SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at

No. 361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year, for the United States, Canada, or Mexico.....$3.00
One copy, one year, to any foreign country, postage prepaid, £0 16s. 5d. 4.00

THE SCIENTIFIC AMERICAN PUBLICATIONS

Scientific American (Established 1845) .....$3.00 a year
Scientific American Supplement (Established 1876)..... 5.00 "
American Homes and Gardens..... 3.00 "
Scientific American Export Edition (Established 1878)..... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, JULY 14, 1906.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

TUNNELING BY THE FREEZING METHOD UNDER THE EAST RIVER.

In nearly all sub-aqueous tunneling as at present practised, air pressure within the tunnel of sufficient strength to counterbalance at the heading the pressure of silt and water is obligatory. The increase of pressure required above that of the atmosphere is approximately one pound per square inch for every two feet of depth. With a small tunnel of, say, six feet bore, the difference of pressure required between the top and bottom of the tunnel is slight (three pounds), but with a tunnel of a large diameter (twenty-three feet) such as is required for a railway, this difference in pressure becomes four times as great. As the air pressure at the top of a tunnel heading of the latter size is some ten or twelve pounds greater than is needed to properly counterbalance the inward pressure of sand or silt at that point, there is a constant seepage of compressed air through the river bed. This tends to loosen the material of which the bed is composed, and if the thickness of silt is not sufficient, or if its consistency is not good, there may be a blowout, whereby a hole is made in the bed of the river and the tunnel is liable to be flooded. The expedient must then be resorted to of dumping clay upon the bed of the river, in order to strengthen it and fill the hole, as well as to increase the depth of earth above the tunnel roof.

In the two tunnels now being constructed for the Pennsylvania Railroad Company under the East River, there have been a considerable number of blowouts. These occurrences are rather spectacular, as a great column of water is projected twenty-five feet or more into the air. They have been the object of much comment from the newspapers. According to the engineer in charge of the work, however, these blowouts have not been more numerous than was expected. The method of stopping them by dumping clay upon the river bed is an old one, it having been first used some seventeen years ago by the same engineer in the initial work upon the Hudson River tunnel. This engineer is the man who superintended the construction of the Blackwall tunnel under the Thames, in which case there was a distance of five feet intervening between the top of the tunnel and the top of the river bed. A blanket of clay fifteen feet thick was deposited upon the river bed at this place, and the tunnel was driven without any blowouts. Somewhat similar conditions have been met with on the west shore of the East River. The twin tunnels, which are only fourteen feet apart, start from a shaft which was sunk at the edge of the river, and run for about one hundred feet through solid rock. As they emerge from this rock, the face of which forms a gradual incline, they run partly through rock and partly through sand. At this point there was but ten feet of sand above the line of the tunnel, and it was necessary to dump clay upon the river bed in order to obtain a total thickness of twenty feet. After the tunnel had been completed for about one hundred to one hundred and fifty feet, this clay was removed and discharged farther out in the river, thus making it possible to push forward another section of tunnel. This, it will be seen, is a rather laborious method of preparing the way for the tunnel, but despite the fact that this method had to be resorted to for a considerable distance from shore, the tunnels have advanced at an average rate of from five to eight feet a day. The contract time for the completion of the tunnels expires in a little over two years hence. In order to complete them within this time, the contractors have only to progress at the rate of three or four feet a day. Thus it will readily be seen that in all probability they will be able to carry out their contract. Of the four tubes being run under the river, one of each pair has been pushed forward 600 feet from the shaft on the Manhattan shore, while the other two have gone out 110 and 250 feet respectively, the former being just about to emerge from the rock, while the latter is in the section consisting of rock and sand. The reason that one tunnel of each pair is being pushed forward instead of the two is that the contractors did not want to run the risk of a blowout in one tunnel affecting the work in its twin. This would not be liable to happen if one of each pair was pushed forward, since the two pairs of tunnels are 150 feet apart. The total distance under the river is about 4,000 feet. The two tunnels that are farthest along have reached the point of greatest depth—83 feet—below the surface of the river. The tunnels which are being driven to meet these from the Long Island side have been constructed for a distance of 1,500 feet from East Avenue, Long Island City, and they are already out some little distance beneath the surface of the river. At just what point the tunnels being driven from the two shores will meet, it is at present difficult to say. The Blackwell's Island ledge of rock must be penetrated at the center, and the probabilities are that the western tunnels will be driven through this rock, and will meet the eastern tunnels on the other side of it.

With a view to using it in future tunneling operations, the Pennsylvania Railroad is experimenting with a new system which was invented by Mr. Charles Sooysmith, and which consists, in the main, in first driving a small pilot tunnel and then, after installing in it a series of circulating pipes, of freezing the moist material around the tunnel a sufficient distance to allow of enlarging the smaller tunnel in the frozen silt. In order thoroughly to test the practicability of this idea, the company drove, from the base of an eighty-foot shaft located at the foot of East Thirty-fifth Street, a seven-and-one-half-foot tunnel, 160 feet long, out beneath the surface of the river. The least depth of material above this small tunnel is about twenty feet. Placed longitudinally along the walls of the tunnel, throughout its entire circumference, are a series of pipes for the circulation of the brine of a refrigerating plant located on the pier. By means of this arrangement a temperature of about 35 deg. Fah. below zero has been constantly maintained in the tunnel for some months, with the object of freezing the sand to a radial distance of thirteen and three-quarters feet. At different points in the tunnel holes have been pierced through the cast-iron shell, and run at varying distances into the sand. Sealed in these holes are thermometers with electric recording devices, which record the temperature constantly at the different depths. The result reached thus far is that the sand has been frozen about the tube a distance of nine feet in all directions, so that about two-thirds of the distance to be frozen has already been reached. The idea is to obtain a frozen cylinder thirty-five feet in diameter, or twelve feet larger in diameter than the completed tunnel. There will thus be a ring of frozen earth six feet thick to sustain the pressure of sand and water above and around the larger tunnel while the plating is being placed. By removing the plates of the small tunnel and quarrying out the frozen material, the enlargement of the tunnel can thus be accomplished without the use of any compressed air and without the danger of blowouts. It is estimated that the enlargement of a tunnel by this method will require from three to six months. The pilot tunnel can be driven in half the time required to construct a full-sized tunnel, and as all delays from blowouts would be avoided, it seems probable that a gain might be made in the time required for construction as well as in the cost of building. Perhaps the greatest advantage would be found in the fact that no air pressure would be required, and, consequently, there would be no delays to the work nor loss of life from this cause. In the present East River tunnels, according to the statement of the engineer in charge, fourteen men have succumbed as the result of working in the high pressure (thirty-four pounds to the square inch above atmosphere), while the work has been greatly delayed by the frequent necessity of changing the pressure when different kinds of material were being passed through.

THE GOVERNMENT AS AN ARMOR-PLATE MANUFACTURER.

Another periodical investigation of the armor-plate industry of this country is about to be undertaken. The House of Representatives has instructed the Secretary of the Navy to ascertain whether or not it is advisable to establish a government mill, thereby placing once more upon record its dissatisfaction with the present methods of obtaining armor plate for our navy.

So highly specialized is this industry of making armor plate, that it may well be doubted whether the government can very successfully compete with the Carnegie, Bethlehem, and Midvale companies, the only three firms which now maintain properly equipped mills for the rolling of armor. Many years ago, long before the Midvale company was started, the public harbored dark suspicions of a secret understanding between the Carnegie and Bethlehem companies whereby the price of armor plate was maintained at an inordinately high figure. Although the investigation which was then instituted for the purpose of determining the advisability of establishing a government plant failed to expose any such dishonest agreement, it may be questioned whether these gloomy doubts were ever removed. The new investigation which has been ordered would seem to show that they still linger.

A very cursory examination of the armor-plate industry should convince even the most ardent advocate of the Federal making of armor how hopeless a competitor of the private steel mills the government would be. In the first place, a plant must be designed and constructed at an expense that may, perhaps, be utterly disproportionate to the cost of its product for many years. In the second place, not every engineer is capable of designing a great mill, and the competent men are in the permanent employ of the great steel mills on a salary princely in comparison with the small sums the government usually doles out to its employés. It may be that Congress by appropriating the necessary funds for the employment of able engineers may overcome this obstacle. Still, the difficulty remains of obtaining efficient workmen. Whatever may be the willingness of Congress to set aside funds for the designing and building of a plant, it is questionable whether it would be willing to pay the salaries now drawn by the superintendents and higher officials of the larger steel mills. To add to the possible troubles in which the government may be involved, we must mention the difficulties which would be presented by the labor unions. The private steel mills have the great advantage over the government in having at their command a large force of picked technical experts skilled by long years of experience in manufacturing armor plate for the special tests which it must withstand at the hands of the government inspectors. Because the labor unions make no distinction between capable men and incapable and because they will tolerate no attempt on the part of employers to pay a competent man more for his labor, the private mills have rid themselves of men whom they could ill afford to pay the disproportionately high wages demanded and have retained only the very flower, as it were, of their operatives. The government can, therefore, hope to secure for its own mill (if it should ever be constructed) merely the discarded labor of the Bethlehem, Carnegie, and Midvale plants. An edifying picture of the possible results of such a course is to be found in the government printing office.

THE CANADIAN COMMISSION'S REPORT ON THE ELECTRIC SMELTING OF IRON ORES.

The preliminary report of the commission appointed by the Canadian government to inquire into the advisability of establishing a plant for the smelting of iron ore by electricity will not be deemed as illuminating or as exhaustive by those metallurgists who had hoped to find in it more trustworthy information than the desultory papers scattered through the technical press are able to impart. The chief criticism to be leveled at the report is to be found in the fact that the experimental plant, the operation of which constitutes the chief topic of discussion, was not worked for protracted periods under commercial conditions, and that the efficiency and cost data given are based on a few very good performances which may or may not be repeated in active practice. Realizing that the conditions which underlie the electrical reduction of iron in Europe must necessarily be different from those which obtain in Canada, it was determined to build a plant at Sault Ste. Marie for the purpose of ascertaining the cost of electrical reduction in Canada. Basing its estimate on a 10,000-horse-power hydro-electric plant, equipped with furnaces for producing 120 tons of iron during a day of twenty-four hours, the commission found as a result of its experiments that a ton of pig iron could be made for $10.69. Assuming that furnaces and accessories would cost $100,800, a charcoal plant $50,000, a power plant $500,000, and a furnace electrode plant $6,000, making a total of $656,800, and, furthermore, allowing 15 per cent for depreciation, interest, and amortization, the commission figures that the cost would be about $2.43 per ton of iron produced. Unfortunately this estimate is based upon the production of 4.32 tons of pig iron per horse-power year, which was obtained only in one instance. Apparently no estimate is available on continuous operation under commercial conditions for any extensive period.

It may be that a plant designed and operated continuously on a large scale would be able to produce its pig iron at a cost within the figures given by the report. Still we are hardly justified in making that assumption on the basis of the experimental tests conducted at Sault Ste. Marie.

A NEW ALGOL VARIABLE.

A few Harvard plates examined by Mrs. Fleming led to the discovery of an interesting variable, RR Lyrae, 192242, described in Harvard Circular 54. From a similar examination of recent plates, Mrs. Fleming

finds that the star C. DM. —30 deg. 16169 is a variable of the Algol type.

From an examination of 324 photographs it appears that the star had nearly its full brightness, magnitude 8.58, on 298 plates. On twenty-six photographs the star was distinctly below its maximum magnitude.

SUMMER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

BY WILLIAM H. HALE, PH.D.

No more entrancing spot for a meeting of the American Association for the Advancement of Science than the campus of Cornell University, Ithaca, N. Y., was ever visited by that association in all the years of its history; and this return to summer meetings, which have for several years been discontinued, was rendered memorable by the dedication of the largest and best-equipped physical laboratory in America.

The meeting, which began on June 29 and continued till July 3, was a special summer one for the reading of papers only and for field meetings, for which meetings the environment of Ithaca presents many attractions to botanists and geologists. Dr. William H. Welch presided, but the presidential and the several vice-presidential addresses will be deferred till the meeting at New York next December.

Rockefeller Hall of Physics was dedicated on Friday afternoon. President J. G. Schurman, of Cornell, made the opening address. Prof. E. L. Nichols, head of the department of physics, gave some account of that department and of the new hall, which cost $285,000, has some 20,000 meters of floor space and 478 rooms, and will accommodate the 2,000 students who are expected during the coming year—a striking contrast to the conditions existing at the time of constructing the old hall less than a quarter of a century ago, when the lecture room, accommodating eighty, was supposed to be larger than would ever be required.

Prof. William A. Anthony, former head of the department, was unable to attend, and his address on "The Beginnings of Physics at Cornell" was read by Prof. Ernest Merritt. Dr. Elihu Thomson spoke of "Physics and the Industrial Arts," and President Welch of the "Relation of Physics to Medicine."

A large number of papers were read in the section of physics. Prof. Wallace C. Sabine spoke of neglected factors in determination of musical quality. When a complex tone is sounded, the fundamental tones do not die away so soon as the overtones, and it is found that the material of which the walls of an auditorium is constructed has a material effect in deadening the overtones, and thus changing the quality of the music or of the voice. Hence it seems that more attention should be paid to the material with which the walls are covered. Prof. Henry S. Carhart and some associates report that silver perchlorate gives better results as an electrolyte in the silver voltameter than the silver nitrate now universally used.

Profs. E. L. Nichols and Ernest Merritt reported results of experiments on the phosphorescence of sidot blende. Light deadens phosphorescence, but not all wave lengths have equal effect. The greatest effect is produced by the infra-red waves, about 1½ millimeters; which, however, while they kill the green phosphorescence, very curiously stimulate the violet, which is conspicuous in sidot blende.

In the Mechanical Section, the paper of Prof. William H. Burr on the Panama Canal was read by title only in his absence, but he still insists on his position that the canal ought to be a sea-level and not a lock canal, not only because it is in an earthquake zone, and liable to derangement, but also because experience with all other important canals shows that they must be enlarged, and this cannot be done with a lock canal without putting it out of business for a long time. Dr. Mansfield Merriman reported on constant and probable errors in the estimation of linear distances and vertical angles determined by 1,712 observations on 128 students at the Lehigh University. He found that in estimating length, width, and thickness of boards, 60 per cent of the estimates were too large, and in estimating angles by degrees 80 per cent were too large, while the estimate of angles by ratio showed 60 per cent of estimates to be too large. The higher classmen made better estimates than the freshmen. Dr. H. T. Eddy gave technical data of interest in a novel line of investigation, the flexure of a heavy horizontal disk on a vertical axis increasing in thickness toward the axis, as used in the Curtis steam turbine.

The American Chemical Society, in joint session with Section C of the association, had a great array of papers covering a wide range of interesting topics. Special interest was shown in the paper of Dr. Eugene Haanel, superintendent of mines for the Dominion government of Canada, on smelting of ore by electricity in the manufacture of steel as now introduced at the Sault Ste. Marie mines, which process promises to revolutionize the steel industry.

The feature of the meeting of chemists was the reports of researches carried on during the past year at leading American universities, which included Toronto, Pennsylvania, Johns Hopkins, Cornell, Yale, Chicago, Columbia, Purdue, Ohio, Illinois, Minnesota, and North Carolina universities, Lafayette College, College of the City of New York, and Massachusetts Institute of Technology.

Dr. L. O. Howard, government entomologist, told the Section of Zoology about the great work now in progress by the government under his supervision, of introducing parasites to prey upon the brown-tail moth and the gypsy moth, which has been carried out on a far larger scale than was ever before attempted. Appropriations having been made both by the State of Massachusetts and by the general government, Dr. Howard visited Europe in June, 1905, and arranged with experts in Italy, Austria-Hungary, South Germany, Switzerland, and France, to send to Boston full-grown larvæ and pupæ of the gypsy moth. The many specimens received were cared for at Malden, Mass., and many different species of parasites issued; the most promising being the tachina fly.

Dr. Howard again visited Europe last April, and secured shipments from many localities, importing into Massachusetts 185,000 nests from forty different localities, ranging from Rennes on the northwest to Buda-Pesth on the southeast. From these nests were bred thousands of parasites of different groups; these have been colonized in the open and in outdoor cages, and placed over good-sized trees thoroughly infested with moth larvæ. It was realized that the introduction of additional pests of the same species could do no possible harm in localities already so thoroughly infested, whereas by such wholesale introduction vastly greater numbers of the parasites would be secured, thus promising earlier relief than by the method of introducing only the parasites themselves.

The Economic Section has maintained the high standard reached at previous meetings, both in the number and interest of the papers presented in the first two days of the meeting, which included a paper on the "Economic Advisability of a National Department of Health," by Prof. I. Pease Norton, in which he strongly urged the project with a cabinet officer, Secretary of Public Health, at the head of the department. The paper was discussed by several eminent sanitarians.

Prof. James W. Crook read a paper on the "Limitation of Great Fortunes." The morning of June 30 was given up to a discussion of Conditions and Problems of Agriculture in the United States, Socially and Economically Considered, led by Prof. Liberty H. Bailey; Rural Conditions and Problems in Europe, by Prof. G. W. Lanman; Causes and Consequences of the Past Ten Years of Agricultural Prosperity in the United States, by George K. Holmes; Economic Geography, by I. Russell Smith, and Investigation of Mathematics and Formal Discipline by Prof. G. V. Collins.

Prof. Carhart gave an evening lecture on the meeting of the British Association for the Advancement of Science in South Africa last summer, which he attended as an invited guest. His story of this new region so rapidly opening up to civilization, illustrated by photographs taken by him on that memorable journey, proved most fascinating to the large audience gathered in Sibley College.

The attendance of members at this meeting was less than usual, hardly over 200 having registered. Sections A, H, and I did not meet, but the proceedings of the other sections were none the less valuable.

THE SENSE OF COLOR IN ANIMALS.

The hypothesis that the sense of colors is possessed to a high degree by animals, and especially by birds, furnished a basis for some of the most beautiful and fecund of the Darwinian theories of sexual selection. No Darwinist doubts that the brilliant colors of the male birds of some species are destined to attract the attention of the female birds, and this presupposes naturally on the part of these birds a fine sense of color. Wallace has asserted that to the fact that certain plants bear fruit of brilliant colors is due their preservation; the animals, attracted by these colors, break the fruits from the trees or plants, carry them off, and thus indirectly assist in the dissemination of the seeds which they contain over large tracts of land. And this function of selection on the part of animals presupposes in them a certain sense of color. Still, scientific documents in support of these hypotheses are rare. Dahl, alluding to the scarcity of them in an article in a recent number of the Naturwissenschaftliche Wochenschrift, relates some interesting experiments which he made with a monkey. He colored some sweets with a certain colored dye, and some bitter substances with that of another color, and declares that after a few attempts, the monkey learned to leave without even tasting those articles of food colored with the dye which indicated bitter-tasting substances, and seized at once upon those which indicated sweets. Varying the experiments sufficiently he found that the monkey distinguished all the different colors readily, save only dark blue. Dahl calls attention to the fact that Mayer has stated that many savage tribes cannot distinguish dark blue from black, and that even children do not distinguish this color until later than all others.

SCIENCE NOTES.

A deep sink-hole near Orlando, Fla., has recently become of considerable geological interest. Through its subterranean outlet it had carried away the overflow water of more than a dozen neighboring lakes, and may have done this for a thousand years; but about two years ago this passage became stopped, and the water, thereby shut off from this means of escape, filled the sink-basin to overflowing and formed a lake which eventually covered nearly 250 acres of the surrounding lower-land, driving many colored people from their homes and covering gardens and cultivated fields. It is not known how the subterranean passage became stopped, but it may have been from a cave-in of the walls, or from water hyacinths which filled the sink basin. Many attempts were made to open the passage, and relieve the rising water situation by dragging the sink bottom, exploding dynamite among the debris collected there, and in other ways, but although much time and money were spent in this work, the opening remained stopped apparently as tightly as ever. A short time ago the idea was conceived of trying to find a new passage, or make a new opening into the old one, by drilling a well near the sink. A two-inch hole was first made and a passage was found, the hole carrying down the water easily and rapidly. Then an eight-inch hole was drilled, and now these holes are carrying away the water so freely that the big sink lake which has been so unmanageable a thing and the cause of much alarm in its ever-enlarging area for a long time is rapidly being drained, and the big sink environment will soon be in its normal condition.

An important scheme has been decided upon for the study of tropical diseases, by the Indian government. At the present time there are scattered over various parts of the country five centers, where the process of research is carried out upon a small scale. These institutions are the outcome of private enterprise, and work independently. Owing to their limited resources, the work they accomplish, while valuable, is necessarily somewhat small in scope. The Indian government has now arranged to consolidate these various institutions, to enlarge their field of operations, to found additional laboratories in other parts of the country where investigation on the spot is urgently required, and to control their operations from one central institution. The latter is to be located at Kasauli, a small hill station in close proximity to Simla, from which point it can be easily reached and the institute supervised by the central medical and sanitary authorities of the Indian government. The situation is well adapted for the work, the temperature being moderate, while scattered among the surrounding hills are numerous sanatoria, each of which possesses a large hospital. There is a Pasteur institute already in operation, but this will be merged with the new building, and the present administrator of the Pasteur institute, who has carried out much important and valuable work, will be the first director. The new laboratory will carry out original researches, and prepare and investigate curative sera for tropical diseases indigenous to this country and other similar climes, and the training of scientific workers. The existing scattered institutes will continue their present operations, original research in particular being stimulated. This new arrangement will prove of great value for all investigators of different countries of tropical diseases, since they will be encouraged to avail themselves of the institutions in India for carrying out on-the-spot investigations.

When we remark that in the manufacture of cocaine it is the percentage value of the alkaloid which determines the value of the raw material, we can see the necessity for the planter of finding a method of drying by which he will lose the least amount. In two series of experiments made by M. de Jong, of France, upon two products having different origins, he obtained the percentages of 1.49 to 2.77, or, in mean, 1.52 to 2.75 and 2.05 to 2.91. The fresh leaf furnishes the greatest amount of alkaloid, or from 2.72 to 2.91 per cent. When dried over lime, the leaf loses cocaine, and the value falls to 2.55 per cent. Drying in the sun is found to give values from 2.38 to 2.50 per cent, while drying at a heat of 40 deg. C. gives 2.28 per cent. A heat of 60 to 75 deg. affords 2.16 per cent of cocaine. By drying in the shade for four days and then for over an hour in the sun, we find from 2.05 to 2.18 per cent. The method of drying in the sun after immersion in boiling water gives 1.50 per cent. From this we find that it is not an advantage to dry the leaf over quicklime in practice. If sun-drying is to be advised, we must remark that the leaves should not be allowed to become overheated. It is not a good plan to let the leaves dry up naturally in the shade, but they should be dried as quickly as possible. By the use of hot water we dissolve out some of the alkaloid. The best yield of cocaine is afforded from the fresh leaf.