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 "
Scientific American Building Monthly (Established 1885) ..... 2.50 "
Scientific American Export Edition (Established 1878) ..... 3.00 "

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, MARCH 26, 1904.

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.

SALT-WATER MAINS FOR FIRE PROTECTION.

The provision of water mains and pumping stations as a protection against fire continues to be the subject of earnest and very intelligent discussion in the daily and scientific press; which in itself is proof that the Baltimore and Rochester fires have served the valuable purpose of opening the eyes of other large cities to the ever-present and stupendous danger which confronts them.

In our recent article urging the installation of a salt-water service, we stated that in this matter, while New York had been talking, other cities such as Philadelphia and Cleveland had been acting, and that the latter were now in possession of a thoroughly efficient equipment. The subsequent quotation of this article in the New York Sun has brought a letter to that paper from an engineer, who draws attention to the fact that in a certain sense New York city and Brooklyn were the pioneers in this type of fire service, inasmuch as the fire-boat system was established in these cities about thirty years ago for water-front fire service. He claims that certain western cities, taking the hint, soon adopted the same method, and that being situated on fresh water, and using fresh water in their fire-boat service, they soon conceived the idea of running iron pipes up the various streets from the water front, to which the fire-boats might be connected when needed. The next step in the development was taken by Philadelphia, which substituted a stationary pumping plant for the fire-boats. The same correspondent points out that the objection to the use of salt water is that there would probably be serious and rapid deterioration of the mains and connections, due to the action of the water on the metal, if it were allowed to remain permanently in the mains.

Among the many articles which have appeared on this subject, we think that the most practical is that of our esteemed contemporary, Engineering News, which proposes that an auxiliary pipe system, of large volume and fitted with the necessary standpipes, should be provided for purposes of fire protection alone, and that these standpipes and mains should be filled with salt water only on the rare occasions when the magnitude of a fire may demand the calling in of an auxiliary source of water supply. Our contemporary proposes to lay a system of high-pressure mains, which would be distributed in respect of its capacity according to the particular requirements of the districts of the city that were served. This system would be provided, at points of special danger, with standpipes and street hydrants for hose connections. At some suitable point on the water front, a powerful pumping station would be located, containing high-pressure pumps, delivering directly into the high-pressure mains. Ordinarily these mains would be connected to the regular city fresh-water supply, and the standpipes, mains, etc., would be filled with fresh water only, thus obviating the dangers of corrosion and general deterioration. For all ordinary fires the pumping station would draw from the regular Croton water supply. But should a fire begin to assume serious proportions, the suction of the station pumps would be cut off from the Croton mains, and connected directly with the salt water of the Hudson or the East River, as the case might be, thereby giving the Fire Department an unlimited supply adequate to any possible magnitude of conflagration. When the fire was subdued, the salt-water connection would be cut off, and the mains would be thoroughly flushed out and filled with fresh water, thus removing all danger of corrosion.

In response to the letter of Mayor McClellan to the Department of Water Supply, Gas, and Electricity, to which we made reference in a recent issue, the department's commissioner has submitted a report of a comprehensive plan for protecting two large areas in Manhattan and Brooklyn. The report is published in the current issue of the Supplement, and it will be sufficient to state here that the plan agrees broadly with the provisions above outlined. The first installment in Manhattan would cover the area bounded by Twenty-third Street and Chambers Street, Fourth Avenue and the Bowery, and the North River. It would consist of a system of mains served by three separate pumping stations. Over one thousand hydrants would each supply five three-inch hose at a pressure at the nozzles of 200 pounds to the square inch. There would be two hydrants at each street intersection, thus providing forty such streams to each block. The total supply in emergencies that could be concentrated on a single block would be 1,200,000 gallons per hour. Provision would be made for salt water connections should they prove necessary.

Brooklyn would be similarly served in three districts: Coney Island, the dry goods district, and the lower water front district. The total first cost of the installation would be $3,950,400 if electrical power were used, and $5,293,200 if gas engines were employed. Although the first cost is large, it is small in comparison to the great value of the interests protected.

FUTURE EXTENSION OF THE SUBWAY SYSTEM.

With the present subway lines in such a state of completion that the opening of the system for public use is only a matter of a few months' time at the most, the question of the location and inter-relation of new subways becomes of pressing importance, especially in view of the fact that at least four great corporations, to say nothing of the general public, are vitally interested.

The Inter-Borough Rapid Transit Company, in which is included the old Manhattan Elevated; the Metropolitan Railway Company, which owns practically all the street surface railways in Manhattan and the Bronx; and the New York and New Jersey Company, representing New Jersey trolley interests, have all applied to the Rapid Transit Commission for authority to build subways in this city; while the Brooklyn Rapid Transit Company, although not an applicant for authority to build, is anxious to cross the Williamsburg Bridge and run its cars over a belt line to be built between the two bridges that land in Manhattan, although it prefers that the connection should be made by means of an elevated structure.

It must be exceedingly gratifying to the Rapid Transit Commission to compare the present eagerness on the part of the big transportation companies to build subways with the indifference or distrust with which the rapid transit scheme was regarded by these same interests only four years ago, when bids for the construction of the present subway were solicited. At that time it looked for a while as though the years of labor entailed in arousing public interest, and securing the necessary legislative powers, were to be rendered useless by the reluctance of capital to embark upon an enterprise calling for such a large outlay of money, and necessarily involving many engineering problems of a novel and difficult nature. Great credit is due to the contractor, Mr. Macdonald, and his financial backer, Mr. Belmont, for the courage with which they took hold of this scheme, and the successful issue to which they have carried it. The practicability of building subways, the solution which it has afforded of many questions of construction and cost, and the flattering prospects of profitable operation, have removed subway enterprises from the domain of doubtful ventures to that of practical and very promising investments.

By the middle of the present summer, or at the latest by the early fall, when the term of the present subway contract expires, the new system will be in operation, and it will provide New York city with a four-track road from City Hall Park by way of Elm Street, Fourth Avenue, Forty-second Street, Broadway, and the Boulevard to 104th Street, and two divisions from 104th Street, one running north to the Harlem River and the other extending northeastwardly to a tunnel beneath the Harlem River, and through the Bronx to Bronx Park. The extensions now proposed are as follows: The Inter-Borough Company has applied to the Rapid Transit Company for permission to build an extension of the present subway system below Broadway from Broadway and Forty-second Street, where there is a station on the present subway, to Twenty-third Street, and thence south below Fifth Avenue, West Broadway, and Greenwich Street, to connect with the subway loop, which is now under construction at the Battery as part of the present extension of the subway to Brooklyn. They also seek authority for the construction of a subway and elevated system from the intersection of the present subway and Melrose Avenue in the Bronx, to and beneath the Harlem River, and down Lexington Avenue to a junction with the present subway at Forty-second Street and Fourth Avenue, in front of the Grand Central Station. This is obviously the next natural extension to be made of the present system; seeing that it provides an independent north-and-south line to the west of the present subway below Forty-second Street, and an independent line in the eastern section of the city north of Forty-second Street.

The Metropolitan Street Railway Company, which is one of those interests that was earnestly urged to undertake the construction of the present subway four years ago, are now so thoroughly convinced of the value of the system, that they have filed with the Rapid Transit Board an application for an even more extensive series of lines than that asked for by the Inter-Urban Company. They propose to build a subway from Third Avenue and 138th Street in the Bronx, to extend down Lexington Avenue to Fifteenth Street, then under Union Square to Broadway, down Broadway to Chambers Street, thence eastwardly below Chambers Street to William Street, down William Street to Hanover Square, and then to the Battery, by way of Coenties Slip and South Street; around the Battery outside of the present subway to Greenwich Street; up Greenwich Street, West Broadway, and Hudson Street to Eighth Avenue; and up Eighth Avenue, through the new Pennsylvania tunnel, and eastwardly through Thirty-fourth Street to a junction with its proposed line down Lexington Avenue. There would also be a crosstown connection between the east and west side branches on Thirty-fourth and Chambers Streets. As it is carefully stated in the application that the proposed subway would pass under the existing subway, evidently no connection is contemplated between the two, a defect which, we think, must militate very strongly against the application of the Metropolitan Company in its consideration by the Rapid Transit Commission. On the other hand, the company pledges itself to a system of transfers between its subway lines and the sixteen crosstown surface lines which it controls.

The evidently careful avoidance of the present subway lines, which is manifested in this application, will suggest at once to the public mind that the proposition, if accepted, will be directly opposed to that very unification of the transportation system of this city which is so eminently desirable, as proved by the good results shown in the excellent management by the Metropolitan Company of its own amalgamated street surface lines.

In addition to these very ambitious proposals, the New York and New Jersey Company, which has just completed its first tunnel beneath the river, has applied to the Rapid Transit Commission for authority to extend its tunnel by way of Tenth Street and Sixth Avenue to Herald Square, an extension which would put the large residential districts of New Jersey in direct touch with what is rapidly becoming the principal shopping district of New York city.

The last, and not by any means the least important, subway extension is that proposed by the Rapid Transit Commission itself, which has for its object the provision of a belt line between the termini of the Brooklyn and Williamsburg bridges. This subway would extend from the Brooklyn Bridge by way of Centre Street, Grand Street, and Delancey Street to the terminus of the Williamsburg Bridge. It is sincerely to be hoped that the connection between the two bridges will be made by subway, and not by elevated structure. The elevated structure is preferred by the Brooklyn Rapid Transit Company, for the reason that the Brooklyn Rapid Transit Company's cars are not suited, because of their lack of fireproof provision, for subway travel. If a subway is built, it would be necessary for the company to provide an entirely new equipment of cars, and this, in their present condition, they are utterly incapable of doing. To build an elevated structure between these points would add a further disfigurement to the city and would be a step backward from modern, up-to-date methods. Perhaps the best way out of the dilemma would be to build a subway between the bridges, and operate it as a separate system, providing loops at the Manhattan end of the Williamsburg Bridge for the return of the Brooklyn cars. This would serve until the advent of the day, which is most certainly coming, when the whole of the transportation system in Greater New York, elevated, surface, and subway, in Manhattan, the Bronx, and Queens, will be unified in one system, with a single five-cent fare between all points.

A FLORAL MAP OF THE UNITED STATES AT THE ST. LOUIS EXPOSITION.

The exhibit of the Bureau of Plant Industry of the United States at the St. Louis Exposition will be one of the most interesting exhibits at the Fair. Work has already been commenced upon the making of the monster map of the United States, to form a greater portion of the exhibit. Mr. D. A. Brodie, an expert in the employ of the Plant Department, is superintending the work of laying out the map, though the United States government board appointed by Congress to represent the Federal government at the Exposition will have charge of the appropriation of $5,000. The map will cover six acres, and each State is to be outlined by a cinder path. The entire area has already been underlaid with wooden drains, plowed deep and planted in cow-peas as fertilizers. In each State reservation will be shown plants grown in that State. Where the climatic conditions of St. Louis forbid the growing of plants out of doors, they will be grown under glass. Cotton, tobacco, and sugar cane are to be shown in the Southern States, orange and pineapple in Florida, and corn and wheat in the Middle States. No attempt

will be made to show the principal waterways of the United States. The waste places on the margin of the map, resulting from irregular coast lines, will be used for plant exhibits of various kinds, showing plants grown around the world. Men in the employ of the Bureau of Plant Industry are now scouring the world in search of grasses and plants to be shown to visitors at the Exposition. One patch of ground is to be devoted to cereals, another to poisonous plants, another to fiber, and still another to seed production, grasses, plant breeding, etc. A school of gardening will also be a portion of this exhibit. School children living in St. Louis will attend to a model school garden to be furnished by the government. Prizes are to be awarded to the most apt pupil at this school. School gardens are now becoming more and more popular. The map is located on a sloping hill, and adjoins the agricultural and horticultural exhibits and buildings. It may be seen from any portion of the main exposition grounds, and will be one of the instructive and beauty spots of the Fair.

BORINGS ON A CORAL REEF.

One of the most complete and important contributions to the study of coral reefs and their mode of formation that has so far appeared, even if we bear in mind Prof. Alexander Agassiz's recent work "The Coral Reefs of the Tropical Pacific" (Memoirs, Museum of Comparative Zoology, Harvard College, 1903), may be seen in a monograph just issued by the Royal Society of London, entitled "The Atoll of Funafuti: Borings Into a Coral Reef and the Results."

The project for the investigation of a coral reef with the object of elucidating its structure, originated at the Nottingham meeting of the British Association, held in 1893. At that gathering Prof. W. J. Sollas was successful in promoting a committee, charged to consider whether an exploring expedition was feasible; in the end it was decided to go forward with such an undertaking, and eventually the Royal Society took over the necessary arrangements.

After many meetings and consultations, it was decided to select Funafuti, an island in the Pacific Ocean, as the site for inquiry, the primary aim being the bringing up of a core of rock in order that the composition of the reef might be determined from zoological and chemical standpoints. Actual operations at this ring-shaped spot of land were begun as long ago as 1896, and they continued until 1898.

The well-known hypothesis of Darwin respecting the development of coral reefs in their several forms, although at one time regarded as a truth in geology, is no longer tenable in its entirety, a result largely due to the later observations of Agassiz and Murray. Darwin, himself, however, earnestly desired a fuller examination, *in situ*, than had been at all practicable in his own day, and in fact went so far as to express his conviction (in a letter to Agassiz in 1881) that nothing of a really satisfactory nature could be brought forward as contributory evidence until a boring was made in one or other of the Pacific and Indian atolls, and a core obtained down to a depth of at least 500 or 600 feet. That hoped-for consummation has, however, been over-achieved, since the boring at Funafuti was carried down to a limit of 1,114 feet.

Three expeditions were made before this could be accomplished. The first attempt was made in 1896 with Prof. Sollas as leader, but it ended in failure owing to a breakdown of the diamond-drill borer, consequent upon an inrush of reef "sand." A second, which set out in 1897, having Prof. Edgeworth David, of Sydney, as conductor, and aided by the loyal co-operation of various authorities in Australia, so profited by past experience that a depth of 698 feet was attained; while a third, under the guidance of Mr. A. E. Finckh, also of Sydney, carried the main bore down to 1,114 feet.

The general story of the expeditions is given in the monograph by the leaders who took part in them, and the narratives, whether detailing the various steps in making borings, or treating of the difficulties and even dangers that were encountered, provide a fascinating chapter of plucky and long-sustained effort. Besides the primary purpose of the survey, a good deal of correlated scientific work was done, in which Capt. Field, R.N., of H.M.S. "Penguin," who conveyed the first party, took a prominent part. He made a complete topographical survey of the atoll, and charted an extensive series of soundings in the waters of the lagoon and the outer sea, as well as carrying out a magnetic survey of Funafuti, not alone in the interests of terrestrial magnetism, but as specially bearing upon the geological investigation that was in hand. Then again, the opportunity was embraced of making collections representative of the general fauna, flora, and anthropology of Funafuti and adjacent islands in the Ellici group.

The cores from the early borings, and that from the later and main bore, were all of them shipped to Prof. J. W. Judd, F.R.S., of the Royal College of Science, London, for detailed examination by him and by other experts, thus fulfilling Darwin's old wish, and it may be readily imagined that this transport virtually marked the commencement of the inquiry. Although many papers and memoirs in various departments of science have laid Funafuti under contribution during the years that have passed since the expeditions, it was only to be expected that a long interval would elapse before the materials that were obtained could form the subject of a satisfactory official report. The magnitude of the task is abundantly indicated by the present monograph.

Dr. G. J. Hinde supplies an elaborated descriptive account of the organisms which have contributed to the building up of the atoll, compiled from an examination of hundreds of microscopic core slittings and other desiderata. The evidence derived from this piece of work goes to show that, whether in the form of solid rock-cores or as incoherent granular particles, the material appears to be entirely of organic character, traceable to the calcareous skeletons of marine invertebrate animals and calcareous algæ; of the latter, Halimeda and Lithothamnion occur in abundance. And Prof. Judd's comment is that "from top to bottom the same organisms occur, sometimes plants, sometimes foraminifera, and sometimes corals predominating; but in the whole depth bored the same genera and species of these various groups of organisms take their part in the building up of the mass," a striking and significant summary. The only portion of a vertebrate noticed in the borings was a fragment of bone or spine, met with in the center of a core of compact dolomite, from a depth of 1,060 feet, which appears to belong to a fish. Mr. Finckh deals with the biology of the living reef-forming organisms at the atoll, and the mode of formation of rock brought about by their presence. He assigns their relative importance thus: (1) Lithothamnion, (2) Halimeda, (3) the Foraminifera, (4) the Corals. This, and another important section on the geology of Funafuti, by Prof. Edgeworth David and Mr. G. Sweet, are of especial value.

The conclusions reached in this opportune monograph are presented in no controversial fashion; the idea has been to put forward facts and leave the interpretation to others. But unfolding as they do the conditions surrounding the present-day life of an atoll and the structure of the deeper parts of its body, they will be read with profound interest by all who study the problems indicated by the formation of coral reefs.

THE UNITED STATES IN 1903.

The Statistical Abstract of the United States for the year 1903, issued by the Department of Commerce and Labor through its Bureau of Statistics, has just made its appearance. It is a solid mass of 650 pages of figures, with scarcely a line of "reading matter" other than the tables of figures and their necessary headlines. Yet a study of its tabular statements develops many interesting facts about the United States, its progress, development, and relation to the other countries of the world. It is interesting, for example, to observe, as shown on page 564, that the exports of domestic products from the United States now exceed those of any other country of the world. They amounted to $1,392,231,000, against $1,379,283,000 from the United Kingdom, $1,113,313,000 from Germany, $820,671,000 from France, and $732,975,000 from Netherlands. In imports the United States stands third, the world's largest importer being the United Kingdom, $2,571,416,000; Germany second, $1,340,178,000; the United States third, $1,025,719,000; Netherlands fourth, $867,308,000, and France fifth, $848,046,000. The above figures of imports and exports are, in the case of the United States, for the year ending June 30, 1903; the others, the calendar year 1902.

Regarding the details of the foreign commerce of the United States, the Abstract shows that 72 per cent of the exports were sent to Europe, 15 per cent to North America, and the remainder distributed in much smaller percentages to South America, Asia, Oceania, and Africa. The total value of the exports from the United States to Europe in 1903 was $1,029,256,000; to North America, $215,483,000; to South America, $41,138,000; to Asia, $58,359,000; to Oceania, $37,468,000; and to Africa, $38,437,000. Considering the exports by countries, the largest total is to the United Kingdom, $524,263,000; the next largest to Germany, $193,842,000; and to Canada, $123,267,000.

Comparing conditions in 1903 with those of 1873, the exports have grown from $522,000,000 to $1,420,000,000, including domestic products and foreign merchandise re-exported. Agricultural products of course still form the largest group of exports, amounting to $873,000,000 in 1903, or 63 per cent of the total, while manufactures amount to $407,000,000, or 29 per cent of the total. Manufactures are, however, gaining rapidly upon agricultural products in the share which they form of the total exports. In 1880 agricultural products formed 83 per cent and manufactures but 12½ per cent of the total exports of domestic products, while in 1903, as already indicated, agricultural products formed 63 per cent and manufactures over 29 per cent of the total.

The value of domestic manufactures exported had never reached so much as $100,000,000 prior to 1876, and in 1896 for the first time crossed the $200,000,000 line. Since 1896, however, the growth has been rapid, the total exceeding $300,000,000 in 1899, passing the $400,000,000 line in 1900, and remaining above $400,000,000 constantly since that date, with a prospect that the total exports of manufactures for the fiscal year 1904 will exceed in value those of any previous year.

SCIENCE NOTES.

Dr. Hildebrandsson has presented his report to the International Meteorological Committee respecting the position, number, and dimensions of the permanent air currents of the globe. The summary of this report as the result of direct observations is as follows: (1) Above the heat equator and the equatorial calms there is throughout the year a current from the east, which appears to have very great velocities at great altitudes. (2) Above the trade winds there is an anti-trade current from the southwest in the northern, and from the northwest in the southern, hemisphere, respectively. (3) This anti-trade wind does not extend farther than the polar limit of the ordinary trade winds, but is deflected more and more to the right in the northern, and more and more to the left in the southern hemisphere, until it finally becomes a current from the west above the crest of the tropical high-pressure belts, where it descends to supply the trades. (4) There is an anti-trade upper monsoon above the districts at the equatorial margin of the trades, the anti-trade in winter and the equatorial current from the east in summer. (5) From the tropical high-pressure belts, the air pressure decreases on the whole as it approaches the poles; while the air of the temperate zone is drawn into a vast polar whirl turning from west to east. The air of the higher strata flows away from the whirl, and the air of the lower strata flows toward the center of the whirl. Furthermore Dr. Hildebrandsson asserts that the theory that there is a vertical circulation of air from the equator to the higher regions, finally falling at the poles, is altogether a fallacy. Dr. Hildebrandsson's report is a valuable and important contribution to the science of the new meteorology, and destroys many existing notions respecting the permanent air currents of the world.

Before the Institution of Civil Engineers, on December 22, Dr. T. E. Stanton read a paper on the resistance of plane surfaces in a uniform current of air. The paper deals with the results of experiments made in the engineering department of the National Physical Laboratory on the distribution and intensity of the pressure on thin plates and combinations of plates placed in a uniform current of air, and is intended as the first part of a research on the nature and distribution of the pressure of the wind on structures. By a uniform current of air is meant a current in what is known as "eddying motion" as distinguished from stream-line motion, the mean velocity at any point in the direction of flow being uniform across the current. This condition of motion is considered to be the nearest approximation to that of winds of fairly high intensity. The main object of the present research was to determine, if possible, a general relation between the velocity of the current, the dimensions of the plates, and the resultant pressure, as it was felt that experiments in the open air could not be undertaken with any prospect of success until some general relation of the kind has been established. The results of the experiments show that, under the given experimental conditions, a definite relation of the kind existed, and may be stated thus—for similar and similarly situated plates or combinations of plates in a uniform current of air, the intensity of pressure is the same for the same velocity of current and general atmospheric conditions. On the assumption that the motion of the wind approximates to that of a uniform current as defined above, the above relation shows that the distribution and intensity of the pressure of the wind on structures may be studied experimentally by means of models of the structures set up in a current of air produced by means of a fan, as in the present case. In illustration of this, the results of experiments made on models of roofs and lattice girders of simple form are given in the paper. Tabulated results are also given for the cases of parallel plates at varying distances apart, plates inclined at varying angles to the direction of the current, and the rectangular plates of varying ratio of length to width.

The Belgian and French governments have come to an agreement relating to the establishment of telegraph communication between the Congo Free States and the French Congo. Under the agreement a submarine cable is to be laid between Brazzaville and Kinshassa, the cost of which is to be borne equally by the two countries concerned. It is proposed to use Morse registering apparatus in the stations at either end of the cable. The tariff will probably be 2½d. a word, with a minimum rate of 10d. per message.