and Mediterranean forms, together with others of Indian, and still more of American type.

New Fossil.—Mr. R. C. Field of Greenfield, Mass., in a letter to the Boston S. N. H., says he thinks he has discovered an entirely new footprint of a biped web-footed animal, two and a half inches long, with a stride of about ten inches, and with an impression of a tail. He thinks this is much more perfect than the one described by Prof. Hitchcock, and may even prove that the latter was not made by a web-footed animal.

NEW FOSSIL SHELL FROM THE CONNECTICUT RIVER SANDSTONE.

Mr. E. Hitchcock, Jr., in a communication to Silliman's Journal, states that he has recently found in the coarse sandstone of Mount Tom (Easthampton, Mass.) a shell of a mollusk, the first, he believed, that has been discovered in the sandstone of the Connecticut Valley. It is preserved and not petrified, and a considerable part of it has disappeared. Enough remains, however, to enable us to refer it to a family, if not to a genus of shells. The upper part is gone, leaving an oval opening about an inch and three quarters in one diameter, and an inch and one quarter in the other. It extends downwards, tapering somewhat rapidly nearly an inch and a half, and is left without a bottom, the lower opening being about an inch wide. The walls are very thick, in some places nearly half an inch, and made up of several concentric layers. From the resemblance of this shell to a model of the lower valve of the Sphærulites calceoloides in the Cabinet of Amherst College, it seems probable that it may be referred to that family of Brachiopods denominated Rudistæ by Lamarck. Its lower parts as well as the lower valve are missing, but what remains approaches nearer to the genus Sphærulites than to any other of the Rudistæ of which he has seen specimens or figures. This fossil seems to lend additional strength to the inference derived from the discovery of the Clathropteris, that the upper part of the sandstone of the Connecticut Valley is as high at least as the Liassic or Jurassic series. It might seem even to carry us higher in the series, but it would be premature to draw such an inference from a single imperfect specimen, even though its true analogies be ascertained. The specimen now belongs to Amherst College Cabinet.

ON THE SKIN AND FOOD OF THE ICHTHYOSAURUS.

The following is an abstract of a paper read before the British Association by Mr. C. Moore, at the last meeting:—

In clearing specimens of this fossil animal, dark patches of matter have been frequently seen, in association with which thousands of minute black hooks may be noticed by the aid of the lens. These have been supposed portions of the outer skin of the Ichthyosaurus covered by the hook-shaped processes referred to. It was stated by Mr. Moore that out of twenty-three saurians in his museum he had traced these black patches in not less than sixteen; but that as in every instance they were connected with the stomach of the saurian, the conclusion was forced upon him that they were not portions of skin, but were to be accounted for by supposing that the Ichthyosauri had fed upon naked cephalopods, allied to the cuttle fish. Continuing his investigations on this subject, Mr. Moore proved that there were many cephalopods existing with the Ichthyosaurus that would supply these hooks, and that they were frequently to be found on the fleshy arms of the Onychothentis and allied genera. Mr. Moore exhibited to the Meeting the body of a small saurian, which at this distant time had its soft skin entire; and appealed to it in confirmation of his opinion, that these black patches and the hooks were no portion of its outer covering. In conclusion, Mr. Moore produced some of the dark matter taken from the stomach of one of his Ichthyosauri, and stated that he could show to the Meeting that, although it had through so many ages been lying in the stomach of this ancient creature, and had been mixed with other food, it could be no other than what was once the fluid ink of a cuttle fish; a fact which was demonstrated to the Meeting by his showing them that it retained its coloring matter almost as perfectly as if it had been taken from a recent sepia. In clearing this specimen, Mr. Moore was fortunate enough to make an incision into the stomach, in which, though so long a period had elapsed since it had taken its last meal, there was still to be seen in perfect preservation a small fish of the genus Leptolepis.

NEW SPECIES OF DINORNIS.

At a recent meeting of the London Zoological Society, Prof. Owen read a description of a new species of Dinornis, the *Dinornis Elephantopus*, Ow. Mr. Walter Mantell having deposited in the British Museum his extensive collection of remains of great wingless birds from New Zealand, and Professor Owen having, at the request of Mr. Waterhouse, undertaken the examination of the collection with a view to determine the bones and the species to which they belong, the Professor had discovered a species distinct from, and more extraordinary than, any that he had previously seen and described. For this species, which he regarded as the most remarkable of the feathered class for its prodigious strength and massive proportions, he proposed the name of *Dinornis elephantopus.* The parts of its skeleton selected for the subject of the evening's discourse were the femur, tibia, fibula, metatarse, and phalanges of the three toes; the Professor having been able to recompose an entire lower limb of the elephant-footed bird. Its title to that name may be judged of by the proportions of some of these bones. In the *Dinornis giganteus, e.g.*, described by Professor Owen in 1843, the length of the metatarsal bone is eighteen inches and a half, the breadth of its lower end being five inches and a half; in the *Dinornis elephantopus*, the length of the corresponding bone is nine inches and a quarter, the breadth of the lower end being five inches and one third. The extraordinary proportions of the metatarsus of this wingless bird will be perhaps still better understood by comparison with the same bone in the ostrich, in which the metatarsus is nineteen inches in length, the breadth of its lower end being only two inches and a half. Professor Owen contemplates the probability of reconstructing, from the materials accumulated by Mr. Mantell, the entire skeleton of the elephant-footed Dinornis, which would be a worthy companion of the Megatherium and Mastodon. The *Dinornis elephantopus* appears to have been restricted to the Middle Island of New Zealand. No bone or fragment of bone indicative of this species had ever reached the author from any part of the North Island of New Zealand. The specimens described, together with many other bones of the *Dinornis elephantopus*, were discovered by Mr. W. Mantell at Ruamoa, three miles south of the point called the First Rocky Head in the Admiralty charts of the island.

THE GREAT GLACIER OF GREENLAND.

It was in full sight—the mighty crystal bridge which connects the two continents of America and Greenland. I say continents—for Greenland, however insulated it may ultimately prove to be, is in mass strictly continental. Its least possible axis, measured from Cape Farewell to the line of this glacier, in the neighborhood of the 80th parallel, gives a length of more than twelve hundred miles, not materially less than that of Australia from its northern to its southern cape. Imagine, now, the centre of such a continent, occupied through nearly its whole extent by a deep unbroken sea of ice that gathers perennial increase from the water-shed of vast snow-covered mountains and all the precipitations of the atmosphere upon its surface. Imagine this—moving onwards like a great glacial river seeking outlets at every ford and valley, rolling its icy cataracts into the Atlantic and Greenland seas, and having at last reached the northern limit of the land that has borne it up, pouring out a mighty frozen torrent into unknown Arctic space.—*Dr. Kane's Second Expedition.*

CEDAR SWAMPS OF NEW JERSEY.

From the recent report on the geological survey of New Jersey, by Prof. Kitchell, we derive the following description of the cedar swamps which constitute so remarkable a feature in the forests of the southern part of this State.

These swamps are common to all the counties south of Monmouth, but probably the most extensive are in Cape May, and the adjoining parts of Cumberland and Atlantic counties. The Cedar Swamp creek which runs into Tuckahoe river, and Dennis Creek, which runs into Delaware Bay, head in the same swamp, and the whole length of the two streams, a distance of seventeen miles, is one continuous cedar swamp. The wood is the white cedar, the *Cupressus thyoides* of the botanist. The original growth of trees which covered these swamps at the first settlement, has been all cut off; scarcely any are to be found more than one hundred years old, and it is usual to cut them at fifty or sixty years. Formerly they attained a great age, from seven hundred to one thousand rings of annual growth having been counted on an old tree, which was living at the time it was cut down. The trees stand very thick upon the ground and grow rapidly at first, but as they increase in size and crowd each other, the tops become thin and the annual growth exceedingly small. The rings near the centre of a large cedar log are often almost an eighth of an inch in thickness, while those near the bark are not thicker than paper. Trees, four or five feet in diameter, have been found, but this is uncommon, and in the second growth timber they are much smaller.

A swamp of sixty years' growth will yield from 4,000 to 7,000 split rails, halves and quarters; besides the top poles or *cullings*, and a considerable nnmber of logs for sawing. And in the older swamps the product is proportionally large. The value of an acre of such timber is from $400 to $1,000, and some acres are thought to have yielded a larger sum still. The soil in which these trees grow is a black, peaty earth, composed of vegetable matter,* which when dry will burn. This earth is of various depths, from two or three feet up to twenty or more, and the trees which grow on it have their roots extending through it in every direction near the surface, but not penetrating to the solid ground. When the earth is open to the sun and rains, it decays rapidly, but when covered with a growth of trees, and so shaded that the sun does not penetrate to the ground, it increases rapidly from the annual fall of leaves, and from the twigs and small trees which die and fall. This process of covering and preserving timber has been going on for a long time. Trees are found buried in this peaty earth at all depths, quite down to the solid ground. The buried logs are quite sound, the bark on the under side of many of them is still fresh in appearance, the color of the wood is preserved, and its buoyancy retained. When these logs are raised and floated in water, it is observed that the side which was down in the swamp is uppermost. The buried trees are some of them found with their roots upturned, as if blown down by the wind, and others are broken off as if they had stood and decayed, till too weak to support their own weight.

These logs are so abundant in some parts of the swamp, and in the salt marshes bordering on them, that a large number of men are constantly occupied in raising and splitting them into shingles. In one swamp this business was commenced fifty years ago, and has been carried on every year since, and though the logs are not quite so plentiful as at first, enough are still found to repay the workmen. The size of the logs is from one and a half to three feet, though four feet is not uncommon, and I have heard of them five or six, and in one instance seven feet in diameter. Occasionally a log is found that will work for thirty feet, but generally the length is less than this.

In searching for logs the workman uses an iron rod, which he thrusts into the mud till it strikes one; then by repeated trials, he judges of its direction, size, and length. The next trial is by digging down, and if possible getting a chip from it. By the smell of this the experienced shingler can tell whether

* The amount of ash left by its burning is astonishingly small: in two trials which I made, the amount of ash in the dried earth was only three and a half per cent. It was almost insoluble in acids, and had not the slightest alkaline taste. It was mostly silica.

the tree is a *windfall* or a *breakdown*, or, in other words, whether it was blown up by the roots or broken off. If judged to be worth working, the stump, roots, and turf, are removed from over the log, and the earth dug out. The trench which is thus made is, of course, full of water. There being no grit in the earth, tools can be used in it without injury, and the logs are rapidly sawn off by a one-handled cross-cut saw, which can be worked directly in the soft earth. As soon as the log is cut off and loosened by means of layers, it rises and floats in the water. It is then divided into shingle cuts, quartered, and thrown out to be split into shingles, and shaved, when it is ready for market.

It is said that for five years past the average number of these shingles sent from Dennisville is not far from 600,000 a year. They are worth from $13 to $15 a thousand. About 200,000 white cedar rails have been sent from the same place this year. They are worth from $8 to $10 a hundred.

DESCRIPTIVE LABELS FOR MINERAL COLLECTIONS.

At the British Association, Mr. Tennant, the well known mineralogist, presented a new plan for constructing labels for mineral collections, with a view of making them more available to the student, by bringing before him, at the same time with the objects themselves, their chief characteristics and uses. Thus each label gives the name of the mineral, its synonymes, chemical constitution, crystalline system, hardness, specific gravity, optical properties, fusibility or infusibility before the blowpipe, &c., together with a concise description of the principal localities where it has been found, and its application to the arts and manufactures when it can be usefully applied. By its introduction it is hoped many local institutions may be rendered not only more instructive to the student but also attractive to the intending emigrant, who thus may be induced by its facility to acquire a knowledge beneficial not only to himself, but which may serve to discover mines of wealth hitherto unknown. The following is a specimen:—

Pyrite.—Iron Pyrites, Sulphuret of Iron, Hexahedral Iron Pyrites. Fe. S_2. cubic. H 6·0—6·5 G 4·9—5·1. Case 6. *Frac.* conchoidal, uneven. Opaque. *Lus.* metallic. *Col.* brass-yellow, gold-yellow, brown. Brittle. B. fusible. Partly soluble in nitric acid. Some varieties contain a small quantity of gold.

A very common mineral, universally diffused in beds and veins of the most different formations. Elba, Piedmont, Saxony, Bohemia, Hungary, Norway, Sweden, Dauphiné, Derbyshire, Cornwall, &c. Used in the manufacture of sulphur, sulphate of iron, and sulphuric acid. Distinguished from copper pyrites by being too hard to cut with a knife; from the ores of silver by its pale bronze color, and hardness and difficulty of fusion. Gold is sectile, malleable, and does not give off a sulphur odor before the blowpipe.

BOTANY.

EFFECTS OF MOONLIGHT ON VEGETATION.

PROFESSOR LINDLEY, in his new edition of *The Theory and Practice of Horticulture*, makes the following remarks on the effects of moonlight upon vegetation:—

"As far as is yet known, solar light alone has the power of producing any practical effect upon vegetation. That of the moon has, however, been shown to be not without influence. That the moon has a great mechanical effect upon our globe is undisputed. Of this, we need not say that the perpetually alternate ebbing and flowing of the tide afford the most evident proof. But, whilst the effects of the moon are admitted to be extremely powerful in this respect, the influence of her light, except as regards illumination, has been often considered by scientific men as inappreciable; and the proverbs to the contrary, current among the unlearned, have been accordingly estimated as popular errors. It has, however, been at last demonstrated that the moon's rays are very far from powerless. We learn from a note by M. Zantedeschi (*Comptes Rendus*, October, 1852), that these rays do affect vegetation. This philosopher states that the influence, physical, chemical, and physiological, of the moon's light, which has hitherto been the object of so much research and speculation amongst scientific and agricultural writers, has been recently investigated by him in consequence of his having had occasion to give a historical summary of the works on the subject. In the course of his inquiries he found it necessary to clear many doubtful points, in doing which his attention was forcibly arrested by the movements exercised in mere moonlight, under certain circumstances, by the organs of plants; and this led him to make the whole subject a serious and profound study. His observations were commenced in 1847, in the Botanic Garden at Venice; they were continued in 1848 in the Botanic Garden at Florence, and at Padua in 1850, 1851, and 1852. In the whole series of his experiments, M. Zantedeschi always remarked certain motions in plants having a delicate organization as soon as they were brought under the influence of the lunar rays. In those experiments the rays were always diffused, being neither concentrated by lens nor mirror. Such movements could not be obtained by the action of heat, in whatever way thermal influences were applied. It was in vain to elevate or depress the temperature; in the absence of moonlight the phenomena in question could not have been elicited. The plants on which M. Zantedeschi principally experimented were Mimosa ciliata, Mimosa pudica, and Desmodium gyrans. He always took great care to determine exactly the position of the leaf stalks and leaflets of the plants after they had been exposed to the open air, and before they were directly illuminated by the lunar rays. He thus avoided any causes of error which might have arisen from the imperceptible motion of the air, or from a slight change of temperature; and he satisfied himself fully that the effects observed did result entirely from the action of the rays of light from the moon. Without entering into minute details, it is sufficient to say that the results were ascertained when the temperature of the air was 70° Fahr.; and when Saussure's hygrometer indicated a medium state of humidity. Under such conditions, the leaf stalks of Mimosa ciliata were raised half a centimetre, or about four-tenths of an inch; those of the Mimosa pudica were raised one inch and two-tenths; whilst the leaflets of Desmodium gyrans exhibited distinct vibrations. It was thus demonstrated that moonlight has the power *per se* of awakening the Sensitive Plant, and consequently that it possesses an influence of some kind on vegetation. It is true that the influence was very feeble, compared with that of the sun; but the action, such as it is, is left beyond further question. This being so, the question remains, what is the practical value of the fact? It will immediately occur to the reader that possibly the screens which are drawn down over hothouses at night, to prevent loss of heat by radiation, may produce some unappreciated injury by cutting off the rays of the moon, which Nature intended to fall upon plants as much as the rays of the sun.

"Even artificial light is not wholly powerless. De Candolle succeeded in making Crocuses expand by lamp-light, and Dr. Winn, of Truro, has suggested that the oxyhydrogen lamp may be made subservient to horticulture in the long dark days of winter. It does not, however, appear that this hypothesis rests upon any experimental basis."

ON THE LAW OF PHYLLOTAXIS.

The following is an abstract of a paper on the above subject, read at the last meeting of the American Association, by Dr. T. C. Hilgard:—

He wished to present an attempt towards constructing an organic law of Phyllotaxis, towards constructing a theory of the cause of the arrangement of leaves. It was well known to the gentlemen that hitherto phyllotaxis, or the arrangement of leaves, had only been studied in its mathematical relations, and in its analogy to cosmical or to zoological order. It had been shown that leaves not opposite are arranged about a stem always in either two, three, five, eight, or thirteen rows, and that if the bases of the leaves taken in their order of height on the stem be connected by a thread winding round the stem, then between any two successive leaves in a row, the thread winds round the stem once if the leaves are in two or three rows, twice if in five rows, three times if in eight, five if in thirteen, &c. In other words, two successive leaves on the thread will be at such a distance, that if there are two rows, the second leaf will be half way round the stem; if three rows, the second leaf will be one third of the way round; if five, the second will be two-fifths of the way round; if eight, three-eighths; if thirteen, five-thirteenths, &c. But the question of Dr. Hilgard is, why is this so? What is the organic law of development that produces this result? If we cannot answer this question, can we not at all events throw some light upon it, some hint towards its solution? If we take a flower-stalk of the common plantain (plantago major) between the thumb and fingers, we can, by twisting the stalk in one direction or the other, arrange its buds in any number of rows that the law of phyllotaxis permits, two, three, five, eight, &c. As we can thus pass from a higher to a lower number, or from a lower to a higher, at pleasure, by simply twisting the stalk, that is, by introducing a constant disturbance at every point of the stalk, it is plain that the mathematicians will allow the organic law to be founded either upon a very high number of rows, which by a constant interference is reduced to smaller numbers, or upon a low number, which is modified into higher ones. The former had been the view of Prof. Pierce, in his paper presented to the Cambridge meeting, viz. that the organic law of vegetable growth contained, as a fundamental constant, the surd towards which the series $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, &c., approximates; and that interferences with it, constant or nearly so in each botanical species, produced the approximations. Dr. Hilgard, on the contrary, had sought for the germ of the law of phyllotaxis in the numerical genesis of cells. Starting with a primal cell generating a second, and assuming that the second requires a time to come to maturity, during which the primal cell recuperates its powers and produces a third, we have a law which gives the phyllotaxian numbers. *One* cell generates a *second*, and then a *third*. The first and second then simultaneously generate each one, which make the whole number *five*. The first, second, and third, are then mature enough to generate each one, which makes the whole number *eight*. Five are then sufficiently mature to generate each one cell, which raises the whole number to *thirteen*. Here, then, is a simple mode of conceiving of the genesis of cells, which gives us at once the numbers that occur in phyllotaxis, and no others. But, we need also the geometrical element, the position as well as the number of the leaves; and if we can obtain it from this same conception of numerical genesis it will be a strong confirmation of the theory, that this lies at the foundation of this organic law. Now, if we take a rosette of the house-leek, for example, and number the leaves of the whorl in phyllotaxian order, we shall find the successive numbers actually placed in juxtaposition to those which in our law of cell genesis would be their parents; that is, 4 and 5 will be placed at the base of 1 and 2; 6, 7, and 8 at the base of 1, 2, and 3, &c. This conception of numerical genesis fulfils, therefore, the geometrical conditions required, and thus asserts its claim to a fundamental position in any theory of the organic law of vegetable growth.

PROTECTING INFLUENCE OF SNOW ON VEGETATION IN ARCTIC LATITUDES.

Few of us at home can realize the protecting value of this warm coverlet of snow. No eider-down in the cradle of an infant is tucked in more kindly than the sleeping dress of winter about this feeble flower life. The first warm snows of August and September falling on a thickly bleached carpet of grasses, heaths, and willows, enshrine the flowery growths which nestle round them in a non-conducting air-chamber; and as each successive snow increases the thickness of the cover, we have, before the intense cold of winter sets in, a light cellular bed covered by drift, six, eight, or ten feet deep, in which the plant retains its vitality. The frozen subsoil does not encroach upon this narrow cover of vegetation. I have found in mid winter in this high latitude of 78° 50′, the surface so nearly moist as to be friable to the touch; and upon the ice floes commencing with a surface temperature of 80°, I found at two feet deep a temperature of — 8°, at four feet + 2°, and at 8 feet + 26°. My experiments prove that the conducting power of the snow is proportioned to its compression by winds, rains, drifts, and congelation. The early spring and late fall and summer snows are more cellular and less condensed than the nearly impalpable powder of winter. The drifts, therefore, that accumulate during nine months of the year are dispersed in well defined layers of differing density. We have first the warm cellular snows of fall, which surround the plant; next the fine impacted snow dust of winter, and above these the later humid deposits of the spring. It is interesting to observe the effects of this disposition of layers upon the safety of the vegetable growths below them. These, at least in the earlier summer, occupy the inclined slopes that face the sun, and the several strata of snow take of course the same inclination. The consequence is, that as the upper snow is dissipated by the early thawing, and sinks upon the more compact layer below, it is to a great extent arrested, and runs off like rain from a slope of clay. The plant reposes thus in its cellular bed from the rush of waters, and protected too from the nightly frosts by the icy roof above it.—*Dr. Kane.*

THE LATTICE PLANT.

The new and curious aquatic plant from Madagascar, called the Lattice Plant (*Ouvirandra fenestralis*), must be placed among the most remarkable of our recent botanical acquisitions. Its existence had been for some time known to botanists through a few dried leaves sent from Madagascar by a traveller, who was unable to transmit living specimens of the curiosity he had discovered; and it was not until within the last few months that this desirable object could be attained, when several living plants were brought over to England from the above mentioned country, by the Rev. Mr. Ellis, a missionary. The interest of this plant lies in the extraordinary structure of the leaves, which, unlike those of any other known plant, are made up of the ribs and cross veins only; the interstices, which in other leaves are filled up with cellular tissue, being here left almost entirely open, so as to give the leaf the appearance of a piece of curious net or lattice work, from which is derived its common name—the Lattice Plant.

RUSTIC ORNAMENT FOR A ROOM.

An ornamental object for a window, or room, may be made by placing a large pine cone in the mouth of a glass having a small quantity of water at the bottom. The scales of the cone are first slightly opened, and lentil seeds are dropped into the openings. Water is sprinkled over the cone, as may be necessary, say twice a day, and, in a short time, the lentils send up their small green shoots, and cover the cone. The scales are opened by placing them in any moderately warm place for a short time.

ON THE LIMITATION OF THE AREA ADAPTED TO COTTON CULTURE.

The following is a *resumé* of a paper on the reciprocal interest of the cotton planter and cotton manufacturer, read at the last meeting of the British Association, by Mr. Dawson. The following series of propositions was laid down:—

1. That cotton, from the condition of climates necessary to its culture, cannot be grown in Europe, but that, with the single and not important exception of the factories in the New England States of America, it is and must long continue to be manufactured almost exclusively in Europe. 2. That the present supply is chiefly raised, and for the present must continue to be raised, by slave labor—seeing that while, for fifty years, we have sought over the whole earth for cotton, we have during that time continued to obtain from the slave states of the American Union a continually increasing proportion of our entire supply. 3. That two-thirds in number at least of the slave population of the United States have been called into existence, and are now directly or indirectly maintained, for the supply of cotton for exportation. 4. That of the cotton thus exported, three-fourths at least in value are raised for and sent to Great Britain alone. And 5. That of the entire quantity we import, four-fifths at least in value are thus derived from the United States. Each proposition was supported by tabular accounts extracted from the public records of Great Britain and the United States, and the conclusion was expressed thus:—"That hence, in the present state of the commercial relations of the two countries, the cotton planters of the United States are interested to the extent of two-thirds at least of their entire exportable produce in the maintenance of the cotton manufacture of the United Kingdom; and that reciprocally the cotton manufacturers of the United Kingdom, and through them the entire population of the kingdom, are interested, to the extent of more than four-fifths of the raw material of that manufacture, in the existing arrangements for maintaining the cotton culture of the United States."

ON THE RELATIONS EXISTING BETWEEN ANIMALS AND MAN.

In a late number of the *American Journal of Medical Science*, Dr. J. Jones gives some very curious and interesting facts in relation to animals and man. In nature there are two great kingdoms, the animal and vegetable. Dr. Jones contends that both have one common origin—the organic cell—the distinction between the two kingdoms every day disappearing, most of the organic products which were thought to distinguish the animal from the vegetable having been found in both; and motion even no longer separates the animal from the vegetable world. This property of matter appears to be most incessantly occupied in the minutest organisms; the motion of the minute ciliæ of vegetables, the contraction of the leaves of the sensitive plant, are familiar examples. The only distinction between the lowest orders of the two kingdoms, the Protozoa and Algæ, is that the former possess to a certain extent voluntary motion. In the vegetable kingdom the rudiment of nervous apparatus, or a cell-generating nervous force, has not been discovered, although there are evidences of the existence of a force requiring the same conditions, viz. heat, moisture, oxygen, and a germ. In the lowest form of animals the rudiments of a nervous cell cannot be discovered; yet these beings possess the attributes of vitality and even nervous force. These facts point to the conclusion that nervous force is entirely distinct from the vital. With reference to the circulation of the blood, Dr. Jones, after coming to the conclusion that the heart is the smallest in fishes and the largest in birds, thus illustrates the theory of the circulation:—The number of beats of the pulse in a minute are in fishes generally from 20 to 24; in frogs, about 69; in birds, from 100 to 200; the pigeon, common hen, and heron having respectively 130, 140, and 200. Taking animals—in an ox the number is 38; a horse, 56; a sheep, 75; an ape, 90; a dog, 90 to 95; a cat, 100 to 110; a hare, 120; a guinea-pig, 140. In human beings, in the first year, the number is 115 to 130; second year, 100 to 115; third year, 90 to 100; about the seventh year, 85 to 90; about the fourteenth year, 80 to 85; middle of life, 70 to 75; in old age, 50 to 65. Taking the mammalia generally, the range is from 38 to 140. A close relation exists between the rapidity of the circulation of the blood and the number of respirations in a minute. From this it appears that cold-blooded animals are such, not from any peculiar chemical or physical endowments of the organic or inorganic molecules of their bodies, but from the peculiarity of structure of their circulatory and respiratory systems; and that the perfection of these two systems may be taken as the index of the rapidity of the physical and chemical changes of the molecules of their fluids and solids, the intelligence and activity of the life-actions being proportional generally to the rapidity and amount of the physical and chemical changes of the organic and inorganic molecules.

ON THE INFLUENCE OF LIGHT AND WATER ON THE GERMINATION OF PLANTS.

At the Albany meeting of the American Association, Mr. Jas. Dascomb read a paper on the influence of light and water on the plumule and radicle in the germination of plants. The theory heretofore held had been that the plumule followed the light and the radicle avoided it. Shultz, of Berlin, had made an experiment in which, by reflecting light upward from a mirror to the mould containing the seed, the plumule grew down and the radicle upward. Mr. Dascomb detailed several carefully conducted experiments, the results of which did not tend to confirm the old theory. The plumule invariably grew upward and the radicle grew downward rather than upward.

Prof. Agassiz said that for a number of years he had been making analogous experiments. His were to ascertain whether the direction of the plumule and radicle was not determined by something within the seed, in order to obtain some analogy to the wings, arms, and other extremities of the body of animals. He sowed cresses in flower-pots, in different positions, and the plumule always grew up while the radicle always grew down, into empty space if there was nothing else there.

TRANSMUTATION OF SPECIES IN PLANTS.

At the last meeting of the British Association, Prof. Henslow presented the result of some experiments, in which he had so far succeeded in changing the character of *Ægilops ovata* as to lead him to conclude that M. Fabre's original statement, that it was the origin of the domestic wheat, *Triticum sativum*, was not altogether without foundation. He exhibited specimens, in which the form of *Ægilops ovata* had undergone considerable change; but he had not yet succeeded in obtaining the characters of *Triticum sativum*. Prof. Henslow then exhibited forms of *Centaurea nigra* and *C. nigrescens*, in which it was seen that these plants had completely passed one into the other. He then referred to instances of the species of Rosa, Primula, and Anagallis, passing one into the other.

Mr. Bentham stated that when he first began to study botany, he thought permanent characters ought to be regarded as distinctive of species. He now, however, believed that permanent characters might be given to plants by locality and climate, which had no right to be regarded as distinct species. He then proceeded to refer to his own experience of the Flora of Europe, Asia, and Africa, as contrasted with that of the British Islands. He instanced more particularly *Bellis perennis* and *B. sylvestris* as the same plant, and *Taraxacum obovatum* and *T. lævigatum*. He thought that all the forms of Rubus, with the exception, perhaps, of *R. cæsius*, ought to be referred to *R. fruticosus*. Sir W. Jardine referred to instances of birds in which external circumstances changed the color of their plumage and other points of their structure. Prof. Balfour referred to instances of plants which varied very much in their characters, according to the circumstances in which they were placed. He mentioned the case of *Pontederia crassipes*, which assumed, according to its treatment, quite different characters. Accidental changes in form frequently became permanent, of which he related an instance in a fern at the Edinburgh Botanic Gardens.

ON THE DEVELOPMENT OF THE EMBRYO OF FLOWERING PLANTS.

In a paper presented at the last meeting of the British Association, Prof. Henfrey announced that Prof. Schleiden and Dr. Schacht had given up their opinion that the end of the pollen-tube produced the embryo in the seeds of flowering plants; and had come to the conclusion that the embryo is formed from a distinct protein mass, contained in the embryo sac. He also pointed out that the embryo mass does not become a regular cell covered with cellulose till after the pollen-tube has come in contact with the embryo sac.

ON THE GERMINATION OF SEEDS.

In Lindley's *Theory of Horticulture*, it is stated that a M. Otto, of Berlin, employs oxalic acid to make old seeds germinate. The seeds are put into a bottle filled with oxalic acid, and remain there till the germination is observable, which generally takes place in from twenty-four to forty-eight hours, when the seeds are taken out, and sown in the usual manner; of course, placed in a suitable temperature as the seeds may require. Another way is to take a woollen cloth, and wet it with oxalic acid, on which the seeds are placed and folded up, and put into a suitably heated structure. By this method, seeds have been found to vegetate equally as well as in the bottle. Essential care must be taken to remove the seeds out of the acid as soon as vegetation is observable. M. Otto found, that by this means seeds that were from twenty to forty years old grew; while the same kinds, sown in the usual manner, did not grow at all.

ON THE STUDY OF THE FUNGI.

Mr. C. L. Andrews, in a recent communication with the Boston Soc. Nat. Hist., remarked, that Mycology (the study of fungi), although beset with serious difficulties, and requiring patient and persevering labor, offers an immense and exceedingly interesting field of study. A series of years would be requisite to complete a catalogue of those found within the borders of the United States. Fries, the well known author of a work on Fungi, mentions having found two thousand species comprised within the limits of a square furlong. Their universality is very remarkable, and we find but few substances in nature exempted from their inroads. Every tribe of plants possesses peculiar and characteristic species on the stem or leaf. They are found upon bottles, cloth, thread, opium, roasted meats, dead flies, pigs' bristles, old stockings, and in other equally curious situations. Our furniture, clothing, fuel, books, food, in short almost every object forms a congenial habitat for some species or other of these vegetable growths.

ON THE PRODUCE AND COMPOSITION OF WHEAT.

At a recent meeting of the British Association, Dr. Gilbert read a paper containing the results of a large number of experiments made by him and Mr. Lawes, during a period of several years, upon wheat grown in England as well as abroad. Dr. Gilbert subjected the various coarse and fine varieties of flour to analysis, and showed that the nitrogen increased in proportion as the sample was coarser and contained more bran. The flour that contained least nitrogen was that which took up least water in the process of bread making, and an interesting question arose as to the nutritive value of bread containing much or no bran; Dr. Gilbert's opinion being in favor of the latter, as far as working men are concerned, notwithstanding the theoretically higher value of bread containing bran. Another interesting fact stated by Dr. Gilbert was, that the Black Sea wheat in Europe and the Southern States wheat in America were far richer in gluten than those from more northern latitudes, those from Dantzic containing least gluten, whilst they stood highest among bread making grain. The character of the gluten seemed dependent in some degree on its oily constituent, and therefore the quality of the bread depends on the maturation of the seed. Dr. R. D. Thompson remarked, that the value of bread might depend on the state of hydration of the starch and gluten; but was doubtful as to the value assigned to the nutritious qualities of starch, as the French chemists proved that the starch was often left undigested. Dr. Voelcker stated that he had arrived at similar experimental conclusions as Dr. Gilbert, but while he acknowledged that starchy bread was mechanically the best, he combated Dr. Gilbert's view, that this was the most wholesome kind of bread for the working man. He traced the phosphoric acid found by Dr. Gilbert in the bran to phosphorus contained as such in the gluten, Dr. Voelcker having found this element in caseine and legumine.

MICROSCOPIC DISCOVERIES OF THE NATURE OF BLIGHT IN WHEAT.

M. C. Davaine has lately published in the *Comptes Rendus* the result of his researches into the nature of blight in wheat, of which account the following is an abstract:—Wheat is subject to a disease which in rainy seasons is very prevalent in certain districts; it is known under the name of blight. This disease is caused by microscopic animalcules, whose organization is similar to that of the cylindric worms which live as parasites in the vorticello and in man. They are helminthes of the order of nematoides—thread worms. These wheat worms have the remarkable capability of remaining in a dry and horny state for years, and then regaining life and motion on being moistened, and this process can be repeated eight or ten times. It was long disputed whether they were animals or vegetables. On examining a grain of blighted wheat, it is found to consist of a hard shell filled with white powder. This powder contains no trace of starch; it consists entirely of microscopic threads, which are dry, stiff worms. When placed in water these worms exhibit hygroscopic motion for a few moments. When the wheat is new they soon make other manifold and considerable movements which are unmistakable signs of life. When the grain is old it requires several hours, or sometimes even days, before they resume motion and life. In a single grain of affected wheat there are generally several thousands of these worms. They have no sexual distinctions; they are the offspring of other forms. Before a blight comes on there are found from two to twelve larger worms in each kernel which is about to be affected, and the females of these larger worms have been observed to lay eggs. If blighted wheat is sown with sound, the worms, after a few weeks, and when the sound wheat has germinated, are awakened into life by the moisture of the earth, break through the thin shell which has confined them, and follow the dictates of individual enterprise. The great mass of them die an unfruitful death, but a few reach the germinated wheat and effect a lodgment in the stalk under the forming leaves. They are carried up by the growth of the plant, and in wet weather by their own exertions. As they are dried up most of the time, they suffer no considerable change until they enter into the forming kernels and lay their eggs. The blighted wheat is no more grain than nutgalls are fruit. Its tissue is composed of hypertrophical cells. It is only after the worms have entered this tissue that their reproductive organs become distinct. Both males and females become much larger, but the females are larger than the males and lay a multitude of eggs, in which can be seen an embryo that soon breaks through the membrane of the egg and commences its larva life. By the time the sound corn is ripe the parents are dead, their remains are dried into almost nothing, the egg shells are absorbed, and the grain is apparently filled with nothing but white powder. This is, as before stated, the dry helminthes.

ORIGIN OF THE WHEAT PLANT.

Much interest has of late been excited among botanists by the statements of MM. Fabre and Dunal, that they have succeeded in producing the cultivated wheat (*Triticum sativum*) from a variety of grass known in the south of Europe as *Ægilops orata*. This grass under cultivation is said to assume the form called *Ægilops triticiides*, and finally to become wheat. M. Fabre says, that the complete change was produced in twelve years by constant cultivation. If this view is correct, then botanists are wrong in supposing wheat to be a *Triticum*, and it must be regarded merely as a variety of *Ægilops*, kept up entirely by the art of the agriculturist. We do not see common wheat in a wild state, but we meet with the grass whence it is derived. Wheat would seem to be a variety rendered permanent by cultivation. The opinions of Fabre have been supported by strong evidence. Of late, however, M. Godron has published a paper in the *Annales des Sciences Naturelles*, in which he maintains that *Ægilops triticiides* is not a mere variety of *Ægilops orata*, but that it is a hybrid between the cultivated wheat and the latter plant. This statement seems, at all events, to confirm the idea that wheat and the *Ægilops* are nearly allied plants, for hybrids are not easily produced, except between plants which resemble each other closely. This would be the first known instance of a hybrid among grasses. There can be no doubt that the wheat and *Ægilops orata* are congeners, and that they exhibit evident marks of resemblance. There appears, therefore, to be much plausibility in the statement of Fabre; and the hybridization spoken of by M. Godron may be merely such as would occur between varieties of the species. The matter is, therefore, by no means settled, and further experiments are required.

SEA WEED FOR FOOD.

At a recent clinique of the New York College of Physicians and Surgeons, Prof. Dalton discussed the subject of articles of diet prepared in part from sea weeds, or Algæ, for the use of that class of patients for whom *Iodine* is indicated. The Professor showed and distributed specimens of the preparations, such as biscuit and chocolate, together with the sea weeds which entered into their composition.

He stated that recent researches by Dr. John Davy and Prof. Apjohn, of Trinity College, Dublin, had proved the great value of many varieties of Algæ as articles of nutriment; that they had established, experimentally, the fact that they contain the *Protein* principles so necessary for the support of animal life, to a greater amount than even the best wheaten flour; that they abound in the phosphate of lime and the fixed alkalies; and that they contain such quantities of *Iodine* as should render them very valuable articles of food for persons laboring under scrofulous and tuberculous diseases.

The attention of a firm in New York having been called to this subject, these gentlemen had formed and successfully carried out the idea of preparing articles of diet which should abound in the active principles of these *Algæ*, and should at the same time be palatable and digestible. For this purpose they have selected some of these sea weeds best adapted to the object in view; and after drying and grinding them, have incorporated them with other common esculent materials, such as flour and cocoa, and converted the mixtures into bread, biscuit, chocolate, and the like.

The preparations exhibited are certainly very palatable, and, we are assured, are entirely digestible. Their constitution was stated to be such that each biscuit weighing half an ounce, contained about one thirtieth of a grain of *Iodine;* and that a similar amount was present in the quantity of chocolate required for each cup of the liquid beverage. After some remarks upon the composition of cocoa, and the peculiar advantages of a combination of it with a natural Iodine-bearing substance to produce an agreeable substitute for the cod-liver oil which is so offensive to most tastes and stomachs, Dr. Dalton concluded by observing that, although these preparations had not as yet been tried as to their medicinal efficacy, the principle involved in them was one which deserved the serious attention of the profession; and he hoped their merits would be fairly and fully tested.

JAPANESE COTTON AND HEMP.

Samples of the cotton and hemp raised in Japan have recently been received in this country. The cotton, examined under a glass, is not as fine as the average of American, and the fibre is shorter and more easily broken. It has a fine color, however, and the fibre has a greater number of barbs, so that it will draw, with proper handling, into a very fine thread. It has apparently a great many natural crooks in each fibre (this appearance may be given to it in dressing), which renders it easier to spin and makes a bat of it very elastic. From this cause and a natural harshness owing to the number of barbs in the fibre, it feels to the touch very much like wood. The hemp is entirely destitute of any flinty appearance, and possesses a long woody fibre about five feet in length. The whole resembles the thin bark of a tree until separated into fibres, and is quite stiff, with a resinous sap.

ZOOLOGY.

MATTEUCCI'S RECENT EXPERIMENTS IN ELECTRO-PHYSIOLOGY.

Prof. Matteucci, in a letter to Prof. Faraday, May 1, 1856, communicates the results of his recent experiments in electro-physiology. He says:—

I have lately succeeded in demonstrating and measuring the phenomenon which I have called *muscular respiration.* This respiration, which consists in the absorption of oxygen and the exhalation of carbonic acid and azote by living muscles, and of which I have determined the principal conditions and intensity compared with that of the general respiration of an animal, has been studied particularly on muscles in contraction. I have proved that this respiration *increases considerably* in the act of contraction, and have measured this increase.

A muscle which contracts, absorbs while in contraction a much greater quantity of oxygen, and exhales a much greater quantity of carbonic acid and azote, than does the same muscle in a state of repose. A part of the carbonic acid exhales in the air, the muscle imbibes the other part, which puts a stop to successive respiration and produces *asphyxy of the muscle.* Thus a muscle soon ceases to contract under the influence of an electro-magnetic machine when it is enclosed in a small space of air; this cessation takes place after a longer interval of time if the muscle is in the open air, and much more slowly still if there be a solution of potash at the bottom of the recipient in which the muscle is suspended. Muscles which have been kept long in vacuum or in hydrogen are nevertheless capable, though in a less degree, of exhaling carbonic acid while in contraction. This proves clearly that the oxygen which furnishes the carbonic acid exists in the muscle in a state of combination. According to the theories of Joule, Thomson, &c., the chemical action which is transformed, or which gives rise to heat, is also represented by a certain quantity of *vis viva*, or by an equivalent of mechanical work. I have therefore been able to measure the *theoretical work* due to the oxygen consumed, taking the numbers which I had found for muscular respiration during contraction, and in consequence the quantity of heat developed by this chemical action, and finally this *theoretical work* according to the dynamical equivalent of heat. I have compared this number with that which expresses the *real work* which is obtained by measuring the weight which a muscle in contraction can raise to a certain height, and the number of contractions which a muscle can perform in a given time. It results from this comparison, that the first number is somewhat greater than the second, and the heat developed by contraction ought to be admitted among the causes of this slight difference: these two numbers are therefore sufficiently in accordance with each other.

I have completed these researches by some new studies on *induced contraction*, that is to say, on the phenomenon of the irritation of a nerve in contact with a muscle in contraction. A great number of experiments lately made on the discharge of the torpedo, and on the analogy between this discharge and muscular contraction, have led me to establish the existence of an electrical discharge in the act of muscular contraction. The general conclusion to be drawn from these researches is, therefore, that the chemical action which accompanies muscular contraction developes in living bodies, as in the pile or in a steam-engine, heat, electricity, and *vis viva*, according to the same mechanical laws.

Allow me to describe to you briefly the only one of these experiments which can be repeated in a lecture, and which proves the principal fact of these researches, although it is limited to prove that muscles in contraction develope a greater quantity of carbonic acid than those in repose. Take two wide-mouthed glass phials of equal size, 100 or 120 cub. centims.; pour 10 cub. centims. of lime-water (eau de chaux) into each of these phials. Prepare ten frogs in the manner of *Galvani*, that is, reducing them to a piece of spinal marrow, thighs, and legs without the claws, which are cut in order to avoid contact with the liquid in the phials. The cork of one of these phials is provided with five hooks, either of copper or iron, on which five of the prepared frogs are fixed. Through the cork of the other phial are passed two iron wires, bent horizontally in the interior of the phial; the other five frogs are fixed by the spinal marrow to these wires. This preparation must be accomplished as rapidly as possible, and both the phials be ready at the same instant, and great care taken to avoid the contact of the frogs with the sides of the phials or the liquid. When all is in readiness, with a pile of two or three elements of Grove, and with an electro-magnetic machine, such as is employed for medical purposes, the five frogs suspended on the two iron wires are made to contract. After the lapse of five or six minutes, during which time the passage of the current has been interrupted at intervals in order to keep up the force of the contractions, agitate gently the liquid, withdraw the frogs, close rapidly the phials, and agitate the liquid again. You will then see that the lime-water contained in the phial in which the frogs were contracted is much whiter and more turbid than the same liquid contained in the other phial in which the frogs were left in repose. It is almost superfluous to add, that I made the complete analysis of the air in contact with the frogs according to the methods generally employed.

ON THE ASSIMILATIVE POWER OF VARIOUS FATTY BODIES.

All fatty bodies do not possess the same power of assimilation; some are digested with an almost inexhaustible facility; with others, on the contrary, the organism soon arrives at what may be termed saturation; so that after a certain time the fatty body will be found in the excrements, almost unaltered.

M. Berthe tells us that butter, olive, poppy, almond, and whale oils, English cod liver oil, cod liver oil washed or discolored with alkalies and charcoal, and pure brown cod liver oil, were all successively administered by him to one man in good health, and under a regular diet, in doses increasing from 30 to 60 grammes during the day. By an exact daily determination of the quantity of oil contained in the fæces, he ascertained the average number of days necessary to arrive at complete saturation, that is, when the whole of the fatty body was found in the excrements;—for poppy, almonds, and olive oils, twelve days; for butter, whale oil, and English cod liver oil, decolored or washed, about a month; while pure brown cod liver oil administered for a month, failed to produce any perceptible increase in the fatty matter of the excrements. Whence M. Berthe divides the fatty bodies into three classes, based on their powers of assimilation.

1*st Class.*—Bodies difficult of assimilation:—Poppy, almonds, and olive oils, and probably all the vegetable oils.

2*d Class.*—Assimilable bodies:—Butter, whale oil, white, washed, or decolored cod liver oils, and probably all the animal fats.

3*d Class.*—Very assimilable bodies:—Brown and pure cod liver oil.

VIVIPARITY AND OVIPARITY.

At the American Association Albany meeting, Professor Agassiz made a communication on viviparity and oviparity, which his researches in embryology have thrown great light on. At one time it was believed that those animals which brought forth their young alive, had peculiarities which indicated exclusive relationship. The progress of embryology had proved that there was no such relationship, and no radical difference between viviparous and oviparous animals. In the family of snakes there were viviparous and oviparous genera. The vipers brought forth their young alive, but they were no more like quadrupeds for all that. Among quadrupeds, too, the marsupials, when first born, were carried about by the mother, attached to the nipple, until they were capable of being born again, and standing on their own legs. Placental connection between mother and young was of no considerable consequence. Sharks showed that—some oviparous, though sharks had not many eggs like most fishes, but few and large in proportion to their size, as those of a hen; some viviparous without placental connection—and some with. Yet the mode of development in all three was precisely the same, and was a shark development. There was nothing in it which was allied to that of birds in animals. This had a decided influence on classification. There was no reason for separating the marsupials from other mammals. In each group and different class the relation between the modes of development indicated the real relations of the animals. Animals which were developed in the same manner were sure to be found in the end to belong to the same general division. He would maintain this, that the distinctions founded on complications of structure must be given up for general classification, and confined to the minor distinctions. This was a modification of the system of Cuvier, but he trusted that we should not much longer be compelled to depend on complications of structure for general divisions, but have a principle over which there should be no possibility of discussion.

INVESTIGATIONS RELATIVE TO THE TEREDO OR SHIP-WORM IN AMERICAN WATERS.

The following is an abstract of a paper recently read before the National Institute at Washington, by James Jarvis, Esq., who has been engaged since 1849 in a series of experiments concerning the Teredo, or ship-worm, by order of the Bureau of Yards and Docks. In order to ascertain the best composition for resisting the attacks of the teredo upon wood he painted a number of blocks and boxes with various compounds—some he left unprepared, and some partly painted—and sunk them in Elizabeth river at Norfolk, Va., in the month of April.

I commence about the twelfth of June to examine the blocks and boxes. I have never been able to discover any of the animalcula until about the 20th of June. The examination takes place as follows: The blocks and boxes are taken from their locations and wiped clean and dry of the fucus and barnacle. After a strict examination, and seeing no orifice, I apply a magnifying glass, with which I run over the surface; no hole appearing where a minute animal might have entered, I take a fine shaving off the surface, and then apply the glass again. About the 20th of June, annually, I begin to discover a minute hole; I then cut around the orifice, and see a very small white bulb of almost invisible matter. I remove the atom by lifting it on the point of a fine needle, and place the object under the microscope, where I see developed the Teredo, the Salt-water Worm, perfect in all its parts, and capable of cutting wood for its subsistence. As soon as the shell-fish is discovered, the *crust* which protects the animal can be also seen formed around it. Daily the animal continues to *grow ahead*—I say grow ahead, for these creatures have no locomotive powers; they have neither arms, legs, nor fins, but grow like an oyster; they are a gelatinous substance; their habitations are only in wood. As they grow, they manufacture a calcareous sheathing adherent to the surface of the burrow. The animal grows as that envelope of lime increases in size; but at all times the shell-fish seems to fill the latter. During the summer they grow from six to twelve inches in length, and generally to about three-eighths of an inch at most in diameter, at Norfolk harbor. The worm excavates a tunnel equal to twelve inches in length and three-eighths of an inch in diameter; the wood excavated would be more than a cubic inch, if in a solid piece. The body of the worm and its shelly envelope, if in a solid, would not be half its contents. What becomes of the wood excavated?

I continue to place the blocks in the river until after frost; I have never (so far) discovered any sign of the shell-fish in any of the pieces of wood deposited after the 29th of September. It may be relied on as to the harbor of Norfolk, and I suppose of the Chesapeake Bay and its tributaries, up stream as far as the water is sufficiently salt, that the salt-water worm does not hatch before the 20th of June of each year, and that they do not enter after the 30th of September of each year. The shell-fish being hatched before the 30th of September will continue to do damage until the cold weather destroys them or the wood is broken, and they die or waste away in their alcoves. In the harbor of New York I suppose their development commences some time about the first of July. I am not sure, but I believe that they will keep developing the whole year in the waters as far south as Charleston, S. C., as well as in all the warm climates, the West and East Indies, &c. In the harbors of Boston and Portsmouth, New Hampshire, where we have Navy Yards, the worm does but little injury. Piles driven for any of the bridges crossing from Boston to Charlestown, or crossing the river from Portsmouth to Kittery, Maine, will not be injured in a number of years; the worm in those harbors is small in appearance, like vermicelli threads used in soups. The damage done to piles in those harbors is at high and low water marks; there seems to be a pause when the tide is done running up or down, and at those two points only are these animals mischievous in those harbors. It is said that they are not as destructive near the New York city side, either in the North or East river, as they are on the Brooklyn side or the Jersey side. I have seen wood seriously injured on the Long Island (Brooklyn) side; and have been well informed that the piles driven at the different ferries on the New York city sides (North and East) are but little damaged, compared to the injury done in the Bay betwixt the Navy Yard, at Brooklyn, and the city of Williamsburg, Long Island. One thing is certain: all vessels employed in the New York trade should be protected from these enemies to commerce. I suppose the cause of the worm not developing near the wharves of the city, is the great quantity of filth which must run off into the river, and may act as poison to the animal. In the harbor of Baltimore, as high as the basin, the worm does not appear, and as far down in the harbor as Fell's Point, the animal does but little damage. Rafts of timber remain in the docks all the summer months, without being injured. It is not advisable to risk a vessel's bottom, *unprepared*, as low down as Fort McHenry; and nowhere in the Chesapeake Bay. I believe it dangerous to risk, unprepared, vessels' bottoms in any river or inlet five miles from its mouth, that empties into the Chesapeake.

In the harbors of Boston and Portsmouth, N. H., it is unnecessary for piles to be charred, or to have the bark on, or to have paint and other substances on them; for the timber is secure from serious damage by the shell-fish for twenty-five years, and that will be as long as the timber exposed to open air will continue clear of other decay. I would prepare or leave the bark on all the piles which I should drive in the harbors of New York and Baltimore; for I believe that in a very *dry season* the worm will develope in the harbor of Baltimore below the basin. There have been such seasons. I am sure it will be found to be more safe to have all the piles driven near the wharves of New York city, on the East or North river, *prepared* against the salt-water worm. In this harbor and its vicinity, it is positively necessary that the piles be protected, that is, that they are driven *in bark*, or preserved in another manner as made plain in this communication.

The bottom plank of a ship *unprotected* here, and kept submerged one summer, will be destroyed. The *inside*, that is, the wood *betwixt* the out and inside surface of the plank, will be riddled to a honey-comb in appearance;

and although so riddled, there cannot be seen a hole on the surfaces where the animal *enters*. I underscore the word "enters," because writers say that "the worm *enters* into the minute pores or perforations of the wood." It may be so—these animals may *enter;* but I doubt it, and I doubt that any man, living or dead, ever saw one of these animals "excluded from the egg." As soon as they are brought forth (no matter how), they commence their ravages. On the surface of the wood exposed there is never a visible sign of an orifice whilst the wood is wet. Mark this: the sixteenth of an inch from where we may say is the embryo, they have grown to a size in diameter equal to the distance *grown ahead.* These animals have a head or bivalved auger, two parts working on a hinge, something like small pearl cups with fine cutters (teeth), that look under the microscope well adapted to the destructive purpose, were the substance a custard to pass through, instead of its being, as it often is, a hard pine knot. How strange it is that these creatures will perforate the hardest wood; I often believe that they have a power (perhaps a peculiar acid) with which the hardest substances can be softened and perforated.

These destructive animals have posteriorly two minute tubular inlets, through which the water as well as the oxygen can be drawn. When a vessel's bottom is examined that has been prepared against the attack of the worm, by exposing the bottom to the sun so as to *dry it*, hundreds of these tubes can be seen thrust through the surface, that were invisible when the bottom plank was first cleansed of the weed. It is to get a supply of water to moisten them, that they make use of their membranous tubular appendages.

One authority says, they were originally brought from India. I am almost certain that the aborigines of this country had to take their canoes out of the water to preserve them from their ravages. These animals, with all their destructive powers, never bore through a ship's bottom plank—never pass through it to open space. The empty boxes which I have had in the river prove this beyond all doubt: more than one hundred boxes have been examined, and not an orifice to be seen on the inside of the box, and no place of entering on the outside surface; all the parts that are injured by the worm, are *betwixt* the out and inside surfaces. If two pieces of wood are fitted together close, these mollusks will pass on as if it were a solid block. They are the secret agents, the cause of many ships being "in the deep bosom of the ocean buried." So far as I have seen, there is no wood, bitter or sweet, except the cabbage-tree, that the worm would not attack or *enter.*

I have prepared many of the empty boxes by painting them, leaving a small part, the edges, *bare*, purposely to invite attack; and have never failed to have the animal in abundance. I have prepared rods not more than one fourth of an inch in diameter, with different kinds of paints, leaving one end bare; the worm would appear at the *bare* end, and bore on to the other end of the rod, one foot in length.

The boxes prepared with paint have not been damaged, except from the injury commencing at the select part left *bare* or unprepared. The boards of the boxes were generally three eighths of an inch thick; by holding the box up to the light after the death of the animal, the meandering of the worm can be traced *very* close to the outside, and as close to the inside surface; but never passing through into the water, or to open space inside of the *surface.* As they progress through the wood, they take care to keep in separate cells; and how strange it is, when their mouth-pieces come to an inconceivable thinness of the outside surface, or very near one of their species, they "try back"—turn from the opening they would cause by interfering with their neighbor's habitation.

Many vessels proceed to sea having parts of their bottoms destroyed, which is unknown to the captain, owners, or underwriters. One nail-hole in a sheet of copper neglected, having no nail driven in to stop the vacancy, might be the cause of the loss of a ship; for wherever the water has access to the wood, certainly there the worm will be found. A ship with a copper bottom may be in Norfolk harbor, and her bottom supposed to be perfect; at the same time one or two sheets of copper may be off, and the worms may have completely destroyed the *inside* of the plank that is betwixt the inner and outer surface. This perforated part of the bottom may strike against a hard object at sea, the plank be broken in, and the ship lost. I do not doubt the above has frequently been the case. Where a ship's bottom is not protected with copper, frequent search should be made for these animals, by which many lives might be prolonged and valuable property saved.

It has been observed by a writer, that these animals do a great benefit to commerce by destroying the floating wrecks at sea, and sunken logs in harbors.

In specimens of wood which are left in the river for more than one season, there will be found, after the winter has passed away, the animal alive in many of the cells. There will be seen also many cells without the animal: after its death the shell gets broken, and the animal (a mere paste) is washed away by the waters.

I believe I have said enough of these enemies to the commercial world, to all foundations requiring piling, and to the wood material generally, wherever kept in the salt water in a temperate climate.

In regard to the preventives against the ravages of these destructive creatures, I will offer a few remarks.

Tredgold says that they never touch bitter wood. I tried all kinds of wood used in building; they bore all. He also says, that charring the surface is not found to be of any use. He is certainly mistaken: no worm is found in charcoal; it is too pure. The charcoal must rub off before the worm can do damage; a pile may remain submerged for a century, if the charcoal part be perfect. Should the charred part be worn off by the ebbing and flowing of the tide, and the wood be subject to the action of the water, the shell-fish is sure to appear. One great neglect in charring is, that the heat required to burn the wood to charcoal on its outside surface will cause a disruption, a fissure, that the fire does not reach; this crack remains uncharred, the water reaches the naked wood, and the terrible animal appears. Fill these fissures or cracks with hot coal tar, and the piles will be safe as long as the charring is perfect, and the coal tar does not pass off: or you might fill the fissures with two or three coats of white lead, white zinc, red lead, tallow, or any good strong-bodied paint, and the piles would be secure as long as the charring and paints remain uninjured. Sheets of copper are used by all the mercantile and naval world as the very best article. It lasts longer and is cheaper in the end than any other metallic substance. Iron soon corrodes and becomes loose, the barnacle and sea-weed fasten on it much more than on copper; sheets of zinc have been used, but they soon wear away; lead is too heavy.

Any strong-bodied paint, such as white zinc, white or red lead, verdigris, Ross's metallic, Edwards's red—three coats of these paints will secure the bottom of a ship one or two years from the salt-water worm. Three coats of hot coal tar and three coats of hot naphtha, applied to dry wood that the pores may be filled with the liquid, will keep the animal off, provided these substances are not rubbed off so as to leave the wood naked. It is quite possible that, after a year or two, the paint would become insipid, and come off in sheets or scales—familiarly called "scaling off;" whenever this takes place, the wood is in danger. The coal tar and the naphtha may, in a year or more, pass off by being dissipated, drawn out by the flowing and ebbing tides. It is certain, that as long as the above substances retain their purity, and can be kept *on* the wood, the wood will be perfect from the water; and I am sure the worm cannot develope itself, unless the water reaches the wood.

It has been suggested, that if wood were first saturated with corrosive sublimate and then well painted, it would be an excellent preventive. It would most certainly protect the wood from the ravages of the worm; but it would be found to be quite troublesome to saturate the bottom plank of a large ship before or after it was put on the frame of the ship. *Three* coats of white zinc paint would have the same effect to keep the animal from the wood, as the poison and *two* coats of white zinc paint.

The bark of all trees, as long as it can be kept on, is positively one of the best securities for piles, except copper: copper is superior to all metals or substances known as regards protection from the ravages of the salt-water worm. White zinc paint is superior to copper in keeping the coral deposits off of the bottoms of ships. The deposits in the West Indies are in the form of vegetation, viz. trees with their branches, all tubular, and containing insects. In Norfolk harbor, the common barnacle and often the oyster are the deposits. These accretions are great hindrances to the sailing of ships: when a ship's bottom is filled with sea-weed, or the common barnacle, or any coral formation, the sailors say the ship is "very foul" and cannot sail fast.

To preserve piles, I would drive all I could with the bark on. There is no danger whilst the bark is kept on. The barnacle on *piles* does no injury. Charring is excellent, provided the fissures are filled with *hot* coal tar, or some other substance of equal virtue, such as the paints already named. White zinc paint will be found excellent to keep the shell-fish from the wood where piles may have the bark broken off before being driven.

I believe that three coats of white zinc paint are next best to copper as a preservative against the ravages of these destructive evil-doers.

THE UTILITY OF BRAN IN BREAD, AS TENDING TO AID INTESTINAL EVACUATIONS.

It appears certain that constipation is more frequent than formerly. One great cause of this is our mode of *sifting corn*, the result of which is, the extraction of all the bran contained in the flour, when done, as it now is, to 20 or 25 per cent., instead of 10 or 12 per cent., which used to be the amount removed twenty years ago. M. Mouriet considers, that in the internal part of the pellicle there exists a ferment which renders starch fluid, and which has the property of converting this substance into sugar, which otherwise would be rejected by the intestines as unassimilable. Thus, if bread in which the bran is left is not so nourishing as bread which is deprived of it, this inferiority is compensated for by qualities which are important with respect to digestibility; it is also more rapid. Moreover, whether from its fermenting properties, or by a mechanical effect of the ligneous matters which it contains, it has the effect of increasing the peristaltic movement of the intestines, and consequently of *aiding their evacuations.* Bran has at all times one inestimable advantage over medicinal drugs: it does not fatigue the digestive organs, and frustrate the intestinal contraction, which is, to the degree desired by nature, necessary for the regularity of the functions. Finally, it has not the disadvantage of medicinal substances, of losing its efficacy from habit, and thus requiring increasing doses to keep up its action. Liebig says, that the separation of bran from the flour *is rather injurious than useful to nutrition.* In many parts of Germany, and almost all over France, the peasantry use the bran with the flour, and there are no people whose digestion is in a better state. It should be remembered, too, that by using unbolted flour for bread, we increase the product at least a fifth or sixth.—*Journal de Chimie Medicale.*

MORTALITY FROM CHLOROFORM.

It appears that the mortality in the London hospitals has increased since the introduction of etherization from 21 to 33 per cent.; or, to vary the expression, instead of amputation being fatal in a less proportion than 1 in 4 of those operated upon, it now proves fatal to 1 in 3. Is not so enormous a sacrifice of life too high a price to be paid for anæsthesia, even granting that this cannot be otherwise obtained with perfect safety? Is life to be held as nothing when compared to pain?—*Medical Times and Gazette.*

ON THE CAUSE OF THE FLUIDITY OF THE BLOOD.

One of the most valuable papers brought before the British Association at its last meeting, was one by Dr. Richardson, on the cause of the fluidity of the blood. The point of Dr. R.'s researches consisted in the discovery of the volatile alkali, ammonia, as a constituent of the living blood, and its escape from blood abstracted from the body. The author related a long series of demonstrative experiments, all proving not only that ammonia was present in the blood, but that upon its presence the solubility of the fibrine, and therefore the fluidity of blood, depended. The peculiarity of this demonstration of the cause of the fluidity of the blood is, that it explains the different hypotheses which have previously been offered on this question, and shows in how far these hypotheses have approached or fell short of the truth. In concluding his paper, Dr. Richardson pointed out that ammonia, in combination with carbonic acid gas, is a constant constituent of the air expired in the breath. The presence of ammonia in the animal economy, and its evolution in respiration, was of interest in that it connected more closely the limit that exists between the animal and vegetable worlds. But the subject was of the greatest importance in relation to the causes, the nature, and the treatment of various diseases.

ON THE PROPAGATION OF OYSTERS.

Mr. T. C. Eyton, in a report to the British Association at its last meeting, on the oyster beds and oysters of the British shores, stated, that he had found, on examining the spawn of three oysters, on a rough calculation the number of young was about three millions; they were semi-transparent, with two reddish elongated dots placed on each side, behind the ciliæ, which were in constant motion, and they are exceedingly tenacious of life. From observations made, it appears that the month might be advantageously altered in many beds, so that the markets might be supplied throughout the greater part of the year. The depth of water is the chief cause of the different time of spawning. The common opinion that oysters spawn in masses is erroneous; and for the benefit of oyster-eaters, it appears that they are best for the table out of shallow water and at the entrance of rivers, as they feed quicker in such situations.

ON THE DIŒCIOUS CHARACTER OF THE ROTIFERA.

Mr. Gosse, in a communication to the Royal Society, shows that Ehrenberg's conclusions respecting the hermaphrodite nature of the Rotifera are not borne out by facts. In 1848, Mr. Brightwell announced his important discovery of separate sexes in a Rotiferous animal, since named *Asplanchna.* The diœcious character has been subsequently extended from a species to a genus, and from the various analogies which have been discovered between them and other animals, Mr. Gosse assigns to the Rotifera a zoological position among the articulata.

CURIOUS ANATOMICAL COLLECTION.

M. Serbes, of the Jardin des Plantes, Paris, availing himself of the opportunity which the war in the East afforded of collecting a great variety of types of human heads, until now unrepresented in the museums of Europe, directed the persons in charge of the French Hospitals at Constantinople to make the desired collection and send it to him. These heads were preserved, just as they were severed from the body, by means of a new process discovered by M. Roux, of Paris. The process consists in placing around the dead matter—first, earth on which sulphuric acid has been poured, and with which flowers of sulphur have afterwards been mixed; and secondly, after the earth has been placed around the object to be preserved, in pouring over the earth a certain quantity of chloroform. The case must be in lead and hermetically sealed. An interesting fact connected with the process is, that it is not only useful in preserving dead bodies in hermetically sealed cases, but after remaining a certain time in this preparation, they resist the action of the atmosphere.

ARTIFICIAL PRODUCTION OF FISH.

M. Coste, the French ichthyologist, communicated a curious and important fact to the Academy of Sciences of Paris in its last sitting—namely, that in the cisterns for the artificial production of fish which he has established in the Collège de France, a female trout produced by the artificial process, and aged two years and a half, deposited in a few days 1065 eggs, and that they were fecundated with perfect success, and with comparative little loss, by the milt of a male trout, aged nineteen months, also produced artificially. This is the first instance on record of artificially-produced trout having reproduced, and having done so, not in a river or stream, but in a mere cistern in which the water is only renewed.

BRINE A POISON.

M. Reynal, of the Veterinary School at Ayort, France, has communicated to the Imperial Academy of Medicine the results of investigations upon the poisonous properties acquired by brine, after a considerable length of time, in which pork or other meats had been salted or pickled. The poisonous properties, he states, are acquired in two or three months after the preparation of the brine, and its use then, mixed with food for any length of time, even although in small quantities, may produce death. A simple solution of salt in water, after the same length of time, does not produce the same effect. The poison acts as a local irritant, exciting violent intestinal congestion and inflammation. It likewise increases the secretion of the skin and kidneys, and exerts a direct effect upon the nervous system, giving rise to trembling, loss of sensation, convulsions, &c.

VIVIPAROUS FISHES.

At a recent meeting of the Boston Society of Natural History, Prof. Agassiz stated that, a few years since he had described a new family of fishes, *Embiotocoidæ*, in which the mode of reproduction is viviparous. He had now to announce the fact, that, in another family, and one well known, there is likewise viviparous reproduction. He had recently been examining the ovary of the common haddock, and had found the ova already passed the stages of segmentation. He had not yet been able to examine them during the latest periods of development, but he had no doubt that the embryos were developed within the ovary. He thought, however, that the young might be brought forth in some kind of an envelope, and thus escape observation. In the cod, whiting, and American hake, the ova likewise undergo development in the ovary. Prof. Agassiz was informed by the fisherman who had supplied him with the specimens in which this discovery was made, that he had for a long time supposed that the young were formed in the parent.

Prof. Agassiz had been endeavoring to find homologies of development in all animals of the vertebrated type, and had succeeded in tracing them so far as to be able to distinguish between vertebrata and invertebrata in the earliest stages of development of the egg.

The President remarked that every new instance of ovarian impregnation was of great importance. The most recent researches go to prove that the seminal fluid comes in direct contact with the ovum, and perhaps enters into its substance; but in Anableps, the ovum is surrounded by a membrane which would tend to prevent any such entrance.

Prof. Agassiz observed that he considered fecundation as a series of acts rather than a single act. In Chelonians, the circumstances under which the eggs are developed, would lead to the inference that an impulse is first received from the male, and then that four successive copulations in four successive years, twice a year, are necessary before segmentation takes place in the egg. In the haddock, ovarian gestation has this physiological import, that it shows that what is a normal condition in one animal of a certain type, may be abnormal, and occur only exceptionally in another animal of the same type, as in man and other of the higher forms of vertebrata.

DISTRIBUTION OF AMERICAN TURTLES.

At a recent meeting of the Boston Society of Natural History, Prof. Agassiz stated, that he had been engaged in an investigation into the Geographical distribution of the Turtles of this country. For a correct determination of specific differences, it became necessary to collect specimens from all parts of the country as extensively as possible, and he thinks he has obtained specimens of nearly all the species existing in North America, and that he has been able to trace their geographical distribution very completely. The results to which he has arrived show this fact, that several species which have been supposed identical throughout their whole geographical range, are now demonstrated to be really distinct; whilst others which have been described as different species, the young alone in some instances having served for description, have been found to be one and the same. He particularly called attention to the danger of describing species solely on theoretical grounds as different because they inhabit different parts of the world, or as identical from general resemblances. Dumeril and Bibron in their work on Herpetology, and others, have attempted to identify marine turtles of different waters without sufficient authority. Prof. Agassiz had taken particular pains to enquire about the Sphagis or Leather-backed Turtle, which is found from the West Indies, northward, and which has been taken at Cape Cod. This animal has been said to inhabit the Mediterranean, but after a thorough investigation he can find only seven or eight instances recorded of its having been found there. The museum at Salem furnishes an opportunity for distinguishing between the Imbricata of the West Indies and that of the

Indian Ocean, which have been considered the same. Holbrook describes the Tryonix of Georgia as existing in the Northern Lakes, and he traces the exact course by which it could ascend along the coast and up the Mississippi river to the lakes. But Prof. Agassiz finds that there are four different species in the United States, three of which are to be included in the one species of Holbrook, and that each species has its own limited locality.

The Chelidra, or Snapping Turtles, have the most extensive geographical range of any of the chelonians. The snapping turtle of Massachusetts is found in South Carolina, Alabama, Louisiana, Missouri, and even at the head waters of the Osage.

Of the family of Emydæ, E. Blandingii is the true type. The swimming Emydæ are either southern or western species; there are none in New England except those which have only a limited power of swimming.

Emys Oregonensis was described by Nuttall as existing west of the Rocky Mountains. Prof. Agassiz doubts its existence west of the Rocky Mountains, because no turtles have been found in those high regions lying between the Rocky Mountains and the Sierra Nevada. Upon the Alleghanies turtles have been found at a height of eleven hundred feet only, and there are no indications of their existence above this height. He has had two specimens from localities east of the Rocky Mountains, one of which was brought from Minnesota. He thinks Mr. Nuttall's specimen must have come from this side of the mountains.

Prof. Agassiz concluded that there is no general law regulating the distribution of the chelonians of North America. They are distributed through four grand divisions of the country, a north-eastern, a southern, and a Pacific range. The facts of their geographical distribution are now well established, but the reasons are by no means evident at present. The probability is, that different individuals of the same species of animals are adapted, by peculiar organizations, to different climacteric influences, and that there is no general law of distribution for which physical agents can account.

OBSERVATIONS ON DEAFNESS.

Granville White, Esq., communicates to the New York Post the following observations on deafness:

Many years ago, while pursuing an investigation of a psychological nature, we obtained the discovery that the sound which is produced by inserting the fingers within the ears, or by covering them with the hands, is occasioned by the circulation throughout the body, and is conveyed to the hearing through the hand. Should another individual close our ears with his hands, the rumbling sound which is obtained proceeds from him. No lifeless body can produce the same, unless it acts as a conductor from the hand or person who supports it. Hence it may be determined, by a reference to the organ of hearing, when the blood ceases to flow and life becomes extinct.

By inserting a cork within the ear—inclining the head for the purpose—with no other support than the ear's orifice, a very slight sound only can be obtained, which is caused by its contact with the sides of the orifice, and thence conducted to the tympanum; but, by pinching the cork with the fingers, the buzzing will be increased to such an extent as to furnish sufficient evidence of the truth of the theory. The same rumbling is sometimes observed in yawning; oftener, however, when the yawning organs act with the mouth closed; also, to a slight extent, in swallowing. By the action of these organs, the curves of the avenues to the drum become distorted—lose their natural forms—and the sides of the orifice are thrown into its own funnel, which conducts the sound. We can, at pleasure, produce the buzzing by a contraction of the muscles in the region of the ear, deforming thereby the channel to the drum.

Being fully satisfied of the validity of this theory of the sound of circulation, and aware that many persons, partially deaf, hear an incessant rumbling, I am convinced that it is occasioned by malformation of the orifice, or funnel to the tympanum—the projection of its sides causing the obstruction of other sounds, and conveying its own buzzing of circulation, the same as from the inserted fingers. An excess of ear wax may, however, produce a similar effect. Persons of deficient hearing can learn whether it is an orifice defect by the expansion therein of a pair of small pincers.

ACTION OF SUGAR ON THE TEETH.

M. Larez, of France, in the course of his investigations on the teeth, has arrived at the following conclusions:—

1st. Refined sugar, from either cane or beets, is injurious to healthy teeth, either by immediate contact with these organs, or by the gas developed, owing to its stoppage in the stomach.

2nd. If a tooth is macerated in a saturated solution of sugar, it is so much altered in the chemical composition that it becomes gelatinous, and its enamel opaque, spongy, and easily broken.

3rd. This modification is due, not to free acid, but to a tendency of sugar to combine with the calcareous basis of the tooth.

ON THE UNITY OF THE HUMAN RACE.

In a discussion which incidentally arose on this subject at the last meeting of the American Association, Prof. Agassiz made the following remarks:—

He regretted that this subject could not be discussed without seeming to many to involve a religious prejudice. But he was bold to affirm that differences exist between the races of men, greater than do exist between animals of different species. Take the family of monkeys, our next cousins. The monkeys constitute a family—all monkeys sharing the same structural endowments, capabilities and propensities, even as men share theirs. The monkey family is a unity, even as the human family is—and no more so. I *never have denied the unity of the human family;* on the other hand I insist upon it. Its unity is recognised in its physical, intellectual, and moral endowments—the three points of superiority over all other animals that constitute its indivisible unity. And there is the same unity in the monkeys; in them the same identity of structure, instincts, wants.

And yet the Orang, the African type of monkey, is so different from the Chimpanzee, the Asiatic type, that zoologists make them two distinct genera.

Now between the races of men there is a greater difference than between the Orang and the Chimpanzee. For instance, nature seldom causes the relative position of the upper and lower teeth to differ in the individuals of the same genera; yet the teeth of the races of men do differ more than the teeth of these two genera of monkeys. That word species very much distracts us, so loosely is it used. Let us not quarrel about words, however. Let us study conscientiously the differences between the races, and when they are found to be so great that one race positively could not be derived from the other, then it is time enough to enquire how they originated. In immediate prospect, however, for our investigation is the question of the natural bounds of the races. There are facts enough in the animal world to justify the expectation that we may *then* find that there were independent and repeated origins for men.

EXTRAORDINARY FLIGHT OF THE CARRIER PIGEON.

In 1850, on the 6th of October, Sir John Ross despatched a young pair of pigeons from Assistance Bay, a little to the west of Wellington Sound, and on the 13th of October, a pigeon made his appearance at the dovecot in Ayrshire, Scotland, from whence Sir John had the two pairs of pigeons which he took out. The distance direct between the two places is about 2000 miles. The dovecot was under repair at this time, and the pigeons belonging to it had been removed; but the servants of the house were struck with the appearance and motions of this stranger. After a short stay it went to the pigeon-house of a neighboring proprietor, where it was caught, and sent back to the lady who originally owned it. She at once recognised it as one of those which she had given to Sir John Ross, but to put the matter to the test, it was carried into the pigeon-house, when out of many niches it directly went to the one in which it had been hatched. No doubt remained in the mind of the lady of the identity of the bird.

By what extraordinary power did this interesting bird find its way, and by what route did it come?

RESISTANCE OF INSECTS TO INFLUENCE OF COLD.

Dr. Wyman, at a recent meeting of the Boston Society of Natural History, stated that he had examined chrysalids of the common mud wasp, a species of *pelopœus*, and found that they were not frozen during the coldest weather. On the morning of February 7th, when the thermometer had been —18° F. and had risen to about —8° F., they were still unfrozen, and when removed from their pupa cases, made obvious muscular motions. The pupa preserved its usual transparency and flexibility; when crushed upon the surface upon which they rested, the fluids of the body instantly became opaque and were congealed. The question naturally presents itself, as to the source of the heat which enables them to preserve their temperature, when exposed to so low a degree of cold. The non-conductors by which they are surrounded, consist of a casting of mud, and within this a tightly woven, but thin, silky cocoon. It would seem that so small a body, exposed to cold so intense, must have an internal source of heat. He had also examined the eggs of the moth of the cankerworm, and found their contents unfrozen.

ASTRONOMY AND METEOROLOGY.

NEW PLANETS DISCOVERED IN 1856.

The number of planetary bodies belonging to the solar system has been increased during the past year, by the discovery of five new asteroids. The whole number of the asteroids at present date is forty-two.

The thirty-eighth asteroid, appearing as a star of the tenth magnitude, was discovered by M. Chacornac, at Paris, on the 12th of January. It has received the name of *Leda.*

In announcing this discovery to the French Academy, M. Leverrier remarked that he was now convinced that a large number of small planets exist between Mars and Jupiter, and that before 1860, probably as many as a hundred will have been detected.

On the 8th of February, M. Chacornac also discovered the 39th asteroid, which appears as a star of the 9th magnitude, and has been called *Lœtitia.*

On the 31st of March, M. Goldschmidt at Paris, discovered the 40th asteroid, *Harmonia.* It appears as a star of the 9-10th magnitude.

On the 22d of May, M. Goldschmidt discovered the 41st asteroid, *Daphne,* appearing as a star of the 11-12th magnitude.

On the 23d of May, the 42d asteroid, *Isis,* was discovered by Mr. Poyson, of the Radcliffe observatory, Oxford, England. It was then rather brighter than a star of the 10th magnitude.

ON THE ORIGINAL ASTEROID PLANET.

In a paper read to the American Association, Albany, Professor Alexander succinctly re-stated the principal features of his hypothesis advanced last year, viz. that there was originally but one planet between Mars and Jupiter, and that this, instead of the ordinary form, approximating closely to a sphere, had the shape much like that of a very thin wafer, the equatorial diameter being enormous in comparison with the polar. In one determination of the equatorial diameter he made use of the mass of the planet derived from a new relation of masses and distances, which itself seemed to be a consequence of the nebular hypothesis. Four other determinations were, however, given in that connexion; but that which included the most extensive relations was also the most consistent with other and independent results.

The other method of obtaining the equatorial diameter consisted, as before, in determining and applying the difference of the velocities of those asteroids which approach most nearly to one, and live in their aphelia and perihelia respectively.

The two independent results were as follows:—

Equatorial diameter . . . . $\left\{ \begin{matrix} 75{,}094 \\ 63{,}846 \end{matrix} \right\}$ miles.

The polar diameter must have been very small, as it was independent of the density. With a density equal to that of the earth, it would be only from about $8\frac{1}{2}$ to $11\frac{1}{2}$ miles. No less than eleven facts were stated, which this hypothesis would reconcile. The recently discovered asteroids had the position of their orbits represented, and the inclination of the orbit of the original planet was deduced anew, and found to be about 4 deg. 20 min.

THE ASTEROIDS.

The following paper has been communicated by Daniel Vaughan, Esq., of Cincinnati: Of the planets already discovered between Mars and Jupiter, none move in orbits having an eccentricity greater than $\frac{4}{15}$, nor less than $\frac{1}{15}$, of their mean distance from the sun. In the orbits of the eight large planets of the solar system, the ratio between the least and greatest eccentricities is a little over thirty. If we leave out the orbits of Mercury and Venus, the ratio will be nearly eleven. In the Saturnian system, the ratio of the least and greatest eccentricities exceeds 20, while in the asteroids, which comprise five times as many members, the ratio is less than four.

The total absence of orbits of small eccentricities in the asteroidal region, is fatal to the idea, that these small bodies originated in the destruction of a primitive planet by centrifugal force; and neither this, nor the hypothesis of Olbers, can account for the great inclination to the ecliptic of the orbits of Pallas, Euphrosyne, Phocea, Hebe, and Egeria. An impulse capable of deflecting any of the fragments of a shattered world 25 degrees from the plane in which it previously moved, should have imparted a hyperbolic orbit to those fragments which were projected in the direction of its motion at the time of the supposed catastrophe. The fragments thrown in an opposite direction, with the same force, should, at their perihelia, approach as close to the sun as the planet Mercury. Had the asteroids been produced by the destruction of a single world, the ellipses which they describe should exhibit the greatest discrepancy in size and eccentricity, and should intersect the orbits of the nearest and most distant members of the solar system.

These difficulties can be only removed by supposing a collusion of two planets once occupying the region beyond Mars. In such an event, it is evident that the fragments of both worlds should fly into space, in a plane perpendicular to the line in which both moved, when the terrible encounter was at hand. The fragments should, accordingly, have the magnitude and eccentricity of their new orbits confined to a very limited range, but would be permitted to deviate, to the greatest degree, from the ecliptic, or from the plane of their primitive motion. It is probable, that so violent a mechanical action would produce heat enough to bring the fragments into a molten condition.

There is reason to suspect the existence of two groups of asteroids in the Saturnian system. Judging from the mean ratio which subsists between the distances of his (Saturn's) satellites, it would seem that there is room for two between Rhea and Titan, and for two others between Hyperion and Japetus. If these vacancies are not filled by future discoveries, they must afford strong grounds for believing, that two pairs of secondary planets have been destroyed by mutual collisions, and converted into two groups of asteroids.

PARALLAX OF THE FIXED STARS.

M. Struvé, the astronomical director of the Pulkowa Observatory, Russia, in his recent annual report says:—In my astronomical pursuits the parallaxes of fixed stars have taken a prominent part during the last year, and I think I have made a considerable progress in these researches. Now that the methods of observation are entirely fixed, I am quite sure that if there is a difference of parallax of $0''\cdot1$ between any couple of stars situated at a distance less than $5'$ from another, four observations made at the epochs of maxima and minima will be entirely sufficient to prove its existence and to define its amount within very narrow limits.

A short review of my observations shows that μ Cassiopeiæ has a parallax of more than $0''\cdot3$, η Cassiopeiæ of more than $0''\cdot2$, and Capella of between $0''\cdot1$ and $0''\cdot2$. For all these cases, the results obtained by the angles of position agree remarkably with those furnished by the distances.

The observations of other stars, namely, of α Tauri, α Aquilæ, α Andromedæ, and α Cassiopeiæ, are about to be closed; but to guard me against any pre-occupation, not even the first step has been made for the reduction of these observations.

RECENT OBSERVATIONS ON THE SUN.

M. Leverrier, in offering a series of tables relative to the sun at a recent meeting of the French Academy, remarked, theory alone does not suffice to represent the total of observations made during the last century, not even if account be made of the influence of all the known masses of our planetary system. "I think I have ground to conclude," says Leverrier, "that besides the movement whose cause is known to us, the solar perigee undergoes an oscillation whose amplitude is 60, and the period 66 2-3 years. When we do not stop at the observations of 1755, 1801, and 1845, but consider besides the intermediate determinations, it will be seen that the greatest equation of the centre also presents a slight secular variation; and further, that the secular variation of that element cannot be entirely produced by the masses at present admitted into the reckoning."

OBSERVATIONS ON SATURN.

At a late meeting of the American Academy, Mr. W. E. Bond exhibited some diagrams of the planet Saturn, and mentioned various facts concerning it; namely, that the inner edge of the rings is constantly approaching the planet itself; that the ball is seen through the rings, which are consequently transparent; that the color is different in different parts of the rings, the equatorial regions being white, the temperate region reddish, and the polar bluish. He also mentioned that the shadow of the ball upon the ring can be seen on both sides of it, being on one side rather faint, but on the other quite decided. This anomalous appearance he first noticed in October, 1852, and as yet he could give no satisfactory explanation of it, nor of the singular shape of the shadow, the convexity of which was towards the ball, instead of from it, as it might be expected to be. His observations were made with the great Cambridge Refractor in the years 1852, 1854, and 1855.

Prof. Pierce, at the American Association, in a discussion on the constitution of Saturn's ring, observed, that the analogy between the ring of Saturn and the belt of the asteroids, was worthy of notice. It was to be remembered that in order to have Saturn's ring remain continuous and flattened into so thin a sheet, the radial or vertical tide in the ring produced by the satellites must be neither too large nor too small. But if the solar system were formed according to the nebular hypothesis, the tides in the remaining mass, after the formation of Jupiter, must have been, from his great size, extraordinarily great, and have produced a different sort of ring at the distance of the asteroids from those produced for the other planets.

Mr. Vaughan observed that the orbits of interior planets would render those of exterior ones circular, as grinding a stopper in the neck of a jar rendered it circular.

ON THE NEBULAR HYPOTHESIS.

The following is an abstract of a paper read before the American Association, Albany, 1856, by Prof. Alexander, on the above subject: Prof. A. observed that this hypothesis had long borne the reproach of atheism, but borne it unjustly. It is not necessary in this hypothesis to substitue blind force for intelligent arrangement. Any theory must fail which would substitute anything for God's wisdom and power. Go back with this theory to a period so remote that even geology never dreamed of it, and ask how did it happen that a gaseous ring rolled itself up into a world so exactly adapted in the length of its years and its days, its seasons and its physical constitution, to the abode of intelligent races? How did it happen, he asked it reverently, but because God reigns from everlasting to everlasting, and because God is true? Laplace's hypothesis is no more atheistic than the law of gravity. It has been, it is true, enormously abused and made use of for atheistic purposes; but we have yet to learn that what has been abused is thereby made untrue, and we shall be slow to take that lesson on the bare authority of those who, upon their own showing, are but the descendants of monkeys improved. But it is said, the foundation of Laplace's theory has been knocked away from under it; that the nebulas seen by Herschel, by which the hypothesis was suggested, are all resolved by Lord Rosse's telescope. But this is not the fact. But suppose it were, does it follow that when the thing which suggests a theory falls the theory falls with it? Columbus started for the Western World in confident expectation of reaching the Indies; did he, because he did not find the Indies, find nothing? If we reason as those do who think the resolution of nebulæ disproves the nebular hypothesis, we must say that this continent does not exist. But we need care nothing for nebulæ so long as comets and the zodiacal light, and the phenomena seen at the eclipses of the sun, prove to us that there is nebular matter about our solar system. We do not serve the cause of truth by condemning so beautiful a theory unheard, and giving it the name of atheistic. Prof. Alexander thought that Laplace himself died believing in a personal Deity. He then proceeded to a discussion of the relative densities and distances of the planets, and from these and other phenomena drew, by mathematical reasoning, confirmations of the hypothesis of Laplace.

ON THE SURFACE OF THE MOON.

Prof. Phillips, of England, in the course of some remarks at the last meeting of the British Association, on *the Lunar Mountains*, observed that daily experience showed that the more their telescopic power was increased, the less circular appeared the lunar craters, and the less smooth the surface of the moon. All was sharp and irritated—a perfect representation of its past history. On the much mooted question as to there being traces of the action of water on the surface of the moon as now presented to us, the Professor said that at one time he believed that there was no trace of water to be seen, but he confessed that more recent observations, particularly those made with Lord Rosse's telescope, shook his belief in that opinion.

At a subsequent meeting, the subject of the physical character of the moon's surface being under discussion, Prof. Phillips commented on the continually growing exactness with which the telescope was applied to the delineation of the lunar scenery, which, to inferior instruments, appearing smooth and even, revealed itself to more powerful scrutiny as altogether uneven, mostly rugged land, deeply cut by chasms, and soaring into angular pinnacles. The so-called seas, under this scrutiny, appear destitute of water, and their surface, under low angles of incident light, becomes roughened with little points and minute craters, or undulated by long winding ridges of very small elevation, comparable to the gravel ridges of Ireland and Scandinavia. On the question thus and in other ways raised for discussion, whether the moon, now devoid of water on the face she presents to us, contains traces of ancient watery movement, Prof. Phillips called attention to the numerous straight rifts and winding "Rillen," as the Germans call them, which, to clear telescopes only, reveal themselves in many tracts of the lunar land. And turning to Gassendi, the mountain which, in connection with Mare Humorum, had been allotted to himself for his survey, according to the system adopted at the meeting of the Association in 1853, he described its long encircling wall, broken through towards Mare Humorum, duplicate in one part, crossed by three deep narrow clefts in another, and partly interrupted by a great oval crateriform appendage, which is broken down or deficient on the side against the great crater of Gassendi. Here, concentrating to, or diverging from, the smaller crateriform appendage, are seen, but only with good instruments, many branching ridges and hollows, whose stems are towards the small crater, and whose extremities reach towards the mountains in the middle of Gassendi. If these are branching tracts of volcanic matter poured out from the smaller crater, their slope will be from it; if they be due to alluvial action, their slope will be towards it; and this is a test which, perhaps, can be accurately applied in this situation, by carefully delineating the shadows which fall in morning and evening from the lofty walls of the crater.

Mr. Nasmith, on the question of ancient traces of water in the moon, maintained the negative, and expressed his conviction that all the appearances sometimes relied on for the affirmative were explicable by considerations of the peculiar character of the old volcanic operations on the moon.

SOLAR SPOTS.

The following is an abstract of a paper communicated to the American Association on the above subject, by Dr. Peters, of Denmark:—

His conclusions, he said, were drawn from observations made in Naples, in the year 1845–6. He and his collaborateurs had computed eight hundred and thirteen heliographic places of two hundred and eighty-six spots. They had ascertained that the spots were not invariably attached to the sun's surface, but that they had motions of their own. These motions were a general tendency to move towards the equator, and where a new spot broke out in the neighborhood of another, the old one moved away from it as if it were pushed away. New spots generally broke out to the east of old ones, and had a motion towards the west, and the motions in longitude were far more considerable than those in latitude. These motions were in some instances at the rate of three or four hundred miles in an hour. Two zones of the sun's surface were particularly fruitful in spots; the maximums occurring at the parallels of 21 degrees of north latitude, and 17 degrees of south. Instances had been noticed in which spots reappeared after an interval of two or three hundred days, although there was one difficulty in determining this accurately arising from the uncertainty of the time of rotation. Since spots arose from invisible points at the exact moment of their origin, they could not be studied.

The first indication which the telescope revealed was a sort of bubbling agitation in the luminous layer. To this succeeded a small spot, which rapidly attained its full size—almost always in the course of a day. They remained in this, the vigorous epoch of their life, with a well defined penumbra of regular and rather simple shape, for ten, twenty and sometimes even for fifty days. But at last their time came. Their margin had always been slightly notched, and soon the notches grew ominously large and deep, penetrating far into the mystic realm of darkness, while hostile columns of light arose as if by magic, occupying the centre. Deeper and deeper grew the invading notches, until, at last, electric flashes passed between two of the more prominent, across the disc. The victory was gained, the centre pierced, and the spot divided into two, after which it was very easy to cut it up in detail. Dr. Peters explained these facts, by the assumption of volcanoes sending up gaseous matter which parts the luminous covering. All the world knows that the sun is supposed to have, at least, two atmospheres, the one next its surface dark but supporting another which is luminous, and which sends forth the light and heat which we find so very convenient.

UPON THE PROBABLE IDENTITY OF THE SOLAR FACULÆ WITH THE ROSE-COLORED PROTUBERANCES SEEN DURING A TOTAL ECLIPSE OF THE SUN.

The following paper has been read before the Royal (English) Astronomical Society, by M. Schweizer, an eminent Russian astronomer of Moscow:—

In an account of the total eclipse of the sun of August 8, 1850, observed at Honolulu, M. Arago threw out a conjecture relative to the possible identity of the solar faculæ with the red protuberances seen around the margin of the moon during the occurrence of the totality. M. Schweizer was induced by this circumstance to institute a series of observations of the solar faculæ about the time of the total eclipse of July 28, 1851, and to cause drawings of their appearances to be carefully executed. The observations were made with a Fraunhofer instrument of 3·3 inches aperture, and a magnifying power of 55. They were commenced on the 9th of July, and were continued till some time after the occurrence of the eclipse. By comparing these drawings with the accounts of the protuberances seen during the total eclipse of July 28, M. Schweizer shows that a remarkable analogy exists between the latter phenomena and those to which the drawings relate. Thus, with respect to the hook-shaped protuberance, seen by all observers of the eclipse on the western limb of the sun, at a distance of about 279° from the north pole of the solar disc, counting towards the east, there was found upon the drawings a similarly formed facula, having the same position, which continued from the morning of the 26th of July, when it was first seen to approach nearer and nearer the margin of the sun's disc, and had already quitted it on the 28th, in virtue of the sun's rotation. An equally satisfactory agreement was found to present itself upon comparing the drawings of the faculæ with the descriptions of the isolated red patch seen in the vicinity of the hooked protuberance, and also in several other similar instances. M. Schweizer sums up the results of his comparison in the following terms:—

1. For every group of faculæ which appeared on the western margin of the sun's disk within two days before the eclipse, and for every group which appeared on the eastern margin within a similarly short time after the eclipse, and which were demonstrated by the drawings not to be on the sun's disk on the 28th of July, corresponding protuberances were seen. 2. Notwithstanding the rather sudden changes of form to which faculæ are subject, still there were several of them which presented a striking resemblance in this respect to the corresponding protuberances. 3. On the western border of the sun the configuration of a hooked, a round, and an elongated protuberance, was exactly the same as that of the corresponding and similarly formed faculæ. M. Schweizer remarks, that it is difficult to suppose so striking a coincidence to be purely accidental, and that the probability rather is, that the protuberances are no other than the faculæ which we so often see upon the sun's disk. This conclusion might be objected to by some persons, on the ground that the light of the faculæ is generally more intense than that of the other parts of the solar surface, while, on the other hand, the protuberances shine only by a moderate red light. M. Schweizer, however, seems to think that

there are circumstances connected with the appearance of the faculæ which serve to obviate this objection. First, he asserts it to be a well-known fact that even bright groups of faculæ, as they advance from the eastern border of the sun towards the middle of the disk, now and then vanish, and even seem to reappear in altered forms after they have passed the middle parts of the disk. Again, he states, that both himself and his assistants have remarked that the faculæ, although occasionally quite visible when they are just upon the edge of the sun's disk, still are, at other times, much less conspicuous in that position than at some distance from the edge. He estimates the maximum brightness of the faculæ to be in those parts of the disk which are situate at a distance of $\frac{1}{2}'$ to 5′ or 6′ from the margin. Hence it would appear that the brightness of the faculæ depends on the position which they occupy with respect to the imaginary line uniting the centre of the sun and the eye of the observer. "Might it not then be easily possible," he says, "that as, in the middle of the sun's disk, so also upon its margin, where the radius forms a right angle with the line before mentioned, the light of the faculæ should not surpass the rest of the solar surface? nay, might it not descend in intensity to the light of the protuberances? The light of the latter cannot be so inconsiderable, since they continued to be seen, according to some accounts of the eclipse, for a considerable time after the reappearance of the sun. If this be really the case, it is probable that the cloud-like faculæ merely represent transparent objects, in a small degree or even not at all self-luminous, which allow the sun's light to pass in certain positions, with respect to the eye of the observer, without being themselves visible; in other positions, to transmit to us a maximum of the solar light, either by refraction or reflection, with such intensity that they appear brighter than the surrounding parts of the surface; and finally, in other positions, to appear with the mild light and color of the protuberances." Without taking into account the impossibility of a mere accidental coincidence of the drawings of the faculæ with the protuberances, M. Schweizer sought to establish a connection between the latter and the penumbræ of the solar spots; but he was unable to arrive at any consistent results. During the days immediately preceding and following the eclipse, the number of such penumbræ visible upon the disk was too small to account for the numerous protuberances, and even of those penumbræ or nuclei which did appear, not one, however small, was situate exactly upon the margin of the disk, as ought to have resulted if they had been identical with the protuberances, and as really occurred in the case of the faculæ. Moreover, the forms of the protuberances do not in anywise resemble those of the penumbræ seen near the margin of the solar disk; while, on the other hand, any person who has observed the solar faculæ, cannot fail to be struck with the resemblance between the forms of the protuberances and those of the faculæ, more especially in the case of the vein-like shoots which gradually lose themselves in the surface of the disk.

CONNECTION BETWEEN METEOROLITES AND ASTEROIDS.

At the British Association Mr. Greg read a paper on 'Meteorolites and Asteroids,' in which he brought forward some circumstances in connection with those bodies, not hitherto noticed, in favor of the theory that they are identical in nature and origin. After stating some arguments against the theory of the atmospheric origin of aerolites, Mr. Greg proceeded to give an abstract of some results he had lately obtained in analyzing a very complete catalogue of aerolite falls. It would appear that since A. D. 1500, there are 175 authenticated instances of falls of aerolites, the month of whose fall is known, the number for each month being as follows:—For January, 9; February, 15; March, 17; April, 14; May, 15; June, 17 falls—first half of the year, 87 falls; July, 18; August, 15; September, 18; October, 14; November, 16; December, 7 falls—second half, 88 falls. Giving an average of 14·6 for each month. The most important thing to notice is the small number of aerolites registered for the months of December and January, and the comparatively large number for June and July. The former two showing but 16 instances of falls, the latter two 35, or more than double. Now, granting that these aerolites, or meteorolites, belong to the system of the asteroids, having orbits therefore whose mean distance is superior to the earth's orbit, it is certainly reasonable to conclude that it is when the earth is farthest from the sun, *i.e.* at her aphelion, that the meeting with aerolites is rendered most probable. This is what would appear to be really the case, for the earth is at her greatest distance from that luminary on the side of the summer solstice, *i.e.* in June and July, precisely the months shown to be most abundant in aerolites. Mr. Greg then referred to a recent number of the *Comptes Rendus*, in which there is a paper by Le Verrier on the asteroids. M. Le Verrier shows by calculation that the sum of the mass of the fragmentary planets, called asteroids, cannot exceed one-fourth of the earth's mass; and also shows it probable that their mean mass or system is at its perihelion, and consequently nearest the earth, at the time when the earth herself is on the side of the summer solstice. This would appear again confirmatory of the theory that aerolites are the minute outriders of the asteroids. There would appear to be also further evidence, though of another kind. It has been supposed that some of the larger asteroids have irregular and angular surfaces, which is precisely the case with the majority of the meteoric stones which fall to the earth. Again, taking the average specific gravity of aerolites at 3·0 (they vary from 1·7 to 3·9), further indirect evidence is afforded as to their position with regard to distance from the sun, and, taking water as 1·0, the following table shows the relative densities of several of the planetary bodies, following the order of their distances from the sun:—Mercury, 15·7; Venus, 5·9; Earth, 5·6; Mars, 5·2; Aerolites, 3·0; Asteroids, (?); Jupiter, 1·4. Another circumstance relating to aerolites which was alluded to by Mr. Greg, was the periodicity of those bodies, and he mentioned more particularly the 19th of May, 29th of November, 13th of December, 15th to 19th of February, and 26th of July, as being aerolite epochs, aerolite falls having been recorded on the following days:—February 10, 10, 13, 15, 15, 15, 18, 18, 18, 19, 19, 25, 27, 27; May 9, 10, 17, 17, 17, 18, 19, 19, 20, 22, 26, 26, 27, 28; July 3, 3, 4, 7, 8, 12, 14, 17, 18, 22, 24, 24, 26, 26, 26, 30; November 5, 7, 11, 13, 17, 20, 23, 25, 27, 29, 29, 29, 29, 30, 30; December 11, 13, 13, 13, 13, 13, 14. In referring, however, to the epochs most remarkable for the periodical displays of luminous meteors, as November and August 9th to 14th days, Mr. Greg observed that the number of aerolites recorded as falling on those days is remarkably small, indeed under the average of the year, for out of 155 falls (the day as well as month of fall being known), but four have fallen between the 9th and 14th days of August and November. The aerolitic and (luminous) meteoric epochs also would appear to differ, with the exception of the 29th of November. From this circumstance it seems probable that aerolites, and the majority of luminous meteors (especially periodic and conformable ones), are resolvable into separate classes; and in corroboration of this it may be mentioned, that while the number of aerolites whose falls have been recorded are about equally divided for the first as for the second half of the year, this is very far from being the case with luminous meteors, by far the larger numbers of which are observed during the second half of the year, viz., from July to December. While, then, we consider aerolites as belonging to asteroids, with orbits superior to the earth's, and partaking of the nature of true though minute planets, the majority of luminous meteors may be considered as having characters more in common with comets. It has been shown by several astronomers, as Olmstead, Pierce, Erman, and others, that the majority of periodic meteors have orbits inferior to the earth's, and their perihelia near the planet Mercury. Mr. Greg concluded, after making some observations in favor of the self-luminosity of meteors, by suggesting the probability of their having a nature less dense than that of aerolites, but denser than that of comets, and that it is not improbable that they have a fluid or viscid nature.

ASTRONOMICAL MEMORANDA.

At a recent meeting of the American Academy, Mr. G. P. Bond stated that he had found that the horizontality of the axis of the great equatorial at Cambridge is subject to a regular disturbance, its position going through a succession of changes almost uniform every year. This he ascribed to the unequal action of temperature upon the two supporting pillars. The western pier rises from March to September, and is depressed during the remainder of the year. Mr. Bond exhibited a diagram, showing by a series of curves the rate of elevation and depression through different months, for the past five years. The amount of departure from a horizontal position is $\frac{1}{1000}$ of an inch in all.

Mr. Bond also said that he had been making some investigations to ascertain whether the attraction of the moon has any effect on the motion of a pendulum, and consequently upon the rate of a clock. He had found this last to be changed to the amount of $\frac{9}{1000}$ of a second daily. At the equator the moon's attraction changes the weight of a body only $\frac{1}{7000000}$ of the whole; yet this force is sufficient to produce the vast phenomena of the tides.

DR. KANE'S OBSERVATIONS ON ARCTIC TEMPERATURES.

On the 17th of January, our thermometer stood at 49° below zero; on the 20th, the range of those at the observatory was at 64° to 67°. The temperature at the floes was always somewhat higher than at the island; the difference being due, as I suppose, to the heat conducted from tne sea water, which was at a temperature of +29°, the suspended instruments being affected by radiation. On the the 5th of Feb., our thermometers began to show unexampled temperature; they ranged from 60° to 70° below zero, and on very reliable instruments stood upon the taffrail of our brig at 65°. The reduced mean of our best spirit standards gave 67° or 99° below the freezing point of water. At these temperatures chloric ether became solid, and carefully prepared chloroform exhibited a granular pellicle on its surface. Spirit of naphtha froze at 54°, and oil of sassafras at 49°. The oil of turpentine was in a flocculent state at 56°, and solid at 63° and at 65°.—*Kane's Second Expedition.*

INFLUENCE OF ARCTIC TEMPERATURES UPON ICE.

The changes of ice at temperatures far below the freezing point confirm the views I formed upon my last cruise as to the limited influence of a direct thaw. I am convinced that the expansion of the ice after the contraction of low temperatures, and the infiltrative or endosmometric changes thus induced; the differing temperatures of sea-water and ice, and their chemical relations; the mechanical action of pressure, collapse, fracture, and disruption; the effects of sun-heated snow surfaces, falls of warm snow currents, wind drifts, and wave action, all these leave the great mass of the polar ice surfaces so broken, disintegrated, and reduced, when the extreme cold abates, and so changed in structure and molecular character, that the few weeks of summer thaw have but a subsidiary office to perform in completing their destruction. —*Dr. Kane.*

NEW METEOROLOGICAL OBSERVATIONS IN ALGERIA.

The French government has recently determined to establish not fewer than twelve meteorological observatories in Algeria; and at the request of the government, the Academy of Sciences at Paris has drawn up a series of instructions as to the observations to be taken, and the time and manner of taking them, in these new establishments. For the present the observations will be limited to, 1. Temperature and distribution of heat; 2. Atmospheric pressure; 3. Humidity of the air; 4. Rain, snow, and hail; 5. Direction and intensity of the wind; and 6. The state of the sky, reserving observations on magnetism, electricity, &c., until a sufficiently numerous and experienced *personnel* shall have been formed. As to the time of taking the observations, the Academy desires that it shall not be merely every three hours during the day, as in most observatories, but that it shall be every hour, day and night. The Academy is of opinion that the taking of meteorological observations in Africa, the only part of the world in which they have heretofore been almost completely neglected, will be of great scientific importance.

CYCLONIC HURRICANES.

A curious and interesting table of Cyclonic hurricanes, which have occurred in the West Indies and the Atlantic Ocean, has been recently published by

Mr. A. Poey, of Havana. The examination of these phenomena extends over a period of 362 years—from 1493 to 1855—and the monthly distribution of 365 hurricanes was as follows:—January, 5; February, 7; March, 11; April, 6; May, 5; June, 10; July, 42; August, 96; September, 80; October, 69; November, 17; December, 7. Mr. Poey observes, that although nothing is known of the causes which produce hurricanes or gales in any part of the world, yet it has now been proved by the examination and careful analysis of perhaps more than a thousand logs, and of some hundreds of storms, that wind in hurricanes and common gales on both sides of the equator, has two motions; and that it turns or blows round a focus or centre in a more or less circular form, and at the same time has a straight or curved motion forward.

ON THE IMPORTANCE OF ASTRONOMICAL OBSERVATIONS IN THE SOUTHERN HEMISPHERE.

At the annual meeting of the Royal Society, Nov. 1856, Lord Wrottesley, the president, in his address, strongly advocated the construction and erection of a large reflecting telescope in some desirable locality of the southern hemisphere, for the purpose of observing the nebulæ. The scheme is not new, having been brought forward by Lord Rosse, the late distinguished president of the Royal Society, but although strongly advocated by the council, the government felt at the time unwilling to advance the necessarily large sum required for the construction of a large reflecting telescope.

"It is not difficult," says Lord Wrottesley, "to demonstrate the importance of this object. The great command of light possessed by the magnificent telescope of Lord Rosse has enabled him to detect certain configurations in the nebulæ visible in this country, which had escaped the notice of prior observers. I allude to the discovery of the spiral form of several of these curious objects. Now this is a fact of very peculiar interest, as bearing upon important questions of physical astronomy.

"Do certain laws prevailing in our own system, and even in many stellar groups comparatively near to us, extend to the very remote regions of space tenanted by the nebulæ? Many ages must probably elapse before these questions can be solved, but it is a duty we owe to posterity to hand down to them the data required for solving them, and it is necessary for that purpose that accurate drawings should be now made of the present appearances of these objects, and preserved, that they may be compared with the observations of after times. Now, Lord Rosse is at present engaged in making detailed observations and drawings of the appearances presented by nebulæ visible in these latitudes, and it is most desirable that a telescope, not much, if any, inferior in power to his, should be set up somewhere in the southern hemisphere, to perform for the nebulæ there visible the like office as that performed by Lord Rosse for our own."

Lord Wrottesley then suggests that, as such a scientific labor would produce results in which the whole civilized world would be interested, it would be very desirable if many nations could be associated in carrying out so great an undertaking.

GEOGRAPHY AND ANTIQUITIES.

ON THE OPENING OF AN ANCIENT TOMB IN THE CRIMEA.

At the last meeting of the British Association, Dr. Macpherson, of the army, gave a detailed account of the opening of one of the ancient tumuli, found near the city of Kertch, in the Crimea, during the recent occupation of the country by the allied forces. The present town of Kertch is built close to the site where 500 years B.C. the Milesians founded a colony. About fifty years before Christ, this colony became subject to Rome. In the year 375 of our era, the colony was utterly annihilated by the Huns. The characteristic features around Kertch are the immense tumuli, or artificial mounds, that abound in this locality. Calculated as they are for almost endless duration, they present the simplest and sublimest monument that could have been raised over the dead. The size and grandeur of the tumuli found in this locality excite astonishing ideas of the wealth and power of the people by whom they were erected, for the labor must have been prodigious and the expenditure enormous. The highest specimens of Hellenic art have been discovered in these tumuli—such as sculpture, metal, alabaster and Etruscan vases, glass vessels, remarkable for their lightness, carved ivory, coins, peculiarly pleasing on account of their sharpness and finish, and trinkets, executed with a skill that would vie with that of our best workmen. All originals were forwarded to St. Petersburgh, duplicates being preserved in the Museum at Kertch, and these might have been with ease secured to England on the investment of the place by the allies; but with the exception of some bas-reliefs, transmitted to the British Museum, the whole of these rare treasures were barbarously made away with. The local tradition is, that these tumuli were raised over the remains, and to perpetuate the memory, of the kings or rulers who held sway over the colonists, and that the earth was heaped upon them annually on the anniversary of the decease of the prince, and for a period of years corresponding to the rank or respect in which its tenant was held, or had reigned; and to this day successive layers of earth, which were laid on in each succeeding year, can be traced in their coating of sea-shell or charcoal having been first put down. I have counted as many as 30 layers in a scarp made in one of those mounds, about two-thirds from its base. They are to be seen of all sizes, varying from 10 to 300 feet in circumference, and in height from 5 to 150 feet, and are usually composed of surface soil and rubble masonry. Most of these tumuli appear to have been violated and their treasures removed. The details of the exploration of one of the largest which remained intact, Dr. Macpherson gives as follows:—

Beneath an extensive sloping artificial tumulus, running at right angles with the ridge extending northwards from Mons Mithridates, I came upon a mass of rubble masonry, beyond which was a door leading to an arched chamber, built under the side of the mound. This led me to a larger chamber, which was also arched. The walls of the larger chamber were marked off in squares, with here and there flowers, birds, and grotesque figures. Over the entrance into this chamber were painted two figures of griffins rampant, two horsemen, a person in authority and his attendant—the latter carrying in his hand a long spear—being rudely sketched on one of the inner walls. There were no remains of any sort in this tomb or temple. A recess in the walls on two sides resembled doors blocked up. On removing the masonry to the right, the skeleton of a horse was found. To the left a human skeleton lay across the door. Tunnelling on each side, the work was carried on beneath the descents of former explorations from above. On the right hand side the tunnel extended ten yards, but nothing of interest was met with. On the left, descending as the tunnel was formed, arriving occasionally at objects possessing much interest, I came upon a layer of natural slate rock, the sides and roof of the tunnel being composed of artificial soil, charcoal, animal remains, and, as usual, heaps of broken pottery. Thirty feet from the entrance, the rock suddenly disappeared to the front and left, the mark of the chisel being perceptible on the divided portion. Tunnelling in the rock, we again reached, 12 feet from the spot where it had disappeared, loose sand occupying the intervening space, into which the exploring rod, six feet long, dropped without any effort. I worked down into this shaft 12 feet. But the left side of the shaft, which was composed of the same loose sand as far as the steel rod could reach, was continually falling in. Moreover, the labor carried on by candlelight of raising the earth in baskets, and conveying it in wheelbarrows to the outside through the building was becoming very arduous, and I was compelled to abandon the work. At this period no relics or remains of any sort were discovered, and the steel rod sunk into the loose sand as if it had been so much flour. I felt satisfied that this shaft led to rich treasures below, but regard for the safety of my workmen prevented my proceeding deeper. The tunnel was carried on a few feet further, and the earth allowed to drop into the shaft. I now sought out other ground, and selected a place removed about 100 yards from that I had just left. Descending some ten feet, I struck upon a tomb cut out of the solid rock. Not far from this my attention was attracted to an excavation in the rock, somewhat similar to, but on a much smaller scale than, that large descent which I had just abandoned. Clearing the surface, I found that the rock was hewn out 3 feet in width and 12 in length, the intervening space being filled with sand, similar in all respects to the other into which the steel rod sunk with ease. Fifteen feet of this sand being removed, I came upon the skeleton of a horse. A few feet further on, an upright flag, four feet high, and the breadth of the shaft, was placed over the entrance of a tomb cut out of the calcareous clay. The opening faced the east by an arched door, 24 inches wide and 32 high. The tomb was of a semi-circular form, arched, 10 feet by 12 in diameter, and 8 feet high in the centre. Above the doorway a lintel-stone was placed, on which the slab which closed it rested. The cavity was cut out of the natural calcareous clay, which was firm and consistent, the form and shape of the instrument by which it had been removed being very distinct. The candle burnt brightly on entering. The floor was covered with beautiful pebbles and shells, such as are now found on the shores of the Sea of Azov. A niche was cut out of the walls on three sides, in which lay the dust of what once was human. It was a sight replete with interest to survey this chamber—to examine each article as it had been originally placed more than 2,000 years ago—to contemplate its use, and to behold the effect of 20 centuries upon us proud mortals. There lay the dust of the human frame, possessing still the form of man. The bones had also crumbled into dust; the space once occupied by the head did not exceed the size of the palm of the hand, but in the disturbed dust, the position of the features could still be traced. The mode in which the garments enveloped the body, and the knots and fastenings by which these were bound, being also distinct. On each niche a body had been placed, and the coffins, crumbled into powder, had fallen in. At the head were glass bottles—one of these contained a little wine. A cup and a lacrymatory of the same material and a lamp were placed in a small niche above. A coin and a few enamelled beads were in the left hand, and in the right a number of walnuts, the wine and nuts being doubtless placed there to cheer and support the soul in its passage to Paradise. Some fibulæ and common ornaments, valuable only on account of their antiquity, were also found. Continuing my researches in the same locality, I came upon other similar shafts, at the end of which were the bones of a horse, and then the large flagstone closed the mouth of the tombs similar to the last. I now resolved to make another attempt to explore the great shaft: the only mode of effecting this being to remove entirely that portion of the hill above it, I brought all my laborers to the spot, although the few days that remained of our sojourn in Kertch would hardly enable me, I feared, to complete the work. Placing my men in two gangs, each were made to work half-an-hour without ceasing. On the third day we struck on two large amphoræ, containing each the skeleton of a child between four and six years of age. Underneath these were the tombs of two adults, and then came the skeleton of a horse.

There was now every indication that a great feast or sacrifice had been held, for a few feet further on we came upon immense heaps of broken amphoræ, fragments of wine jars, the insides of which were still encrusted with wine lees, broken drinking cups, flat tiles which may have served the purpose of plates, beef and mutton bones, fragments of cooking pots still black from the smoke, and quantities of charcoal. Descending still further, we came upon what appeared to have been a workshop—portions of crucibles in which copper had been smelted, corroded iron, lumps of vitreous glass, broken glass vessels, moulds, and other things being found. Five feet deeper we exposed the excavation in the rock, and a shaft exactly similar to, but on a much larger scale than the descent into the arched tombs. As the hill was removed, platforms were scarped on the sides, on which the earth was thrown up, a man being placed on each platform: and as I descended into the shaft, similar platforms of wood were slung from above. On the twelfth day we reached a depth of 16 feet in the shaft, the portion of the hill removed being 38 feet in length, 20 in depth, and 12 in breadth. The mouth of the shaft hewn out of the rock, 3 feet in thickness, was 18 feet long by 12 broad. It then took on a bell shape, the diameter of which was 22 feet, cut out in dark consistent clay, a depth of nearly 7 feet. Beyond this the size of the shaft became a square of 7 feet, cut out of successive layers of sandstone and calcareous clay. A few feet beyond the bones of the horse, and exactly in the centre of the shaft, the skeleton of an adult female appeared enveloped in sea-weed. Under the neck was a lacrymatory, and on the middle finger of the right hand a key-ring. Three feet further we met a layer of human skeletons, laid head to feet, the bones being here in excellent preservation,—as, indeed, we found them to be in all places where the calcareous clay came into immediate contact with them. There were 10 adult male skeletons on this spot, and separated by a foot of clay between each. Five similar layers were found, being 50 in all. I may state that toads in large numbers were found alive in this part of the pit. We had now reached a depth of 42 feet in the shaft, the bones of another horse were turned out, and then we came on loose sand to a depth of 5 feet. Six more skeletons were here again exposed. The sides of the shaft were regular and smooth, the mark of the chisel on the rock being as fresh as when first formed. Six feet more of the loose sand being now taken away, hard bottom could be felt by the steel rod, and there lay two skeletons, male and female, enveloped in sea-weed; and in a large amphora at the corner, which was unfortunately found crushed, were the bones of a child. Some beautiful specimens of pottery, an electrine urn, much broken, lacrymatories, beads, and a few coins, were all that I got to repay my labors on this spot. I examined well on every side, and in the rock below, for a trap-door or concealed passage, and an abrupt perpendicular division in the natural strata or layers of calcareous clay appeared to indicate the existence of such, but I found none. Everything during the descent had promised so favorably, that I fully expected to have found a large chamber leading on from the termination of the shaft; but if such does exist, the discovery of the passage to it utterly baffled all my researches. When the coins I discovered are cleaned, I shall probably be able to fix a date to this wonderful place. The deep fosse, the mode in which the skeletons were found at the bottom, the five discovered immediately above these, the 50 about the centre, and the bones of the horses, are exactly in harmony with the description of Herodotus of the mode in which the Scythian kings were buried. There was now no time to enter upon fresh explorations.

DR. LIVINGSTON'S RESEARCHES IN CENTRAL AFRICA.

The detail of the journey of the Rev. Henry Livingston, across the continent of Southern Africa, is a record of human energy which has frequently been exhibited in the interior of Africa—a worthy sequel to the stories of Mungo Park, Burckhardt, Denham, Clapperton, and Lander.

Dr. Livingston reached St. Paul de Loando, in May, 1854, after a foot journey of a thousand miles from his mission among the Bechuanas. He remained at St. Loando until the close of the year, when he set out for the unknown East. In March he arrived at Quillimane, where he was taken up by a British man of war. On the way he traced the Lecambye down to the Zambeze, thus demonstrating the existence in the centre of this unknown land of a river some two thousand miles long.

This immense stream, whose discovery is the great fruit of the journey, is in itself an enigma without parallel. But a small portion of its waters reach the seacoast. Like the Abyssinian Nile, it falls through a basaltic cleft, near the middle of its course, which reduces its breadth from 1,000 to 20 yards. About these falls it spreads out periodically into a great sea, filling hundreds of lateral channels; below it is a tranquil stream of a totally different character. Its mouths seem to be closing. The southernmost was navigable when the Portuguese first arrived in the country, 300 years ago, but it has long since ceased to be practicable. The Quillimane mouth has of late years been impassable, even for a canoe, from July to February, and for 200 or 300 miles up the river navigation is never attempted in the dry season. And in this very month of July, when the lower portion of the river, after its April freshets, has shrunk to a mere driblet, above the falls the river spreads out like a sea over hundreds of square miles. This, with frequent cataracts, and the hostility of the natives, would seem to be an effectual bar to all hopes of future trade and commerce.

During this unprecedented march, alone and among savages, to whom a white face was a miracle, Dr. Livingston was compelled to struggle through indescribable hardships. The hostility of the natives he conquered by his intimate knowledge of their character and the Bechuana tongue to which theirs is related. He waded rivers and slept in the sponge and ooze of marshes, being often so drenched as to be compelled to turn his armpit into a watch pocket. His cattle were destroyed by the terrible tse-tse fly, and he was too poor to purchase a canoe. Lions were numerous, being worshipped by many of the tribes as the receptacles of the departed souls of their chiefs; dangerous too, as his crushed arm testifies. However he thinks the fear of African wild beasts greater in England than in Africa. Many of his documents were lost while crossing a river in which he came near losing his life also, but he has memoranda of the latitudes and longitudes of a multitude of cities, towns, rivers, and mountains, which will go far to fill up the "unknown region" in our atlases.

Toward the interior he found the country more fertile and more populous. The natives worshipped idols, believed in transmigrated existence after death, and performed religious ceremonies in groves and woods. They were less ferocious and suspicious than the seaboard tribes, had a tradition of the deluge and more settled governments. Some of them practised inoculation, and used quinine, and all were eager for trade, being entirely dependent on English calico for clothing, a small piece of which would purchase a slave. Their language was sweet and expressive. Although their women, on the whole, were not well treated, a man having as many wives as he chose, they were complete mistresses of their own houses and gardens, which the husband dared not enter in his wife's absence. They were fond of show and glitter, and as much as $150 had been given for an English rifle. On the arid plateau of the interior water-melons supplied the place of water for some months of the year, as they do on the plains of Hungary in summer. A Quaker tribe on the river Zanga, never fight, never have consumption, scrofula, hydrophobia, cholera, small-pox or measles. These advantages, however, are counterbalanced by the necessity of assiduous devotion to trade and raising children to make good their loss from the frequent inroads of their fighting neighbors.

Dr. Livingston's discoveries, in their character and their commercial value, have been declared by Sir Roderic Murchison to be superior to any since the discovery of the Cape of Good Hope by Vasco de Gama. But greater than any commercial value is the lesson which they teach—that all obstacles yield to a resolute man.

Dr. Livingston's researches confirm a theory proposed by Sir R. I. Murchison in 1852, viz. that high crests of hard rocks constituted the eastern and western flanks of the great continent through which the rivers escape, by deep transverse fissures, from a comparatively low and flat marshy region, intersected by a profusion of rivers and lakes. In the central region the watersheds are determined by slight elevations only, some of the rivers flowing northwards into the Congo or Yaire, and others into the Zambezi, down the banks of which the author travelled. The chief geological features of the eastern and western flanking ridges of the continent were described by Dr. Livingston, the principal altitudes having been approximately estimated by the ebullition of water. On approaching the tract where he was once more to be in communication with civilised beings, Dr. Livingston gives a very striking account of the scenery around the great falls of the river Zambezi, where that broad stream, after rushing over rapids, is suddenly compressed into a narrow gorge and cascades, once a stupendous precipice, fringed on all sides by the richest and most pictorial vegetation.

ON THE GREAT FRESH WATER LAKE OF SOUTH AFRICA.

The existence of Lake Ngami—long a matter of vague doubt and speculation—was established, towards the close of 1849, by Messrs. Uswell, Livingston, and Murray. Mr. Andersson, who has recently visited its shores, presents us with the following description of it:—

The whole circumference is probably about sixty or seventy geographical miles; its average breadth seven miles, and not exceeding nine at its widest parts. Its shape, moreover, is narrow in the middle, and bulging out at the two ends; and I may add, that the first reports received many years ago from the natives about the lake, and which concurred in representing it of the shape of a pair of spectacles, are correct. The northern shore of Ngami is low and sandy, without a tree or bush, or any other kind of vegetation within half a mile, and more commonly a mile. Beyond this distance (almost all round the lake), the country is very thickly wooded with various sorts of acacia indigenous to Southern Africa, the Damara "parent tree," a few species of wild fruit trees, and here and there an occasional baobob, which raises its enormous head high above the highest giant of the forest. The southern coast of the lake is considerably elevated, and the water is so closely fringed by extensive belts of reeds and rushes, that it is only accessible in a few places, or where the native cattle have broken through these natural defences. The west shore of the lake is also somewhat raised, though the water is very shallow; but it deepens considerably towards its eastern extremity. The Ngami must have undergone considerable changes at different periods. The natives have frequently pointed out to me places, now covered with vegetation, where they used to spear the hippopotamus. Again, there are unmistakeable proofs of its having been at one time of smaller dimensions than at present; for submerged stumps of trees are constantly met with. This is not, I believe, to be attributed to the upheaving, or to the sinking of the land, but that, in all probability, the lake was originally of its present size, or nearly so, when a sudden or unusually large flood poured into it from the interior, which, on account of the flatness of the country, could not be drained off as quickly as it flowed in, but caused the water to rise above its usual height, which, remaining in that state some time, soon destroyed the vegetation. * * A great variety of animals are found in the lake regions, more especially in the vicinity of the rivers, such as elephants, rhinoceroses, buffaloes, giraffes, koodoos, pallahs, &c., as also two new species of antelopes, the nakong and the leché. The leché bears some resemblance to the pallah, but is altogether a larger animal. In size, indeed, it almost equals the water-buck (*Aigocerus ellipsiprymnus*), and the horns are very similar to those of the male of that beast. The general color of the skin is a pale brown; chest, belly, and orbits, white; and front of legs dark brown. The fur (which in the young animal is long, soft, and often curly) of the adult is short and "adpressed." The upper part of the nape and withers are provided with a small whorl of hair. The tip of the tail (slender at the base) is adorned with a tuft of black hair. The leché is a species of water-buck; for though not actually living in water, he is never found any distance from it. When pursued, the leché unhesitatingly plunges into the water, however deep. Great numbers are annually destroyed by the Bayeye, who convert their hides into a kind of rug for sleeping on, carosses, and other articles of wearing apparel. * * The nakong is a water-buck. By means of its peculiarly long hoofs (which are black), not unfrequently attaining a length of six to seven inches, it is able to traverse with facility the reedy bogs and quagmires with which the lake country abounds —localities only fit for the feathery tribe. When at the Ngami, I offered very tempting rewards to the natives if they would bring me this animal either dead or alive; but they protested that though they frequently kill the nakong by pitfalls and spears, it was not then possible to gratify my wishes, as, at that season, the beast dwelt almost entirely in muddy and watery localities, where any attempt to follow it would be certain destruction to a man. * * The aquatic birds were particularly numerous and varied. A friend who visited the lake assured me that here, and on the Zouga, he had, at one time and another, killed specimens of no less than nineteen species of ducks and geese. One of the latter varieties is not larger than a common teal, but clothed in the most brilliant plumage. The herons and water-hens vie with the duck tribe in numbers and gaudiness of plumage. During a hurried journey up the Teoge, I procured, in a short time, herons of upwards of ten distinct species, besides several different kinds of storks, cranes, &c. The lake and its rivers swarm with crocodiles. During the cold time of the year, they resort to deep water, where they remain in a state of comparative inactivity; but on the approach of the hot season they again come forward, and may be seen lying in great numbers along the banks, basking in the noonday sun, and looking exactly like so many logs of wood. I have often surprised them in this position; and, if not too close, they have invariably feigned to be asleep. The instant, however, that I have raised my gun, or even merely pointed towards them, they have plunged into the deep like a shot. They are said occasionally to attain a gigantic size; but no authentic instance has come to my knowledge of any specimen being killed which measured above fifteen or sixteen feet, though I have heard it asserted that they sometimes reach double that length. The crocodile chiefly lives on quadrupeds, which he lies in wait for, and destroys when coming to drink; but he is said never to devour his prey before the flesh has arrived at a state of putrefaction. When in its native element, the power of this animal must be enormous; for if the testimony of the inhabitants is to be relied on, he not unfrequently succeeds in destroying the buffalo, which they say he accomplishes by seizing the beast by the muzzle and dragging him into deep water, where he suffocates him. This being done he hauls his victim back to the shore, and, pushing the carcase above water-mark, watches over it until it has become *nicely* tainted, when he commences his feast. From the moist and swampy nature of the ground about the lake and rivers, snakes, as may well be supposed, are numerous; but, though they at times attain a gigantic size, they appear very harmless, being often destroyed by the natives, who devour them with great relish. I never myself saw a specimen exceeding seven or eight feet in length, but procured skins measuring fully three times that size. The bushmen assured me that they not unfrequently surprised these monsters when asleep and gorged, and that on such occasions it was not unusual to dispatch them with a blow on the head from the knob-kierie. These snakes feed chiefly on birds and small quadrupeds. The finny tribe was also pretty numerous; but my stay at the lake was of too short a duration to collect much information on this head. I saw and tasted many different kinds, some of which were most excellent eating, and had a rich and agreeable flavor. The only ones, however, which I remember had any likeness to northern fishes were a sort of perch, and one or two barbel kinds.

TIMBUCTOO; ITS POPULATION AND COMMERCE.

The following paper on the great city of Central Africa was communicated to the British Association, through the Foreign Office, by Dr. Barth. Dr. B., dating from Timbuctoo, on the 2nd of October, 1853, acquainted the Earl of Clarendon, the Foreign Minister, that on the 7th of the month previous he had reached Timbuctoo, and had met with a very satisfactory reception. He entered from the south side, having navigated a considerable channel of the river. He was escorted to the town from Kabara by Sidi Alawad, the brother of the absent Sheikh of Bakay, and welcomed by great part of the wealthier Arabs inhabiting the place; but was obliged to support before the people the character of a messenger of the Sultan of Stamboul, his real character not being known but to his protector himself. When the Sheikh of Bakay himself arrived, he gave Dr. Barth the fullest assurance of his safety in the town, and his safe return home by way of Bornou; he had done so before, and as far as his influence extended, had given "full security to any Englishman visiting this place." Dr. Barth then gives a brief description of the town:— "Timbuctoo is situated, according to an accurate computation of my route, 18° 3′ 30″ till 18° 4′ 5″ north latitude, and 1° 45′ west longitude, Greenwich; and is distant from the river itself further than has been supposed—Kabara, its so-called port, being situated on a very small ditch, which, being inundated by the river, is made navigable for four, or when the rains have been most plentiful, for five months of the year, whereas, during the eight remaining months, all the merchandise has to be transported on the backs of asses to a much greater distance than Kabara..... As for the town itself, it is not now environed by a wall, the former one having long ago fallen into decay; but like the small towns of the Tonray in general, its mud houses form a tolerably entire enclosure, pierced only by narrow entrances. Having been at least twice as large during the period when the Tonray empire was in its prime and glory, its circumference at present does not exceed two and a half miles. The whole town consists of houses built of mud, for the greater part only one story high, while the wealthier people have all their houses raised to two stories. There are at present only three mosques in the town. The market is well supplied with rich merchandise, much better than the market of Kano. But there is a great defect in the scarcity of current coin—salt, a rather heavy, unmanageable sort of money, being the standard for all larger things much more than gold, while cowries are extremely scarce, and dollars are scarcely accepted in payment by anybody. The population of Timbuctoo, as well as its government, are considerably mixed. The original, and by far the most numerous part of the inhabitants, are the *Tonray*, who, after the supremacy of Morocco had ceased, regained once more the government of their town, and were not disturbed by the Bambara, who *did not* obtain possession of Timbuctoo, though on the south side of the river; their empire extended as far as Hombori. Besides the *Tonray* there are the Arabs, partly settled, and partly belonging to different tribes of the desert, and remaining only for several months or years. Certainly, the mixed population of this place for itself is not able to repulse any serious attack, as it was taken twenty-eight years ago (one year before the unfortunate attempt of Major Laing) by the Fullan of Mohammed Lebbo, almost without a struggle." Referring to the Fullan of Hand Allahi, whom he was desirous of visiting, Dr. Barth says:— "Their fanaticism would, if not endanger greatly my situation when among them, at least make it all but intolerable. For these Fullan, who call their brethren of Tokoto 'infidels,' and have threatened them with teaching them Islamism, think themselves the only true Moslems. Amongst other things, they have made smoking a capital crime."

ANTIQUARIAN RESEARCHES IN SOUTHERN ASSYRIA.

Mr. Loftus, the well known explorer of the antiquities of Babylon and Nineveh, thus describes the recent researches which have been made at Warka, in southern Assyria:—

The extent of ground covered by these ruins far exceeds that occupied by any other ruins in Assyria or Babylonia, as the principal portion is still surrounded by an exterior wall forming an irregular circle of five miles and a half. The chief piles bear the local names of Boarich and Waswass, and besides these, there are, also, a ruin which Mr. Loftus considers to be that of a large temple, two curious edifices partially built of brick-cones and oblong vases, the mouths of which are turned outwards, and some conical mounds, the origin of which cannot now be determined. The most remarkable feature, however, of the remains of Warka is this, that with the exception of the principal piles alluded to, the whole of the chief platform and of every smaller mound within the walls is filled with glazed earthenware coffins, whose fragments lie scattered on the surface in such vast numbers as to show that this place has been one vast repository of the dead. These coffins, of which some specimens have been sent to England by Mr. Loftus, and are now in the British Museum, resemble in form a slipper bath, with an oval opening at one end to admit the body, to which is attached an earthen cover. Five rows of small figures are embossed in the upper surface of these coffins, which are for the most part covered with a thick glazing of a rich green color. The hope of finding treasure has led the Arabs of the neighborhood to excavate in these remarkable sepulchral mounds; and hundreds of coffins have been in consequence broken up every year, in search of gold and silver ornaments, which are, however, rarely found.

RECENT ANTIQUARIAN DISCOVERIES AT CANOSA, ITALY.

A correspondent of the London Athenæum gives the following graphic description of an ancient tomb recently discovered and opened by Signor Bonucci at Canosa, in Southern Italy:—

The tomb which has most recently been brought to light has much of an Oriental character, as the doors narrow towards the top. The color of the ground is of a dark red and blue. The chamber facing the entrance appears to have been devoted to the chief of the family, whilst the lateral ones were occupied by the women; and there, on beds of bronze, decorated with ivory statuettes and other ornaments, were found female skeletons. All that beauty, all that wealth ever gave, could not save them from the universal lot. The ground was covered over with gold thread, which Signor Bonucci supposes to be the remains of a golden carpet or cloth; whilst round the walls were disposed more than forty vases, of various though graceful and elegant shapes. In harmony with the idea that the deceased would resume the habits of this life in another world, the skeletons bear upon them the traces of the most magnificent dresses. The principal female figure, for instance, was found with earrings representing two peacocks, not merely in shape but in every tint: the color of the plumage being given by smalt upon gold. Golden bracelets of a serpent form surrounded dry bones, around which once beat the pulses of passion. Her vest must evidently have been embroidered, for garlands of myrtle, both the leaf and the berry, were found in gold, and all are clearly pierced with the holes by which they were once attached to the dress. Round the head was a diadem of various flowers, the cups of which were formed of rubies and jacynths and emeralds of great beauty, and sometimes of smalt of different colors. A beautiful ring was found on one of the fingers of this female. The circle is formed of two clubs of Hercules, the point where they meet beneath being surmounted by a ruby; whilst on the upper and opposite part of the ring is a box, where might have been the hair of a lover or Persian perfumes; the cover is formed of a large emerald. The work is of the most delicate filigree, displaying a great variety of beautiful forms: in short, all regard it with astonishment, and doubt whether modern art could produce anything so perfect. "And when," said I to Signor Bonucci, "might this tomb have been closed upon its inmates?"—"Oh!" was the answer; "judging from the art, it might have been about the time of Alexander the Great, or at all events two thousand years ago?"—"What a field for the play of the imagination! Two thousand years ago!" said I; "so large a period, that it seems to belong not to time but to eternity; and yet the art of the painter, and the potter, and the sculptor, and the architect of that time, is brought before us as fresh as though it had been executed but yesterday; nay, more, the handiwork of the milliner and the upholsterer is shown to our wondering eyes, and, dressed in the habiliments of the drawing-room, the inmates of the tombs seem ready to receive us."

ON THE INTERIOR OF AUSTRALIA.

The following paper on the unknown interior regions of Australia was read before the British Association by Mr. Petermann, the well known geographer:—

At a time when the exploration of the unknown interior of Australia was earnestly thought of, the probable character of that extensive region became a subject of particular interest, and of legitimate inquiry. Scarcely one-third part of Australia could be said to have been even partially explored, and by far the largest portion was therefore entirely unknown. This unknown interior of Australia had frequently been a matter of speculation, at first founded on very few facts. But, as our knowledge increased, and actual facts became more numerous, the theories had been modified. One of these hypotheses was, that the interior, to a certain extent, consisted of a shoal sea. It was in 1814, only forty years since, when the exploration of inner Australia might be said to have been systematically commenced, that Mr. Oxley, the first surveyor-general of New South Wales, a man of acknowledged ability and merit, surrounded about one-eighth part of the longitudinal extent of Australia. By tracing down the rivers Lachlan and Macquarie, he was checked in his progress westward by marshes of great extent, beyond which he could not see any land. He was, therefore, led to infer that the interior was occupied by a shoal sea, of which the marshes were the borders, and into which the rivers he had been tracing discharged themselves. This opinion was probably supported by the fact that the mouth of the largest of the Australian rivers, the Murray, had been overlooked by Captain Flinders, and was not discovered till fifteen years after Mr. Oxley's discoveries, by Captain Sturt. This opinion was adopted by subsequent travellers. In 1845, Mr. Eyre, one of the most distinguished explorers of Australia, in a paper communicated to the Royal Geographical Society, announced that he had arrived at different conclusions, namely, that the interior would be found generally to be of a very low level, consisting of sand, alternating with many basins of dried salt lakes, or such as were covered only by shallow salt water or mud, as was the case with Lake Torrens. He also said that it was more than probable there might be many detached, and even higher ranges, similar to the Gawler Range, and that, interspersed among these ranges, intervals of a better or even of a rich and fertile country might be met with. In 1850, Mr. J. B. Jukes, in his valuable work on "The Physical Condition of Australia," stated his opinion to be that the interior consisted of immense desert plains, which seemed to extend to the sea coast round the Gulf of Carpentaria, or north to that of the Great Australian Bight on the south, and to stretch along the north-west coast to Collier Bay. The general opinion at present entertained on this point seemed to be very similar to that of Mr. Jukes, excepting, perhaps, that it was thought that the deserts did not reach so far to the north, and that the northern parts were considered to consist of some fertile and promising regions. The chief grounds on which these deductions had been made, were the known facts as to the climate and meteorology of Australia, and the absence of large rivers and other features. It was well known that the Australian colonies were subject in summer to occasional blasts of what is called the hot wind, from its extremely high temperature. This hot wind always blew from the interior; in New South Wales and Tasmania, its direction being from the north-west, and from the north in Port Philip and South Australia. The breath of this wind was like the blast from a fiery furnace, increasing the mean temperature of a summer's day, on the westerly side of the eastern cordillera, to 40°; on the eastern side, both in New South Wales and Tasmania, to 25° and 30°; and while during the hot wind the thermometer rose to 100°, or even 115° in the shade, with the southerly squall there was sometimes a sudden fall of full 40° in the course of half or even a quarter of an hour. This wind swept up from the interior clouds of dust and sand, sometimes intermixed with gritty matter, large enough to strike with painful acuteness on the face. Count Strzelecki, while sailing from New Zealand to New South Wales, was prevented from making the harbor of Port Jackson for two successive days, by the violence of this hot wind. Though sixty miles from the shore, the heat exceeded 90°, and the sails of the ship were covered with a small powder by the breeze. The hot winds were, indeed, identical with the sirocco blowing from the great Sahara of Africa, and similar winds in other parts of the globe. It had been justly said that these hot winds experienced in the southern parts of Australia, could have no other origin than by a current of air blowing over some large expanse of burning desert, and our knowledge of the adjoining regions entirely corroborated this assumption. The discoveries of Captain Sturt, in his last expedition in particular, indicated the very nest and hot-bed of the winds. The situation of Captain Sturt's desert was such that there was good reason to think its influences would extend to the whole of the coasts, even to those of Western Australia, which were the furthest from it, namely, about 1,350 geographical miles; unless the wind blowing from it were intercepted or deflected in the intervening spaces by mountains, or else ameliorated by countries of different character. The influence of the hot winds from the Sahara had been observed in vessels traversing the Atlantic at a distance of upwards of 1,100 geographical miles from the African shores, by the coating of impalpable dust upon the sails. Mr. Petermann proceeded to describe the results of his investigations with respect to the causes of the hot winds, and observed that the heat of the winds in southern and eastern Australia was far more intense than in the north-eastern parts. He then remarked that he believed a great part of the interior of Australia to consist of sterile deserts; that the Torrens Basin and Sturt's Stony Desert formed the centre of the largest of these deserts, which probably extended from 200 to 300 miles around the latter, and that a fringe of 200 to 300 miles extended all along the great Australian bight to Western Australia, and along the western coasts as far as the Gascoyne Basin, or even the river Fitzroy. It also appeared to him that the whole of north-west Australia north of Fitzroy river, as far as the head of Carpentaria Gulf, was a region of the most promising character, and that from this region a spur of more or less elevated land extended as far as the cluster of mountains discovered by Sir Thomas Mitchell, and which gave birth to many beautiful rivers flowing in all directions of the compass. This spur would necessarily form a bar between Sturt's desert and the Gulf of Carpentaria. It seemed to him most probable, that this promising district of north-west Australia extended far to the south, to the middle of the continent, and beyond it, at least to the latitude of Gascoyne river. One significant fact supported the latter opinion, and that was the occurrence of large trees which had been floated down the rivers of north-west Australia, and found at their debouchères—an occurrence unknown in south-western Australia.

PROPOSED CATALOGUE OF PHILOSOPHICAL MEMOIRS.

At the last meeting of the British Association, a committee was appointed to take into consideration a communication from Professor Henry of Washington, containing a proposal for the publication of Philosophical Memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of co-operation on the part of the Smithsonian Institution to the extent of preparing and publishing, in accordance with the general plan which might be adopted by the British Association, a catalogue of all the American Memoirs of Physical Science. The committee who were instructed to consider the best system of arrangement, and report thereon, reported as follows:—They understand the proposal of the Smithsonian Institution to be, that a separate catalogue should be prepared and published for America. In the opinion of the committee, the catalogue should embrace the mathematical and physical sciences, but should exclude natural history and physiology, geology, mineralogy, and chemistry, which would properly form the subject matter of a distinct catalogue or catalogues. The difficulty of drawing the line would perhaps be greatest with regard to chemistry and geology; but the committee would admit into the catalogue memoirs not purely chemical or geological, but having a direct bearing upon the subjects of the catalogue. The catalogue should not be restricted to memoirs in transactions of societies, but should comprise also memoirs in the proceedings of societies, in mathematical and scientific journals, in Ephemerides and volumes of observations, and in other collections not coming under any of the preceding heads. The catalogue would not comprise separate works. The catalogue should begin from the year 1800. There should be a catalogue according to the names of authors, and also a catalogue according to subjects,—the title of the memoir, date, and other particulars to be in each case given in full, so as to avoid the necessity of a reference from the one catalogue to the other. The catalogue should, in referring to a memoir, give the number as well of the last as of the first page, so as to show the length of the memoir. The catalogue should give in every case the date of a memoir (the year only)—namely, in the case of memoirs published in the transactions of a society the date of reading, and in other cases the date on the title-page of the volume. Such date should be inserted as a distinct fact, even in the case of a volume of transactions referred to by its date. The catalogue should contain a list of volumes indexed, showing the complete title, with, in the case of transactions, the year to which the volume belongs and the year of publication; and in other cases the year of publication, and the abbreviated reference to the work. The references to works should be given in a form sufficiently full to be easily intelligible without turning to the explanation of such reference. The author's name and the date should be printed in a distinctive type, so as to be conspicuous at first sight; and, generally, the typographical execution should be such as to facilitate as much as possible the use of the catalogue. As to the catalogue according to the authors' names, the memoirs of the same author should be arranged according to their dates. As to the catalogue according to the subjects, the question of the arrangement is one of very great difficulty. It appears to the committee that the scheme of arrangement cannot be fixed upon according to any *à priori* classification of subjects, but must be determined after some progress had been made in the preliminary work of collecting the titles of the memoirs to be catalogued. The value of this part of the catalogue will materially depend upon the selection of a proper principle of arrangement, and the care and accuracy with which such principle is carried out. The arrangement of the memoirs in the ultimate subdivisions should be according to their dates. The most convenient method of making the catalogue would appear to be that each volume to be indexed should be gone through separately, and a list formed of all the memoirs which came within the plan of the proposed catalogue. Such list should be in triplicate: one copy for reference, a second copy to be cut up and arranged for the catalogue according to authors' names, and another copy to be cut up and arranged for the catalogue according to subjects. The committee have endeavored to form an estimate of the space which the catalogue would occupy. The number of papers in a volume of transactions is in general small, but there are works, such as the *Comptes Rendus*, the *Astronomische Nachrichten*, the *Philosophical Magazine*, *&c.*, containing a great number of papers, the titles of which would consequently occupy a considerable space in the catalogue. Upon the whole, the committee consider that, excluding America, they may estimate the number of papers to be entered at 125,000, or, since each paper would be entered twice, the number of entries would be 250,000. The number of entries that could conveniently be brought into a page quarto (double columns) would be about thirty, so that, according to the above estimate, the catalogue would occupy ten quarto volumes of rather more than 800 pages each. It appears to the committee that there should be paid editors, who should be familiar with the several great branches respectively of the sciences to which the catalogue relates, but that the general scheme of arrangement and details of the catalogue should be agreed upon between all the editors, and that they should be jointly responsible for the execution. It would, of course, be necessary that the editors should have the assistance of an adequate staff of clerks. The principal scientific transactions and works would be accessible in England at the library of the British Museum, and the libraries of the Royal Society, and other philosophical societies. It would be the duty of the editors to ascertain all the different works which ought to be catalogued, and to procure information as to the contents of such of them as may happen to be accessible. The catalogue according to authors' names would be most readily executed, and this catalogue, if it should be found convenient, might be first published. The time of bringing out the two catalogues would of course depend upon the sufficiency of the assistance at the command of the editors.

OBITUARY

OF PERSONS EMINENT IN SCIENCE. 1856.

Admiral Beechey, R. N., a distinguished Arctic navigator and geographer.

Henry Bellville, an English meteorologist.

A. Binet, an eminent French mathematician, formerly President of the French Academy.

Prof. Bojer, a well known French botanist.

W. M. Buchanan, Editor "Glasgow Practical Mechanics' and Engineers' Journal."

Dr. Buckland, the well known English geologist.

Alex. Campbell, a distinguished American engineer.

Adrien Chenot, a celebrated French metallurgist.

M. Coutourier, a young French explorer of Central Africa; died on the Sahara.

Joseph Drayton, the well known artist of the U. S. exploring expedition and a naturalist of eminence.

M. Duval, a French botanist.

David Dyson, an English naturalist.

Prof. von Fuch, the well known German physicist and chemist.

M Gerhardt, the eminent chemist of Strasburg, France.

M. Goujon, a French astronomer.

Dr. W. T. Harris, the eminent American entomologist.

Prof. Hentz.

Dr. John Lock, of Cincinnati.

M. Loewell, a German chemist of repute.

Col. Madden, President Edinburgh Botanical Society.

C. B. Mansfield, of England, well known for his researches in connexion with benzole.

François Michaux, Editor North American "Sylva."

Hugh Miller, the eminent Scottish geologist and author.

Francisco Orioli, Professor of Physical Science, University of Bologna.

M. Partsch, of Vienna, naturalist.

Dr. W. H. Paris, an eminent English chemist, and friend of Sir Humphrey Davy. Dr. Paris was the author of the well known work, "Philosophy in Sport," &c.

J. G. Percival, geologist, &c.

M. Constant Prevost, the distinguished French geologist and physicist.

John Reeves, an English horticultural writer.

Admiral Sir John Ross, the Arctic explorer.

M. Schwilgue, the inventor of the marvellous astronomical clock of Strasburg.

Daniel Sharp, President Royal Geological Society, England.

George Steers, the distinguished naval architect.

Robert L. Stevens, a distinguished American mechanic.

Paul Stillman, a distinguished American engineer.

M. Sturm, French mathematician.

William Swainson, the well known English naturalist.

Zadock Thompson, of Vermont, naturalist.

Dr. John C. Warren, Boston, Mass.

John Wilson, a Scotch naturalist.

William Yarrel, naturalist.

LIST OF BOOKS, PAMPHLETS, ETC.,

ON MATTERS PERTAINING TO SCIENCE, PUBLISHED IN THE UNITED STATES DURING THE YEAR 1856.

Alvord, Benjamin, U. S. A. The Tangencies of Circles and Spheres. Smithsonian Contributions.

American Almanac for 1857. Crosby & Nichols, Boston.

Annals of the Astronomical Observatory of Harvard College. Vol. I., Part I. cxci. pp. 4to. Cambridge, 1856.

Army Meteorological Register for twelve years, from 1843 to 1854 inclusive; compiled from observations made by the officers of the Medical Department of the Army at the military posts of the United States. pp. 764.

Bouvier, Hannah M. Familiar Astronomy: Illustrated by Celestial Maps and upwards of 200 Engravings; together with a Treatise on the Use of Globes, and a comprehensive Astronomical Dictionary for the use of Schools, Families, and Private Students. Philadelphia, Childs & Peterson. 1 vol. 8vo. $2.

Butler, T. B. The Philosophy of the Weather, and a Guide to its Changes. 414 pp. 12mo. Appleton & Co., New York, 1856.

Draper, John W., LL.D. Human Physiology, Statical and Dynamical. 8vo.

Elderhorst. Manual of Blowpipe Analysis, for the Use of Students. By William Elderhorst, Professor of Chemistry in the Rensselaer Polytechnic Institute. 78 pp. 12mo. G. P. Putnam & Co., New York, 1856. Price 75 cents.

Emmons, Dr. E., M.D. Geological Report of the Midland Counties of North Carolina, with Illustrations. G. P. Putnam & Co., New York.

Force, Peter. Records of Auroral Phenomena observed in the Higher Latitudes. Smithsonian Contributions.

Foster, J. M. Report on the Mineral Resources of the Illinois Central Railroad, made at the request of the President. March 4th, 1856. 30 pp. 8vo., with a plate of sections illustrating the Coal Fields of Southern Illinois. New York, 1856.

Gillespie, W. M. Treatise on Land-Surveying, and the Practice with the Chain alone, the Compass, the Transit, the Theodolite, the Plane Table, &c. Illustrated by 400 Engravings, and a Magnetic Chart. 8vo. Price $2. Appletons, New York.

Gillis. U. S. Naval Astronomical Expedition, Vol. II. Lieut. Gillis.

Gray, Prof. Asa. Manual of Botany of the Northern States, including Virginia, and all East of the Mississippi. New Edition, enlarged. G. P. Putnam & Co. $2.50. 739 pp.

Haven, Sam. F. Archæology of the United States. Smithsonian Contributions.

Jones, Rev. Geo., U. S. A. Observations on the Zodiacal Light, 4to., forming the third volume of the History of the Japan Expedition. Pub. Doc.

Kane, Dr. E. K. Arctic Explorations. Second Grinnell Expedition. 2 vols. Childs & Peterson. Philadelphia.

Kitchell, Prof. Wm. Second Annual Report of the Geological Survey of the State of New Jersey for the year 1855. 248 pp. 8vo. Trenton, 1856.

Lesley. Manual of Coal and its Topography. Illustrated by Original Drawings, chiefly of facts in the Geology of the Appalachian Region of the United States of North America. By J. P. Lesley, Topographical Geologist. 224 pp. 12mo. Philadelphia, 1856.

Leidy, Prof. J. Contributions towards a Knowledge of the Marine Invertebrate Fauna of the Coasts of Rhode Island and New Jersey. 18 pp. 4to., with two 4to. plates. Philadelphia, 1855.

Leidy, Prof. J. A Memoir on the Extinct Sloth Tribe of North America. 68 pp. 4to., with 16 Lithographic Plates.

———— Notices of Remains of Extinct Reptiles and Fishes, discovered by Dr. F. V. Hayden in the Bad Lands of the Judith River, Nebraska Territory. Proc. Philadelphia Acad. Nat. Sci., vol. viii.

Maury, Lieut. N. F. Astronomical Observations made during the year 1848 at the U. S. Naval Observatory, Washington. 1 vol. 4to.

Mayer, Brantz. Observations in Mexican History and Archæology, with Special Notice of Zapotec Remains. Smithsonian Contributions.

Meech, L. W. On the Relative Intensities of the Heat and Light of the Sun from Different Latitudes of the Earth. Smithsonian Contributions.

Metals for Cannon, Reports of Experiments on the Strength and other Properties of, with a Description of the Means for Testing Metals, and of the Classification of Cannon in Service. By Officers of the Ordnance Department, U. S. A. By authority of the Secretary of War.

Morfit, Campbell. A Treatise on Chemistry applied to the Manufacture of Soap and Candles. A New and Improved Edition, Illustrated with Two Hundred and Fifty Engravings on Wood. Parry & M'Millan, Philadelphia, 1856. 1 vol. royal 8vo. 600 pp.

Ninth Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto. Albany, 1856.

Olmstead, Denison. On the Recent Secular Appearance of the Aurora Borealis. Smithsonian Contributions.

Patent Office Reports, for 1855.

Piesse, Septimus. The Art of Perfumery and the Method of Obtaining the Odors of Flowers. Lindsay & Blakiston, Philadelphia.

Porter, Prof. John A. Principles of Chemistry, embracing the Recent Discoveries in the Science, and the Outlines of its Application to Agriculture and the Arts. A. S. Barnes, New York.

Safford, Jas. M. Geological Reconnoissance of the State of Tennessee, with a colored Geological Map of the State. By Jas. M. Safford, Prof. Nat. Sciences, Cumberland University.

Shumard and Yandell. Notice of a New Fossil Genus belonging to the Family Blastoidea, from the Devonian strata near Louisville, Kentucky. By B. F. Shumard, M.D., and L. P. Yandell, M.D.

Sixty-Ninth Annual Report of the Regents of the University of the State of New York. 392 pp. 8vo. Albany, 1856.

Smithsonian Contributions to Knowledge. Vol. viii.

Smithsonian Institution, Publications of Learned Societies and Periodicals in Library of. Parts I. and II.

Sullivant, W. S. Mosses and Liverworts of the United States. Illustrated. 1 vol. G. P. Putnam & Co., New York, $2.50.

Swallow, Prof. G. C. The First and Second Annual Reports of the Geological Survey of Missouri. 1 vol. 8vo.

Transactions of the Connecticut State Agricultural Society for 1855. 350 pp. Hartford, 1856.

Warren, Dr. J. C. The Mastodon Giganteus of North America. Second Edition. 260 pp. 4to., with 31 Plates, and additional New Matter.

Wells, David A. Annual of Scientific Discovery for 1856. Gould & Lincoln.

———— Knowledge is Power. Knight. Re-edited.

Wilkes, Capt. Chas. Theory of the Winds, accompanied by a Map of the World, showing the Extent and Direction of the Winds; to which is added Sailing Directions for a Voyage around the World. 116 pp. large 8vo. G. P. Putnam & Co., New York. $1.50.

Wyman, Prof. J. Description of a Portion of the Lower Jaw and a Tooth of the Mastodon Andium; also of a Tooth and Fragment of the Femur of a Mastodon from Chile. 10 pp. 4to, with two Plates.

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