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 "

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, SEPTEMBER 3, 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.

THE MANHATTAN BRIDGE FIASCO.

In our issue of July 16 we presented a *résume* of the history of the city's abortive attempt to build a suspension bridge across the East River, at a point adjacent to the present Brooklyn Bridge; and we think that the average citizen of New York would have found that story positively entertaining, had it not been so completely humiliating to his civic pride. In the article in question, which is accompanied with illustrations of the substitute plans which are proposed by the present Bridge Commissioner, no attempt was made to criticize the engineering features of these plans, and this, not for the reason that they were by any means beyond criticism, but because we felt that the time was not then ripe for such discussion.

Judged purely from the æsthetic standpoint, the new design, if we except the anchorages, is pleasing, particularly as compared with the recently completed Williamsburg Bridge. The improvement is due to the very shallow depth of the stiffening truss, which runs at the floor level from end to end of the structure. Unfortunately for the design, what it gains in appearance from this shallow truss, it loses in structural efficiency. The object of such a truss is to prevent local sagging of the cables under a concentration of load at any point in the bridge where it may occur; but the ability of a truss to resist this bending is proportionate to its stiffness, and its stiffness is directly proportionate to the cube of its depth. Hence, other things being equal, the shallow truss, such as here proposed, will be a weak truss, unless, indeed, it be made extraordinarily heavy and an immense amount of steel material be massed into the upper and lower lines of the trusses, or what are technically known as the top and bottom chords. But if such a massing of material be made in order to compensate for weakness due to shallow depth, the truss becomes inordinately heavy, and an additional amount of material must be put into the steel cables to carry the increased weight of the trusses; consequently the bridge becomes proportionately heavy and costly.

Now this decreased strength and stiffness, or greatly increased weight and cost, as the case may be, does not appear in such a dainty little drawing of the bridge as was shown in our issue of July 16. It does not appear in the elaborately-shaded plans that were submitted to the Municipal Art Commission. All that is seen in those plans is a pretty picture of a rather graceful-looking structure. Such a drawing gives no information whatever as to the strength, the weight, the rigidity, the ease of erection, the cost of erection, and the thousand and one other items which must be carefully considered by the expert engineer before it can be said whether such a design is a practicable and useful one. It may be pretty—it is pretty. But before the city embarks on an expenditure of twenty million dollars for a public utility, it wants something more than a fanciful sketch, hastily drawn up by a newly-installed Bridge Commission.

Let us briefly state what are the indispensable requirements for the bridge in question. First, in view of the frightful conditions of congestion on the present Brooklyn Bridge, the new design should be of such a character as to admit of the most speedy erection. Secondly, in view of the astonishing rate at which travel between New York and Brooklyn increases, and the absolute certainty that big and wide as the bridge is being made, it will, before many generations have passed, be called upon to carry even more than its estimated load, it is imperative that the structure should be made exceptionally rigid and strong. Thirdly, it should have as great architectural or æsthetic beauty as is consistent with the requirements above stated. Now, comparing the two designs, the one accepted by the Municipal Art Commission was provided with eye-bar cables with a view to speedy erection, and it is certain that it can be constructed under contract in from three and a half to four years. It is equally certain that the new design with wire cables would take from one and a half to two years longer to construct, for the new Williamsburg Bridge, built generally upon the same lines and with wire cables, consumed over seven years in construction. As regards the comparative rigidity, the design accepted by the Municipal Art Commission embodies stiffening trusses that have a maximum height of 58 feet, whereas the new design gains its architectural appearance by cutting down this height from 58 to 24 feet, which is 16 feet less than the height of the trusses in the existing Williamsburg Bridge. We venture to say there is not a single competent bridge engineer in the world who, when first looking at this design, did not feel astonished to see that the designers should have returned, in a bridge of this stupendous magnitude, to principles of construction in the way of shallow stiffening trusses that were condemned and abandoned forty years ago. This very element of shallowness in the trusses condemns the design from an engineering point of view at the very first glance.

There is one more point of comparison of the two bridges which is perhaps the most important of all, and that is that whereas the design accepted by the Municipal Art Commission, prior to its acceptance, was submitted by the Mayor to the most eminent board of bridge experts that could be gotten together in this country, and was cordially indorsed by them, the new design, which was drawn up by one of the subordinates of the engineer who designed the first bridge, has never been submitted to any board of experts, and therefore has nothing back of it, in an engineering sense, more than the individual opinion of the engineer and his associates. The Municipal Art Commission can pass upon the æsthetic elements of the new design; but until this design has been submitted to an expert board, the Art Commission finds itself at a great disadvantage in making any comparison of the comparative engineering value of the two designs. For reasons best known to himself, the present commissioner appears unwilling to have any expert commissioner pass upon his plans; although if those plans are in complete shape it would not take more than a month's time to secure a report upon them. Why is the present bridge commissioner unwilling to submit these plans to the same expert investigation which passed upon the plans that he had rejected?

PERILS OF THE SUBMARINE.

The narrow escape of the crew of the submarine torpedo boat "Porpoise" from a terrible death during some recent practice off Breton's Reef, again brings forcibly to mind the great perils which attend submarine work. As far as can be learned it seems that the "Porpoise," in charge of two lieutenants and eight men, took a position off the lightship and there submerged, intending to make a run at the depth of 20 feet. The type of submarine to which the "Porpoise" belongs accomplishes its diving by maintaining a slight reserve of buoyancy, and then setting the submerging rudders so that they carry the boat beneath the water, the depth of submersion being determined by the angle at which the rudders are set. It seems that, in the present case, the rudders became jammed, so that they continued to carry the vessel down until she rested on the bottom at a depth, according to press reports, of 120 feet. To raise the vessel, an attempt was made to blow out the water-tanks; but of course, at this great depth, the water pressure tending to crush in the "Porpoise" was considerably greater than that which she was designed to stand, amounting to 52 pounds to the square inch, or about 3¾ tons to the square foot. It seems that when the valves of the trimming tanks were opened in the endeavor to expel the water from the tanks, it was found that they would not operate. Moreover, the enormous crushing pressure upon the boat started leaks, and the water began to come in through the seams of the plating and around the joints of the torpedo tube. In this emergency, which was about as terrible as could be imagined, Lieut. Nelson, who was in charge, utilized an air pump worked by hand, to expel the water, and after a long period of hard work on the part of the crew the boat slowly rose to the surface and was towed into Newport.

It is supposed that the trouble was due to the fact that the boat had not been overhauled for cleaning for nearly twelve months, and that, consequently, the sea cocks had become choked. The terrible plight in which the crew found themselves brings to mind the recent accident in the British fleet when a submarine was run down and lost with its entire crew. If the accident proves to have been due to negligence in the upkeep of the boat, of course there will be nothing in the incident to shake the faith of those who believe in the submarine as such. On the other hand, the incident serves to illustrate the special perils that attend this form of naval service, unless it be conducted with extreme caution and unremitting watchfulness.

ELECTRIC POWER FOR OIL WELLS.

M. L. Gaster, a prominent German engineer, has recently brought out some facts regarding the use of electricity in connection with petroleum production. The world's petroleum production for 1903 stands at 20,000,000 tons, and of this more than one-half is furnished by Russia, the rest coming from the United States and Canada, Roumania, and Borneo. The demand for petroleum greatly exceeds the present production. The substitution of oil for coal, in order to be advantageous, needs a better regulation of the methods of producing it and also of the price. In this connection the use of electric motors is a question of great interest. One point of superiority is the suppression of fire risks. As concerns the industrial applications, it will be remarked that in Russia oil is cheaper than coal, so that all the vessels of the Caspian Sea and Volga, as well as the locomotives of the Caucasus between Baku and Batoum, are now burning oil in preference. In England and France the question is not so far advanced and is only in the experimental stage both as regards locomotives and stationary engines. The use of current, which is generated in a large central station to operate motors for petroleum wells, is justified by the great extent of ground covered by the wells, as well as the danger from fire caused by the steam engines which operate the drills and pumps. Another reason for using such a system is the variations of load which occur at the different wells. These three points alone will therefore explain the advantages of a central station system.

The first wells to be drilled by electric motors were in Roumania, where the system was inaugurated five or six years ago. The first installation, provided with a set of motor-driven pumps, was put in by the Dutel Company. A central station was erected at a distance of 1½ miles, to supply the current. The motors are of the three-phase type, operating at 300 volts. The total capacity of the station is 200 kilowatts. Later on, the Lahmeyer Company, one of the leading German electrical firms, erected a large station for the Roumanian company Steana Romana to be used in operating a great number of wells. Hydraulic power is used here and the turbine plant can furnish 1,500 horse-power. Four dynamos of the three-phase type were installed, giving 300 volts each. A set of transformers raises the voltage to 11,000 for a high-tension line which runs for 20 miles or more to the well-district. Near the wells is a reserve station which can run in connection with the central plant. It uses three Diesel motors of 300 horse-power each. The motors use crude oil and consume 0.28 liters per horse-power-hour. A year ago there were as many as 30 electric motors in use at the wells at Campana and 27 at Bushtenari, or about 60 in all. The first cost of the plant was $2,400 per well, and the running expenses $40 per horse-power-year.

In Russia the conditions are less favorable for the use of electric power. This lies in the fact that the oil which is now consumed to furnish the power for the wells, is not subject to any tax, and therefore a very cheap supply of energy can be had, although it is wasteful and accompanied by fire risks. However, it is to be noted that there are a number of electric plants for operating the wells in the Russian district. One of these is at Balachani and it was the first to be installed. Almost at the same time a second electric station was erected in the district belonging to the Nobel Company. In the spring of 1901 a large central plant was laid out for 1,500 horse-power to supply the wells belonging to the Apcheron Company, on the Caspian. The station uses two steam engines and two dynamos of the Allgemeine (German) make. A great number of motors are used at the wells. Since then other electric plants have been installed at Balachani, Bibi-Eybat, Baku, and other localities.

THE PRODUCTION OF IRON ORES IN 1903.

Again the United States has surpassed all competitors in its yearly output of iron ores. This is the most important fact contained in the report made by Mr. John Birkinbine to the United States Geological Survey on the Production of Iron Ores in 1903. The report, which will be part of the annual volume "Mineral Resources, 1903," has just been published as a separate pamphlet and may be obtained free of charge from the Director of the Survey. Its opening paragraph declares that the quantity of iron ore produced in the United States in the year ending December 31, 1903, was 35,019,308 long tons. This means a decrease of 534,827 long tons, or about 1½ per cent, from the maximum of 35,554,135 long tons in 1902. The quantity mined in 1903 is, however, the second largest recorded and is greater than the combined totals for the year 1902 of Germany, Luxemburg, and the British Empire, which are the nearest competitors of the United States. The data for 1903 for these countries are not yet available, but the same comparison will probably prove true for this year also.

The iron ore obtained in 1903 came from 22 States and 2 Territories. Minnesota, Michigan, Alabama, and Wisconsin were the leaders in production. Nevada was added this year to the list of producing States, while Vermont and Montana reported no ore mined in 1903.

The iron ore mined was of the four general commercial classes: red hematite, brown hematite, magnetite, and carbonate. In 1903 the quantity of red hematite mined in the United States was 86.6 per cent of the total for the country, and of that Minnesota contributed over one-half. Alabama was the most important contributor of brown hematite. The three principal States that mined magnetite in 1903 were New Jersey, New York, and Pennsylvania. The red hematite showed a decrease of about 1 per cent from the production of 1902, the brown hematite and the magnetite a decrease each of 7 per cent. Only the carbonate ores, the least important class, showed an increase over the output of 1902. That increase amounted to no less than 26 per cent. As in 1902, all of this class of ore was obtained in Ohio and Maryland.

The Lake Superior district stands pre-eminent as a producer of iron ore. Its annual output exceeds that of any foreign country, and the average character of its ore is excellent. In the year 1903 the Mesabi and Vermilion ranges in Minnesota, the Marquette range in Michigan, and the Menominee and Gogebic ranges in Michigan and Wisconsin produced a total of 26,573,271 long tons of iron ore. Of this ore the Mesabi range alone produced 51 per cent. In addition to the above-named ranges in the United States, a sixth, the Michipicoten range, was opened in Canada in the year 1900, but its product in 1903, 223,976 long tons, is not included in the above data.

Of special interest in connection with the production of Wisconsin is the fact that the year 1903 witnessed the initial output of iron ore in the new Baraboo iron range, near the town of Freedom, in the southern part of the State. These deposits of Bessemer ore, which are within convenient railroad haul of the blast furnaces at Chicago, Ill., may furnish important additions to the ore supply of these furnaces.

The State of Pennsylvania showed a decline of 22 per cent from the total of 1902. This decline is due almost entirely to the diminished output of one of the large mines, the Cornwall Ore Hills, to which Pennsylvania has been mainly indebted for its position as a prominent producer of iron ores. New Jersey, on the other hand, showed an increase of nearly 10 per cent over its 1902 production. The construction of several modern furnaces was the chief cause of the increased output in New Jersey, and it is probable that an augmented production may be expected in the near future.

The total value at the mines of the 35,019,308 long tons of iron ore produced in the United States in the year 1903 was $66,328,415, or $1.89 a ton, an increase of 5 cents a ton, or 3 per cent, over the value per ton in 1902, viz., $1.84. In 1903 the highest average value at the mine was placed on the Colorado iron ores, viz., $3.12 a ton, and the lowest on Texas ores, $1 a ton.

Iron ore to the amount of 980,440 long tons, valued at $2,261,008, or $2.31 a ton, was imported into this country in 1903 from Cuba, Canada, Spain, Newfoundland, Algeria, the United Kingdom, British Columbia, Belgium, and Germany. It is evident from the relatively high value placed on the ores from some countries that the estimate is based on some other constituent than the iron contained in the ore. The total export of iron ore in the year 1903 was 80,611 tons, valued at $255,728. The greater portion of this went to blast furnaces located in the Province of Ontario, Canada.

THE HEAVENS IN SEPTEMBER.

BY HENRY NORRIS RUSSELL, PH.D.

The principal item of astronomical news for the past month comes from the Harvard Observatory. It may be remembered that in 1899 the announcement was made that a faint satellite of Saturn had been discovered upon photographs taken at the Harvard station at Arequipa, Peru. So long a time has passed since then that astronomers were beginning to fear that the satellite had been "lost," because it had not been possible to obtain enough observations to determine its orbit. But a short note from Harvard, which appeared a few weeks ago, sets these doubts at rest.

The satellite has been photographed on many occasions in the last five years, and a long series of observations obtained this spring has made it possible to calculate the orbit, and predict the satellite's motion accurately. The details of this are to be published in the "Harvard Annals," but have not yet reached us.

The following facts have, however, already been published: The period of the satellite is about a year and a half and its distance from Saturn is nearly 8,000,000 miles. It is an exceedingly faint object, its magnitude being about 15½, and it requires a telescope of two feet aperture to see it at all—though it can be better observed photographically. Judging by its brightness, its actual diameter is about 200 miles.

This satellite, the faintest known in the solar system, has been named Phoebe by its discoverer, Prof. W. H. Pickering. Phoebe was a sister of Saturn, and as three of his other sisters, Rhea, Deone, and Tethys, as well as two brothers, Hyperion and Iapetus, are already commemorated among his satellites, she will find herself in good company.

In addition to its extreme faintness, the new satellite is remarkable for its very long period—six times as long as that of any other satellite in the solar system. The calculation of the changes produced in its orbit by the Sun's attraction will furnish a problem of great intricacy, which will keep the theoretical astronomers busy, while to secure accurate observations of so faint an object will demand great technical skill.

The astronomers of the Harvard Observatory are greatly to be congratulated upon this very interesting discovery—especially Prof. W. H. Pickering, who discovered the satellite by a comparison of photographs, and Dr. Stewart, who took the plates at Arequipa.

The European delegates to the Astronomical Conference at the St. Louis Exposition are now in America. The English delegate, Prof. Turner, of Oxford—the present president of the Royal Astronomical Society—has visited America several times, and requires no introduction; but the name of his colleague, Prof. Kapteyn, of the University of Groningen, in Holland, may be less familiar.

He is probably unique among astronomers in being the director, not of an observatory, but of a laboratory—an institution whose business is not the making of observations, but the working up of observations made by other people.

With a modern photographic telescope, it is possible to take so many plates in one night that weeks are required for their measurement and reduction. Very few such instruments can therefore be worked to anything like their full power, simply because few, if any, observatories have a large enough staff to handle the enormous amount of material that would be obtained.

Prof. Kapteyn, who had no large telescope at his disposal, conceived the idea of working in co-operation with some one who had one, and entered into an arrangement with Sir David Gill, by which a great number of plates taken at the Cape of Good Hope were forwarded to Holland for discussion. The result of twelve years' work appears in the three bulky volumes of the "Cape Photographic Durchmusterung," containing a catalogue of the places of more than 450,000 stars in the southern sky.

Since the completion of this great work, there have appeared a series of the "Publications of the Astronomical Laboratory of Groningen," some of which deal with the parallaxes of stars and clusters determined from measures of plates taken at other observatories, and forwarded to Groningen for reduction, while others, treating of mere general topics, such as the average distance of stars of a given magnitude, or the relative numbers of stars of different degrees of actual brightness, are perhaps the most important contributions that have been recently made to our knowledge of the sidereal universe.

All this work is of the highest scientific value, and the fact that it has been done with relatively very inexpensive apparatus points a useful moral.

There is no way in which an American amateur astronomer, or a professor in a small college, could do more useful astronomical work than by following Prof. Kapteyn's example, and working up photographs in co-operation with some great observatory.

A good deal of work of this kind has been done at Columbia University, as its long list of publications dealing with the Rutherford photographs testifies; and recently this work has been taken up at some other observatories—for example, at Vassar—but there is still plenty of room for more workers.

This sort of work is admirably fitted for the smaller colleges. A measuring machine of the highest accuracy costs only a few hundred dollars, and if used in co-operation with one of the great observatories, work of the highest quality could be done with a relatively small outlay. There is no doubt that photographs would be available for any one who knew how to use them.

This would be particularly good work for students, as its educational value is great, and it can be done at the student's own time, involving no night work, and being independent of the weather.

It is much to be hoped that a number of "astronomical laboratories" may soon be founded in the United States.

THE HEAVENS.

The brightest constellations now in sight lie in or near the Milky Way. Cygnus is directly overhead at nine o'clock in the evening in the middle of September, and Lyra is west of it. Aquila is south of Cygnus, just past the meridian, and Sagittarius is below it on the right.

Capricornus is due south. It contains no bright stars, but at present it includes Saturn, which is the brightest object in the southern sky. Aquarius and Pisces, which lie in the southeast, contain no bright stars, but Fomalhaut, which is south of them, in the constellation of the Southern Fish, is fairly conspicuous.

Pegasus lies above these, with Andromeda and Perseus on the left, and Aries below the two. Cassiopeia and Cepheus are in the Milky Way, between Perseus and Cygnus, and Auriga is rising in the northeast.

Boötes is low in the west, beginning to set. Corona and Hercules lie between it and Lyra. Ophiuchus and Serpeus fill the southwestern sky. Ursa Major is low in the northwest, with Draco and Ursa Minor above it.

THE PLANETS.

Mercury is evening star until the 15th, when he passes through inferior conjunction and becomes a morning star. He is invisible to the naked eye except for the last week of the month, when he rises about an hour before the Sun.

Venus is evening star in Virgo, setting about an hour after sunset. On the 23d she is quite near the bright star Spica.

Mars is morning star in Cancer and Leo, and is slowly moving out to the westward of the sun. He rises between 4.30 and 5 A. M. On the 28th he passes within a degree of the bright star Regulus.

Jupiter is on the borders of Pisces and Aries, and rises at about 8 P. M. in the middle of the month. His satellites afford a very interesting study for a telescope of three inches aperture or larger. On the evening of the 24th there is a specially interesting display, as the third and second satellites are successively eclipsed, and a little later the first satellite and its shadow cross the disk of the planet.

Saturn is evening star in Capricornus, southing at 10.30 P. M. on the 1st and at 8.30 on the 30th, and is well placed for evening observation.

Uranus is evening star in Sagittarius. On the 19th he is in quadrature, and comes to the meridian at 6 P. M.

Neptune is morning star in Gemini, and is observable before sunrise.

THE MOON.

Last quarter occurs at 10 P. M. on the 2d, new moon at 3 P. M. on the 9th, first quarter at 10 A. M. on the 16th, and full moon at 1 P. M. on the 24th. The moon is nearest us on the 9th, and farthest away on the 23d.

She is in conjunction with Neptune on the 4th, Mars on the 7th, Mercury and Venus on the 10th, Uranus on the 16th, Saturn on the 20th, and Jupiter on the 26th.

On the 9th of September there is a total eclipse of the sun. It is a remarkably long one—the duration of totality reaching six minutes—but, unfortunately, the track of the shadow, though 9,000 miles long by over 100 miles wide, lies entirely in the Pacific Ocean, without encountering any land at all, except at the extreme end. The eclipse can therefore only be observed on board ship, which precludes the use of telescopes and makes it improbable that any observations of much scientific value will be obtained.

Cambridge Observatory, England.

SCIENCE NOTES.

The relations between transparency, color, and temperature of the water are discussed by O. d'Aufsess in Ann. d. Physik.; the color affects the temperature, the temperature does not affect the color. It is not necessary to make comparative transparency observations always under the same conditions of the sky; the author found with his white disk, 1 meter in diameter, the same transparency value at noon with a cloudless sky, and after sunset. To study the influence of organic compounds which turn the color into yellow, he filtered water through vegetable earth, and determined the amount of soluble organic matter in the lake water.

For the meteorological service in German East Africa H. Maurer has devised a sun-dial which has proved useful at twenty stations whose magnetic declination is unknown and whose latitude is only known within half a degree. The instrument is disk-shaped. The dial forms a semi-cylindrical surface, the axis of the cylinder, the style, lying in the plane of the framing. When the style is mounted parallel to the earth's axis, a plummet rests against the quadrant plane and marks the latitude on it. There is a notch in the style, producing on the dial a spot of light, whose position is, by turning the instrument, adjusted to the sun's declination for the day according to a table.

At the International Hydrographical conference recently held at Copenhagen, the Scottish delegate, Mr. Robertson, of Dundee, described some recent and interesting new discoveries he had made concerning the Gulf Stream. It has heretofore been popularly believed that the section of the Gulf Stream which reaches the Faroe Islands goes direct to Norway. Mr. Robertson has discovered from the result of his investigations that the section, however, travels first to the Shetland Islands and then to Norway. He also pointed out that the Southern Gulf Stream sends a section to the North Sea which runs along the coast of Scotland and the North of England, touches Jutland, and then travels north. The high degree of saltness and the temperature in the North Sea this hydrographer has found to be purely attributable to this source.