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, MAY 23, 1903.

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 ARTISTIC ELEMENT IN BRIDGE DESIGN.

At a time like the present, when we are constructing in this country, and notably at New York, so many important municipal long-span bridges, it is of interest to turn to similar work which is being designed and executed by foreign engineers and contractors. We present in the current issue of the SUPPLEMENT a series of views of some recent notable bridges constructed in Germany and Switzerland, which are characterized by that strict regard for the æsthetic and architectural side of bridge construction, which is such a marked feature in the best Continental work.

Thanks to the Municipal Art Commission, in the city of New York strict attention is being paid, and we hope will continue to be paid, to the artistic side of all bridges, great and small, that are erected in the metropolis. Of course, the architectural embellishment of an engineering structure is something that requires to be undertaken by the architect or artist in direct collaboration with the engineer who designs the structure. This collaboration is now being carried out; but it is quite a question whether the bridge engineer, particularly if he intends to devote himself to city or county work, would not do well to round out his professional course by including instruction in at least the elements of architectural design, or some kindred study. Hitherto, American bridge engineers have been governed in their work too much by the strictest considerations of utility; and in the endeavor to design bridges that can be built with the least expenditure of time and material for the maximum amount of strength, they have produced structures that are a literal translation into steel of the straight lines and angles of the strain-sheet diagram. For economy of material and speed of erection, these bridges stand unsurpassed in the world; but it must be confessed that, with a few notable and praiseworthy exceptions, our bridges do not compare in beauty and harmony with their surroundings with the work of the Continental engineers. Among the exceptions may be mentioned the noble Washington Arch Bridge, over the Harlem River, and the design by the present Bridge Commissioner for the new Manhattan Bridge across the East River, New York; while it need scarcely be added that the famous Brooklyn Suspension Bridge will be always a thing of beauty, in spite of the fact that the details of its construction, judged from the modern engineering standpoint, must be considered rather crude.

AMERICAN RAPID TRANSIT IN LONDON.

The managing director of the Anglo-American Company which is building and equipping a large section of the London Underground Railways, states that the vast system of rapid transit which is being built beneath the city of London is progressing with far less disturbance to the streets and discomfort to the public than is our own in New York city. The difference is due to the depth at which the "tubes" are being built and to the fact that the material is soft and easy to tunnel. The most remarkable feature of the London system, according to Mr. Yerkes, is the great power station on the bank of the Thames, from which power for the entire system will be furnished. The building will contain ten 7,500-horse power engines, and when the plant is all in, there will still be room in the building to increase the power capacity by fifty per cent. An interesting detail of the enterprise is that a portion of the system is being equipped with four rails, of which two are the main rails for the cars, while of the other two one is the feeder, and the other the return rail for the current. The placing of the fourth rail is due to one of those government regulations—so common in Great Britain—that are inserted for the protection of the general public when important franchises are granted to public corporations. In the present case the Board of Trade stipulated that there must not be a drop of more than three or four volts in the pressure of the return current as received at the power house. The object of this restriction is to prevent leakage with its well-known disastrous electrolytic effects on gas and water mains. Now, it would be impossible to prevent leakage, if the common system of return by way of the track rails were adopted; since the ordinary vitrified earthenware insulators could not be used between rail and track. Hence the necessity for a separate properly-insulated return rail.

THE NEW CUNARDERS.

Some interesting light was thrown upon the subject of the two new express steamers for the Cunard Line at the recent annual meeting of the shareholders, when the president of the company stated that there was no truth in the report that the objections of the shipbuilders are due to their inability to construct two ships of the huge proportions and high speed called for by the government requirements. It seems that the shipbuilding firms consulted are fully prepared to build these vessels, which are to be of the same beam as the "Cedric," 75 feet, and are to be about 150 feet longer than the "Kaiser Wilhelm II." Moreover, they are prepared to guarantee that they shall show an average sea speed of 25 knots an hour, which is a knot and a half better than the highest speed for a single voyage ever made by a transatlantic steamer, and is over two knots higher than the average sea speed for a whole season of any existing ship. The government requirements, however, demand that the average sea speed, voyage by voyage, shall be 25 knots, and to insure this result the vessels would have to be capable of making an average speed for a single voyage under the best conditions of wind and sea of not less than 26½ to 27 knots an hour. As matters now stand, the British government expects the company to put these two ships in service with the stipulation that if they do not maintain an average throughout the season of 25 knots, they will be thrown back upon the shipbuilders' hands. As the two vessels will cost about $10,000,000, it can readily be understood that private firms are reluctant to undertake the contract subject to such onerous conditions.

The obligations imposed upon the builders of German express steamers are that the ship must give satisfaction on the trial trip, and that the builders must be prepared to remedy any defects that may show themselves during a specified period of their service; and these requirements would seem to be sufficiently exacting to protect the interests both of the government and of the steamship companies. It begins to be pretty evident that unless the government makes a considerable modification of its demands, the 25-knot steamers will never get beyond the paper stage.

FLIES AS CARRIERS OF BACTERIA.

There is, of course, nothing new in the theory that flies may be active agents in the spread of bacteria, but a forceful demonstration made under the auspices of Johns Hopkins University, which has been recently brought to our notice by a member of the medical staff of that institution, is well worthy of record in these columns. The experiments were conducted with a box that was divided into two compartments, in the first of which was exposed some food material infected with an easily-recognizable species of bacteria—harmless bacteria, of course, being used—while in the second compartment was placed an open dish containing a sterile nutrient such as is used as a culture medium for bacteria. Flies were placed in the first compartment, and, as soon as a number of them had been seen to walk upon, or eat of, the infected material, they were allowed to pass through a small door into the second compartment, where they had a chance to come in contact with the culture medium in the dish. The result was that bacteria deposited upon the surface of the sterile nutrient, multiplied there, and formed characteristic colonies. In these experiments molasses mixed with a growth of yellow bacteria was spread on a plate in the first compartment, and a dozen flies were put into the apparatus. Half an hour later, the door between the two compartments was opened, and as soon as several of the flies had been seen to come in contact with the sterile nutrient, the dish that contained it was covered and put away to develop. A few days later there had grown on the nutrient over a hundred colonies of yellow bacteria. The experiment was repeated with red and violet culture, and colonies of corresponding color were obtained. To prove that the germs from which these colonies grew came from the infected material in the first compartment, and not from accidental sources, further experiments were made with other groups of flies, but with no infected material in the first compartment. In this case, however, none of the dishes used in the second compartment developed yellow, red, or violet colonies. To prove further that the flies were the only means of transmitting the bacteria, experiments were made with infected material in the first compartment, but with no flies in the apparatus. The dishes containing the nutrient in these experiments also developed no colonies; and from these results it was considered to be absolutely demonstrated that flies are capable of carrying bacteria from one place to another, if they have an opportunity to come in contact with material containing these organisms.

BRITISH WORKMEN ON AMERICAN INDUSTRY.

The Mosely Industrial Commission to the United States, of which we have lately heard so much, was organized by the gentleman after whom it is named, who offered to pay the expenses of a certain number of secretaries of British trades unions for a visit to this country, in order that they might examine and report upon American industries. Not only did Mr. Mosely provide the necessary funds, but he accompanied the delegation himself; and the report of the findings of the various delegates is prefaced with one by himself, which is perhaps the most valuable, because of his broader point of view and his more philosophical treatment of the subject. There are in all twenty-two separate reports by the trades union delegates, representing as many different British industries. To insure that the field should be fully covered, a list of forty-one questions was proposed, which each delegate was requested to answer as far as he could. These questions related to the early training of the workmen in America; their general social condition; and the relations between employe and employer. The organizer of the commission reaches the conclusion that "The true-born American is better educated, better housed, better fed, better clothed, and more energetic than his British brother, and infinitely more sober. As a natural consequence, he is more capable of using his brains as well as his hands."

The commission as a whole agreed with Mr. Mosely. The reports are practically unanimous on the question of sobriety, although one of the delegates considers that "while the American workman is sober during working hours, yet he is as much inclined to a spree as the ordinary Britisher." On the question of gambling, it is considered that the American workingman, as such, knows practically nothing about it, and in this connection we are surprised to learn that the wagering habit is increasing rapidly in the present day among British workmen. Mr. Mosely draws attention to the fact that many of the leading positions in industry in America are held by men who are either English or Scotch. The delegates agree with him in the statement that one of the chief reasons why the American workman has an advantage over his British brother is that he has received a more thorough and generally better education. There can be no question that one of the chief inducements to self-improvement in American education, is the reasonable hope of advancement that social conditions hold out to young men of all classes in America, if their abilities fit them to fill higher positions. The delegates frequently allude to the great appearance of equality or absence of restraint in the intercourse between the masters and men. "But this," it is asserted, "is an effect and not, as seems to have been imagined, a cause. The American employer has more sense of the value to himself of what may be comprehensibly described as talent among those who do the work of the establishment than his British *confrère*." In this connection an instance is quoted of a young British mechanic whose ambition prompted him to come to America, and who was rapidly promoted until he became manager of one of the largest works in the United States, which under his vigorous direction forms one of the most successful in the country. It is urged that a little encouragement of the same sort would doubtless have kept the workman at home, with a benefit to English industry which it is difficult to estimate.

There is no doubt whatever that just here is to be found at once one of the greatest secrets of our industrial success in the United States, and of the comparative stagnation in many British industries. In Great Britain a workman or subordinate who presents a new device or theory to a superior will more likely than not be coldly received for his trouble. Here a premium is placed upon ingenuity and useful suggestions. Another most fatal hindrance to successful competition on the part of Great Britain with her Continental and American rivals is the fact, as pointed out by Mr. Mosely, that, "It has been the rule for generations past that as soon as a man earns beyond a certain amount of wages, the price for his work is cut down, and he, finding that working harder or running his machine quicker (naturally a greater strain) brings in the long run no larger reward, slackens his efforts accordingly." We are informed that this policy is rapidly passing away; and surely it is high time; for under such a system, there

can be no growth of that sense of community of interest, which is absolutely essential to secure the best results in the industrial world.

On the important question as to whether the American is on the whole better off than the English workman, the delegates point to the fact that while he receives higher wages, he has to work longer hours; and that though the wages are higher, the cost of living is greater. The general trend of opinion is that after income and expenditure have been balanced, the American is found to be better off than the British workman, to the extent of twenty per cent or so. This estimate, however, cannot be applied too broadly, for the reason that conditions differ considerably in different parts of the United States.

ELECTRIC POWER PLANT BELOW MOUNT RAINIER.

BY EARL MAYO.

The glacier-capped mountains of the Pacific coast offer excellent facilities for the development of hydraulic-electric power. To utilize the glacier flow, a power plant, the largest on the coast, is now being constructed, which will deliver electrical energy to the principal cities of Washington for the street railroads, interurban lines, and lighting plants, and also for mills, factories, and the principal commercial concerns.

The original source of the water power will be the great glacial cap of Mount Rainier, which towers 14,519 feet above sea level and is constantly reinforced by the warm mists and rain-clouds which are brought inland from the Japanese current which impinges on the neighboring coast. The moisture in the air, striking this great ice-cap, high above the limit of vegetation, is condensed, so that the glacial covering is constantly growing from the top while it is being melted away from the bottom. The present undertaking necessitates the damming of the Puyallup River below its junction with the Mowich at an altitude of about 1,700 feet above sea level. Owing to the peculiar formation of the mountain above this point, the Puyallup River drains not only the Mount Tacoma glacier, the Puyallup glacier, the South Mowich, North Mowich, and the Carbon glaciers, but also Crater Lake, into which the Carbon glacier discharges. From beneath the glacial ice, whether it ends in a precipitous cliff or presents a confusion of broken ice, cold water flows throughout the whole year. The hidden streams which flow for several thousand feet between the ice cap and the granite surface of the mountain, burst from beneath the edges of the glaciers with a loud roaring, and sometimes the curtain of water which leaps out, although of slight depth, may have sufficient force to carry a man off his feet.

Below the ice, in the almost impenetrable forests, the rainfall is perhaps greater than in any other part of the country. The wind which brings the mists ashore is always temperate, and the side of the mountain is sufficiently abrupt to catch the precipitation from clouds at varying elevations, while the dense woods tend to the preservation of all falling moisture. From experiments made in the neighborhood it is estimated that the annual rainfall on the western slope of Mount Rainier aggregates 150 to 160 inches. The rainy season begins in October and continues into the early summer—nearly every day during this period showing some appreciable precipitation. During this season there is more water available than is needed, and it happens therefore that the flow from the glaciers, although it never fails, is diminished by the cold weather. During the dry season, including the months of July, August, and September, when little or no rain is expected, the glacial flow is at its height and can be relied upon to provide an ample supply of water.

The water power which nature has stored in this cap of ice is regulated to the demands of man not only by its yearly variations, but also by the so-called glacial tides, which are manifest daily. The greatest flow from the glacier, owing to the influence of the sun, occurs from perhaps eleven in the morning until four or five o'clock in the afternoon. Owing to the distance that this water travels before being utilized for power, these high tides will reach the power station five or six hours later, and therefore the largest daily supply is available between five in the evening and eleven at night, when the city's illumination and street car travel make the greatest drain upon the plant. The glacial tides show a rise of perhaps two inches where the stream is broad, and of two feet where the water of the stream is crowded into a narrow channel, and they are the means of great economy, since, to a large extent, they regulate the power without artificial intervention.

At the point where the Puyallup River is being dammed, a series of rapids start, and extend to the comparatively level ground about 900 feet below. While the river normally travels down a cañon, it will be diverted by a flume and ditch along a bench or spur of the mountain, until it approaches a point above Lake Kapowsin, where there is an almost sheer decline to the foot of the rapids. The flume will be built with a section of eight feet wide by seven feet high, and will carry 2,000,000 tons of water daily. Here the canal, which will be ten and a half miles long, will discharge into a forebay or reservoir, which will hold sufficient reserve supply to operate the plant during any necessary repairs to the flume or ditch.

From the forebay, four steel pipes 1,700 feet long will carry the stream down the declivity at an average angle of 45 degrees, to the power station, which will be situated at the beginning of the level country below. When the necessary reductions are made for friction, the pipes will hold columns of water with a net head of about 850 feet. This is to say, although the pipes will descend diagonally, the water efficiency will be as great as if they descended vertically 850 feet. From these great steel pipes, which will be four feet in diameter at the top and taper to a five-inch nozzle, a compressed stream of water will be released with a spouting velocity of about 15,000 feet, or nearly three miles a minute. This stream will be released in the shape of a solid round bar which strikes the cups of an "impulse" or tangential water wheel, so that the greatest efficiency known to hydraulics may be attained. The four impulse wheels will be connected directly to the generators, which are now being built by the General Electric Company, and which will be unequaled by any now employed west of the Rocky Mountains, having a capacity of 3,500 kilowatts, or 5,000 horse power each. An alternating current of 2,500 volts will be generated and stepped up to 45,000 or 55,000 volts, and then transmitted to Tacoma, which is about 30 miles, and to Seattle, which is about 45 miles distant.

The engineers have completed the laying out of the flume and ditch line, and while the great generators and water wheels are being constructed, several hundred workmen are employed in clearing away the giant trees and rocky ledges that stand in the way of the free passage of the water between the diverting dam and the forebay. Meanwhile, also, preparations have been made for laying the great steel pipes down the face of the headland, and concrete anchors will be set into the hill to sustain the enormous weight of 1,700 feet of water, and prevent the pipes from forcing their way into the power house. Each tangential wheel receiving its impulse from this weight of water will revolve with a speed that would send its periphery 7,000 feet a minute, and the four wheels will develop 20,000 horse power.

CARRIER PIGEONS FOR THE GERMAN NAVY.

For some time past severe experiments have been conducted by the German naval authorities to ascertain the suitability of the carrier pigeon for intelligence service in the navy; and so successful have these trials proved, that permanent pigeon stations are to be erected. The chief of these will be at Wilhelmshaven and Helgoland for the North Sea, and at Friedrichsort for the Baltic. To assist the Admiralty in its scheme, sixty-one carrier pigeon clubs have placed their services at the disposal of the authorities. Six of these clubs have stations on the east coast—two at Kiel, two at Rendsburg, one at Nortof, and one at Lubeck—while there are no less than forty-two stations on the North Sea coast—sixteen at Hamburg, four at Bremen, the others being distributed over the country of the Lower Rhine, between Crefeld and Düsseldorf. The Naval Department will thus have sufficient birds and conveniences at their disposal and will defray the cost of conveying the baskets containing the birds to the various warships, and the return of the baskets to the respective clubs to which they belong.

From the results of the experiments it is estimated that the birds have sufficient endurance to fly home from a point 300 kilometers from land; and to insure the rapid delivery of a message to the desired quarters from a war vessel at sea, a system of duplicating the messages is to be adopted, varying with the atmospheric conditions prevailing at the time of dispatch, the distance to be covered, etc. For instance, up to 80 kilometers two birds will be released bearing the same message, and from 80 to 300 kilometers from three to five birds will be dispatched. Naturally, the time occupied by the birds in flying over the distance to be traversed depends upon the capabilities of the messenger, and the weather, but it is estimated that one kilometer per minute is the minimum speed likely to be attained.

The general practice of sending the message in a quill attached to a tail feather will not be adopted, as this has been proven to be generally unsatisfactory. Instead, the message will be inscribed upon thin vegetable paper, which will be slipped into an India-rubber case and secured to the bird's foot by means of a ring of the same material. As the birds arrive at their respective homes on land the messages will be detached and forwarded unopened to the news-collecting office and there dealt with. At the pigeon stations on the North Sea coast, there are wireless telegraph stations, and the messages will therefore be retransmitted thence to the head office. For this service special regulations have been prepared. In future every warship, except torpedo boats, leaving Kiel or Wilhelmshaven will be compelled to carry a consignment of carrier pigeons to be released at varying distances from the land stations. The utilization of carrier pigeons for intelligence purposes has long been in vogue in the German army, with conspicuous success, and this latest development will mark a new departure in naval warfare.

SCIENCE NOTES.

Dispatches from the Bourges observatory show that the sun after a long period of quiescence has again entered into a state of activity. On March 27, there was visible on the solar disk a large spot measuring 1,864 miles in diameter. Again, on March 30, four sun spots, two of them extensive, were observed.

C. Hartwich and W. Uhlmann state that the fat of gentian root is not a saponifiable oil, but a cholesterin-like body. The chloroformic solution, when treated by Hesse's test with concentrated H_2SO_4, colors the acid a bright red with a green fluorescence, and the chloroformic layer passes from yellow to red, and finally, after standing for twenty-four hours, to violet. By Liebermann's test, treating a solution in acetic anhydride with concentrated H_2SO_4, a red color, passing, on shaking, to bluish-green, and finally olive green was obtained. A similar cholesterin reaction also resulted with Salowski's test. The fat was extracted from the root by means of ether. It occurs to the extent of 5.67 per cent, and forms a dark yellow, viscous substance, having the characteristic odor and taste of the drug. By shaking out the petroleum ether solution with water and alcohol, 50 per cent, the odorous and bitter principle is removed.

That there are bacteria, some large fungi, and rotten woods which give phosphorescence or shine in the dark, has long been known, but it is a question whether there are shrubs or flowering plants that have the same property. Dr. H. Beckurts has recently, however, discovered a notice printed in 1845, stating that at the session of the Royal Asiatic Society, held April 5 of that year, the dry roots of an Indian plant were exhibited which possessed the property of shining or phosphorescing in the dark. An Indian officer, so goes the story, who took shelter from the rain under some projecting rocks, observed that the neighboring grass phosphoreseed, and he gathered several specimens of the grass and brought them to General Cullen. The latter stated that the plant was long known to the Brahmins under the name of "diotishmati," belonged to the family of the vegetable Sapindaceæ, and was identified as the *Cardiospermum halicacabum*. This, however, cannot be, since Lindley, who presented the root to the association, stated that it was a rhizome of a monocotylic plant of the Orchidaceæ or Iridaceæ. According to Watson the Indian plant "diotishmati" belongs to the grasses. It is, however, believed that the fact in the case was that the plant was probably covered with one of the phosphorescing fungi, which caused the error of observation in the young officer.

Mr. F. W. Very, of the Allegheny observatory, recently published a series of measurements on the radiations received from different portions of the solar disk. The measured amounts of radiation were found to diminish outwardly from the center, contrary to the assumption of a uniformly absorbing atmosphere. Taking Mr. Very's figures as a basis, Prof. Arthur Schuster, of Manchester, publishes in the Astrophysical Journal an examination which shows that the difficulty of explaining the law of variation of intensity across the sun's disk is readily removed by placing the absorbing layer sufficiently near the photosphere and by taking accounts of the radiation which this layer, owing to its high temperature, must itself emit. There is no reason to look to a different region in the sun's atmosphere for the cause of the observed diminution of radiation than that which gives the Fraunhofer lines. The simplest supposition to make at present, and one consistent with our knowledge of spectra, is that the layer which gives the line-absorption absorbs also to some extent all wave lengths extending from infra-red to violet, and that the diminution in the observed intensity of the solar radiation toward the edges of the disk is due simply to this absorption. The principles developed in this paper may find a wider application. Some observers have been puzzled by the fact that the radiation of the umbra of sun spots does not diminish as it nears the edge of the sun in the same way as that of the luminous disk itself, but, on the contrary, remains nearly constant. This investigation shows that in the case of the solar disk only about half of the radiation comes from the photosphere and that the rest is made up by the radiation of the absorbing layer itself. If that absorption, either by increased density or by greater thickness, is increased four or five times, practically the whole of the radiation would come from the absorbing layer and would be nearly constant for different portions of the solar disk.