SCIENTIFIC AMERICAN

ESTABLISHED 1845

MUNN & CO. - - Editors and Proprietors

Published Weekly at
No. 361 Broadway, New York

CHARLES ALLEN MUNN, *President*
361 Broadway, New York
FREDERICK CONVERSE BEACH, *Sec'y and Treas.*
361 Broadway, New York

TERMS TO SUBSCRIBERS

One copy, one year for the United States or Mexico.................... $3.00
One copy, one year, for Canada.................... 3.75
One copy, one year, to any foreign country, postage prepaid. £0 18s. 6d. 4.50

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, including Canada, 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, OCTOBER 12, 1907.

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.

A SWEDISH CHALLENGE FOR THE CUP.

At the present writing it looks as though the New York Yacht Club would, in the near future, be confronted with a challenge for a series of races for the "America's" cup from Sweden, a request having been received through the Royal Swedish Yacht Club for full details regarding the conditions which would govern such a contest. Upon the receipt of this information it is probable that a challenge will be sent for a series of races in the year 1909. As far as one may judge from cable dispatches, the proposal has been received with widespread approval in the land of the Vikings, and, indeed, should the event come off, is likely to take on even more of a national character than have some of the recent British attempts to secure the much-coveted trophy. This is so far true that the two yachtsmen who are the moving spirits in the matter, propose, after themselves providing the major part of the price of the yacht, to throw the matter open for general subscription. Novel, if not fantastic, as such a plan might seem to be, it is actually only an extension of the syndicate method, by which the heavy cost of building and racing of our later cup defenders has been distributed.

Now that Sir Thomas Lipton has disavowed any intention of further prosecuting his plans for a fourth challenge for the cup, it must be admitted that there is something very attractive in the idea of seeing a Swedish yacht, designed and built in Sweden, and manned by the far-famous Swedish sailors, competing over the classic Sandy Hook course for the world-famous trophy. Historically Sweden may justly claim to be connected, if not with the cup, at least with the famous schooner which originally won it; for in 1852, the year following the "America's" success at the Isle of Wight, the Swedes who, at that time, were turning out some of the fastest schooners in Europe, built a large schooner which they named the "Sverege," and challenged the "America" to sail a race from Ryde pier to a point 20 miles to leeward of the Nab Light and return, the wind to be of a strength of at least 7 knots at the start. The "America" was then owned by Lord John de Blanquiére, who had purchased her from Commodore Stevens for the sum of $25,000. The Swedish yacht builders had for some time been constructing their boats on somewhat similar lines to those of the "America"; but the "Sverege" was a much larger craft, measuring 280 tons against the "America's" 208. The "Sverege" led the "America" around the outer mark by 8 minutes and 26 seconds; but in rounding she carried away the jaws of her main gaff and the spar had to be nursed somewhat in the beat home against the wind. According to the historian, the Swedish vessel ran into thick weather and overstood the mark by 20 minutes, finishing, however, 26 minutes behind the "America," whose superior sailing with sheets aboard, won the race.

Although in the intervening fifty years Sweden has never been represented by a challenger for the cup, she has been most intimately connected with its defense through her unrivaled sailors, who in late years have constituted the major part of the crews on the defending yachts. If the proposed race should come off, it is probable that we shall have to fall back upon the men from Deer Island, from among whom in previous years Capt. Hank Haff and other American skippers were wont to select their racing crews. The Royal Swedish Yacht Club is a very influential organization with something like two thousand members and a register of over six hundred yachts, of which only comparatively few are steamers. Swedish yachtsmen are second to none in skill and enthusiasm, and although they have had no experience in the construction of extreme racing machines such as have been evolved by the "America" cup contests, there is no reason to doubt that they will send to Sandy Hook a yacht so well built and ably manned that an excellent series of races will be assured.

AMBITIOUS SCHEME OF ELECTRIFICATION.

What is unquestionably the most important project of electrification of a steam railroad under consideration in any part of the world, is that recently announced by the Southern Pacific Railroad Company through one of its vice-presidents, who has requested Mr. Sprague, the father of the multiple-unit system of electric operation, to study the question of electrifying the Sacramento Division of the Southern Pacific system which extends for a distance of 136 miles from Rockland to Sparks. For some years Mr. Babcock, the electrical engineer of the Harriman lines, in company with the engineers of the leading electrical manufacturing companies, has been making a special study of this project; and the joint report of these gentlemen and Mr. Sprague will be the subject of final action by the directors.

The magnitude of the problem will be understood when it is remembered that the other two important electrifications of steam railroads, those of the New York Central and the New Haven lines, cover, in the one case, a stretch of 34 miles, with a branch of 15 miles, and in the other case of 22 miles. It is a far cry from this to the electrification of a road approximately equal in length to the road from New York to Albany; and the difficulties of the Southern Pacific problem are further increased by the fact that the work must be done on a mountain division, over which is carried the entire freight and passenger traffic of the Union Pacific system between Central California and the East. Moreover, in a distance of 83 miles the line rises nearly 7,000 feet, and the road is single-track, full of the characteristic sharp grades of the western mountain summit division, and includes over 31 miles of tunnels and snowsheds. Although there is a heavy traffic, it is intermittent; and the difficulty of keeping open an electric service in the winter is complicated by the fact that the snows will often drift to a depth of 15 and 20 feet. Although this division is worked by powerful modern locomotives it is found to be difficult at times to maintain the traffic, which is occasionally congested to the point of an absolute blockade. However, since this mountain forms, as it were, the neck of the bottle on one of the most important of the transcontinental lines, it is realized by the directorate that a point has been reached when some radical change must be made to secure an increased capacity for traffic. Of the alternatives presented, there is first, that of paralleling the present track, which would be an exceedingly difficult and costly work; second, the location of an entirely new line with easier grades and the reduction of the summit level by the construction of a great tunnel through the mountain; or thirdly, a change of motive power from steam to electricity. The question to be decided is not as to whether it is feasible to operate this 136 miles of mountain road electrically—there is no doubt whatever on that point. The final decision of the directors will be determined by the questions, first, as to whether the present and probable future traffic will warrant the enormous outlay which will be necessary, and secondly, as to whether the change to electric traction would provide an increase of capacity larger than could be secured by any other method

OUR STUPENDOUS RAILROAD SYSTEM.

The railroad system of the United States outranks in mileage and business all the other railroads of the world in much the same way as the shipping industry of Great Britain overtops that of every other maritime nation; and if we were asked to indicate that special sphere of industrial activity in which this country has achieved its most marked and individual success we would select our wonderful system of railroads. The latest statistics for the year 1906, as given in Poor's Manual, show that the rate of growth is steadily maintained therein, reflecting the widespread prosperity which the country is now enjoying.

The total number of miles of railroad under operation is 220,633, an increase of 5,000 miles in the year, and on these roads there were carried over 815 million passengers and 1,610 million tons of freight, the corresponding earnings being on passenger traffic 520 million dollars and on freight traffic 1,650 million dollars. Adding to these totals other sources of revenue we reach a total of gross traffic earnings for the past year of 2,347 milllion dollars, and the net earnings on this business amounted to 790 million dollars. Adding other receipts, a total available revenue was shown of 890 million dollars. This represents an increase in 1906 over 1905 of over 234 million dollars, or more than 11 per cent.

The operation of the system called for the service of 55,439 locomotives, 83,896 passenger cars, 12,295 baggage and mail cars, etc., and 1,979,667 freight cars, making a total of over two million revenue-earning cars. Equally large are the figures representing the financial liabilities. The capital stock amounting to over 7,106 million dollars, the bonded debt is 7,851 million dollars, and other liabilities bringing up the total to the enormous sum of 17,534 million dollars. Of the assets 12,719 million dollars represent the cost of the railroads and equipment, and 2,544 million dollars in stocks and bonds owned.

It is of considerable interest to trace the growth of the system by decades. Thus, in 1881, there were 130,455 miles of track, about 20,000 locomotives, and 667,218 cars. In 1891 there were 214,529 miles of track, 33,563 locomotives and 1,194,130 cars. In 1901, the track mileage had risen to 266,000 on which there were at work about 40,000 locomotives, and 1,445,283 cars, while in 1906 the total miles of track, the track in these figures representing actual mileage of single track, 307,000 miles, with, as we have seen above, 55,439 locomotives and over two million cars.

In view of the present anti-railroad movement in this country and the hostile spirit which is undoubtedly manifesting itself with increasing emphasis, it is notable that the average interest rate on railroad bonds during 1906 was 3.99 per cent, and the average dividend rate on all railroad stock was 3.63 per cent. These low average rates of capital invested in the railroad are highly instructive as bearing on the question of the reasonableness of railroad rates in this country.

THE FORMULA AND THE TESTING MACHINE.

The Quebec Bridge was the victim of a too blind faith in the formula. This primarily. Possibly it was the victim of the unwise practice of permitting the successful contractor for a bridge to work out the details of the design himself. We understand that the contract for this bridge was taken for a fixed sum. If so, this obviously imposed upon the engineer who developed the plans, the task of keeping down the sum total of material in the bridge to the lowest possible figure compatible with safety. The obvious way to reduce the total weight was to use a high unit of stress, and in the Quebec Bridge, and particularly in the compression member which failed, a unit stress was used which, to put it mildly, simply staggered the engineering world when the strain sheet of this bridge was made public. And yet, it is a fact that even with the high unit stress employed, if the formula used in calculating the compression members had been as reliable in these abnormally large sections as it had proved to be in smaller sections, the bridge should not have gone down, even when completed and loaded; and certainly it should not have fallen when loaded as it was at the time of the collapse, with only one-half of the calculated maximum load which might be imposed when the bridge was in operation.

Among the many lessons taught by this catastrophe, the one which stands out pre-eminently is that some of our bridge engineers have been placing an altogether too implicit faith in the commonly accepted formula for compression members, and also that they have been too anxious to practise economy of materials. In proof of this we direct attention to the comparative sections on another page, drawn to the same scale, of the chord member of the Quebec Bridge and that of the Forth Bridge. The strain sheets of the Forth Bridge have never been published, but presumably the load on the corresponding members in the two bridges was about the same. If so, one or other of the two engineers responsible for these designs was wofully in the wrong. Either Baker's enormous and rigid tubes are absurdly big, heavy, and costly, or the curious assemblage of flexible plates in the Quebec Bridge member is ridiculously light and inadequate. A prominent engineer, since connected with the Quebec design, some sixteen years ago stated that an American engineer could have taken the money subscribed for the Forth Bridge, and after building the structure have turned back fifty per cent to the owners, instead of having to collect, as was done, forty per cent in excess of the estimate. We have now seen the experiment made with a cantilever bridge of slightly larger dimensions; and the result of the attempt to build such a structure by the more economical method of using flat plates, pin connections, and high unit stresses, is shown in the 17,000 tons of steel junk which now encumbers the bed of the St. Lawrence River.

And yet, in all fairness it must be admitted that, according to the formula used for the compression members, they should easily have stood up under the load under which they collapsed. Some modification of the formula for built-up rectangular compression members is evidently necessary, when it is applied to such large sizes as those in the Quebec Bridge; and we think it cannot be disputed that the only satisfactory way to determine the actual strength of the largest rectangular columns of the character almost universally used in American bridge practice, is to put up a testing plant sufficiently powerful to make the required tests.

Does it not look as though the time has arrived when, in view of the enormous interests involved, Congress should appropriate funds for the institution of such a plant, in which tests, even as costly as these, could be carried out? The testing of large-sized bridge members would form only a part of the work which such a plant would accomplish. The rapid development of concrete construction, for instance, has brought in its train a number of problems which call for immediate investigation. Evidence of this is afforded by the many failures of armored concrete which are continually occurring. It is positively appalling to think of the number of buildings, factory chimneys, bridges, etc., which are being rushed up all over the country, and contemplate the fact that no small percentage of them embody inherent weakness either of design or construction, which may bring about their ultimate collapse. In the field of concrete-steel alone, a government plant of this kind would yield invaluable results. It is true that the government is doing, and has done, a large amount of work of this character in plants of limited capacity, but the plan we advocate would call for a thoroughly comprehensive, well-equipped plant, presided over by a corps of civil engineers, permanently assigned to their positions, who would thus acquire that store of cumulative knowledge and proficiency which continued service in a special line such as this can alone insure.

HOW TO PREVENT FAILURE IN CONCRETE CONSTRUCTION.

The many failures which have recently occurred in concrete constructions emphasize the necessity for a revision of some of the current methods of design and erection, and the formulation and strict enforcement of building laws of a thoroughly searching character. As we have frequently pointed out in these columns, there is no material of construction that offers such inducements to cheap and fraudulent work on the part of the unscrupulous contractor as armored concrete. As throwing a great deal of much-needed light on this subject, we direct attention to a voluminous paper read before the Western Society of Engineers by Dr. W. Michaelis, Jr., and published in the current issue of the Supplement. The author of the paper deals at great length with the merits and limitations of cement and concrete and the causes of failure in concrete construction, and suggests means for the prevention of such failure. While, on the one hand, manufacturers exaggerate the advantages of cement, on the other hand the engineer and architect make unreasonable demands, and misinterpret the failures in concrete construction that so often occur. The best way to establish confidence in this modern building material would be to minimize the danger of failure by establishing proper building ordinances, which would compel the contractor to handle the material in the prescribed way, and to make proper tests of it while the building is in course of construction. The principles governing modern concrete construction are thoroughly understood, according to the author of the paper, by comparatively few; and this explains the divergence of opinion on many points pertaining to this branch of the building industry. While some engineers are careful to specify concrete of ample strength, others blame such "over-cautious" builders for making use of an excessive factor of safety. In reply to the statement frequently made by engineers that cement is not sufficiently uniform at present, and that if it could be so manufactured as to give as uniform results as steel, it would be possible for the engineer to reduce the larger factor of safety now demanded for concrete over that required for steel, the author of the paper answers that such a statement is entirely without foundation. Steel is a well-defined chemical compound rolled into the desired shape, while concrete is the sum of a number of factors. The calculation of a steel girder and that of a reinforced concrete girder can never be based on equal safety factors, no matter how much the properties of cement may be improved in the future; and it will not be improved in the future for the reason that we have arrived at the limits of its good qualities. In the opinion of Dr. Michaelis, the author of the paper, failures of concrete steel can be materially lessened, if not entirely prevented, by making it compulsory to use concrete of specified proportion of crushed stone, sand, and cement, and to use the proper kind of reinforcement in each case, and the necessary amount of it. Certain standard rules should be laid down by a Board of Building Examiners, and certain types of reinforcing material should be excluded where they are not in their proper place. Moreover, the erection of the building should be accompanied by continuous tests of the concrete that goes into the construction, and the builder should be compelled to inform himself of the strength of each column, girder, beam and floor slab before striking the forms and placing the load upon them.

THE ELECTRICAL SHOW AT MADISON SQUARE GARDEN.

The exhibitions of electrical devices and apparatus held each year at Madison Square Garden afford the public an excellent opportunity to study the progress of electricity in various branches of its development. To be sure, exhibitions of this sort are not intended for the purely technical man, and as a consequence do not include many improvements of a strictly technical character, but show largely those with which the general public is immediately concerned. Naturally, those devices and appliances which are adapted for use in the household claim the greatest popular interest. At this year's show, which has just been brought to a close, the advantages of an electrically-equipped household were strikingly set forth in the exhibition of a model apartment. This comprised a living room, parlor, bedroom, dining room, kitchen, and butler's pantry, equipped throughout with all the latest electrical improvements. Here the spectator had an opportunity to examine in real life many of the appliances which, from time to time, he has seen illustrated and described in the columns of the Scientific American. Naturally, the kitchen, which is the housekeeper's workroom, afforded the best opportunity for the display of inventive ingenuity. Here an electric range was installed, furnished with oven, broiler, griddle, and three "stoves." This was large enough to do the cooking of a family of six. Other apparatus consisted of a meat chopper, a coffee grinder, an electric dish-washing machine, electric irons, etc. The cleanliness of electric cooking has made it possible to do some of this work in a small way on the dining-room table. The dining-room set comprised a chafing dish, coffee percolator, waffle iron, dish warmer, and the like. In the bedroom were the various devices of the toilet, heating pads, foot warmers, milk warmers, and electric lamps which could be turned low to give a dim light at night. In the parlor, aside from the artistic arrangement of the lights and the electrically lighted and heated grate, was a piano automatically played by a Tel-Electric player, and, whenever desired, orchestral music furnished by the Telharmonic system could be had by closing a switch. Electrical appliances for the household were not confined to this exhibit, but were also to be found in other parts of the building. There were various massage apparatus, hair driers, clothes-washing machines, portable vacuum cleaners, also laundry machinery, potato parers, meat choppers, and silver cleaners, made to do the work on a large scale for hotel use.

A feature of the show which aroused great interest was the operation of the cow-milking machine. Every afternoon at milking time a number of cows were milked by means of a vacuum milker operated by electricity. In this exhibit there were included a number of dairy machines, all electrically driven.

Many of the exhibits were very instructive. In one there was a section of a full-sized manhole of an electric main. This gave the public an opportunity to learn something about these mysterious chambers under our streets, and note the methods of splicing the huge electric cables. The method of manufacturing incandescent lamp bulbs was illustrated in practical form, the entire process being shown in actual operation. A lesson in the value of various lights was also given by showing a number of colored fabrics under different electric and gas lights. The introduction of electricity in the factory was shown by the large variety of machines and machine tools driven by electric motors. An elaborate exhibition of testing apparatus was a feature of the show which, if not of particular interest to the general public, was appreciated by the practical electrician. During the exhibition wireless telegraph messages were sent from one part of the building to the other. Altogether, the exhibition was a very successful one, and an improvement on that of last year.

THE SO-CALLED HYPNOTIC INFLUENCE OF SNAKES.

BY THOMAS C. HUTTEN.

It is a popular belief that serpents have the power of capturing their prey by casting a mysterious spell over the victims. Even scientists have seriously considered this supposed mesmeric power over birds. Cuvier ascribed it to narcotic effluvia; Audubon to the self-sacrificing audacity of nest-birds; Bonpland to the "instincts of curiosity and maternal devotion"; Russel Wallace to "optic influences, akin to hypnotism." The latter theory is the most generally accepted, and in the rural districts, both of Europe and North America, bird-charming snakes are classed with such indisputable phenomena as fish-deluding anglers. Contemporaries of more than average intelligence will describe the glaring eyes of a rattlesnake that paralyzed a youngster on his way to school, and maintain that they saw it charm down a squirrel from the top of a walnut tree.

An opportunity was afforded me last summer of disproving the snake-charm theory. The pharmacist of a medical college had procured a number of live serpents for experiments with certain antidotes, and, during the summer vacation, boarded his pets in a suburb of Bennington, Vt. They arrived in a moderate-sized drygoods box, and, with the owner's permission, my neighbor transferred them to a roomy outhouse, with a close-fitting door and a wire-screen front. Through a glass window their movements could be watched in spite of two bundles of straw and other aids to comfort. Cold weather lethargized them; but on warm afternoons, four of five out of ten rattlesnakes and six moccasins were generally in motion.

Were they trying to get out? Their conduct rather suggested a sanitary penchant for moderate exercise and sun-baths. And there seemed no doubt that they had a memory for meal-times. General revivals repeatedly preceded the gong by a minute or two. The owner's signboard, "Dinner at 3 P. M.," attracted rather a surplus of sightseers; and when it became known that our experiments promised to solve a problem of ages, catering, too, became superfluous: volunteer gifts of rats and blackbirds arrived in excess of our needs. Before the summer was over our visitors had settled the snake-charm controversy. Twenty-eight out of thirty intelligent witnesses agreed that there is no hypnotism about it.

Our first doubts were aroused by the complacency of birds and small mammals, and their absolute indifference to the presence of their formidable fellow-captives. Within two feet of a coiled rattler, a blackbird would alight on the rim of the drinking trough, and adjust the defects of his toilet, splashing water in the very face of the reptile that watched him with piercing eyes. Then, after repeated sips, he would condescend to notice the crawler that had uncoiled by that time, and would finally hop aside just far enough to avoid a dispute about bathing privileges, but still within easy reach of a strike. Nor had the restlessness of rats anything to do with the dread of immediate danger. They were trying to gnaw out, but, in the intervals of such efforts, were apt to run straight into the pile of straw that formed the favorite rendezvous of the serpents. The snakes, indeed, were in no hurry to abuse that confidence. When they did get ready, they scorned hypnotic artifices. A gradual elevation of the head, a noiseless approach with a short halt in reach of the bird that was picking crumbs in his feeding corner, then a slow contraction of coils, a snap-like dart, and a leisurely retreat, as from a task accomplished. The bird had taken wing, thoroughly alarmed, now, and fluttered about the wire screen in the desperate hope of finding a loophole of escape. In less than thirty seconds the poison began to take effect. The bird clutched at the screen, with his head hanging further and further back, then relaxed his grip, dangled by one foot for a while, and came flopping down on the floor. It was not dead yet, but dazed, looking this way and that, and fluttering about in a strange aimless fashion, and more than once right toward the destroyer, who at last began to manifest an interest in its antics. Once or twice the serpent, coiled near the center of the floor, seemed strongly tempted to risk a conclusive spring, but drew back again, fully aware, perhaps, that a better chance would be only a question of a moment.

The bird was still on the floor, staggering to and fro, when a sideward collapse marked the beginning of the end. Its foe watched it with lifted head. The chance had come. No risk of a rough-and-tumble fight now; the victim had ceased to flutter, and the old rattler quickly dragged it off to the straw pile. A full hundred experiments repeated this same sequence of maneuvers in all essentials.

The poison-fangs of a snake have no proper roots, but terminate in a virus-bag, and are attached to the jaw by means of ligatures that make them movable to the extent of erection and retraction. This arrangement makes it difficult, and rather superfluous, for the snake to secure his victim at the first spring. The fangs are adapted only for a snap-bite, but their owner can afford to bide his time. The virus that has been known to overpower strong men in half an hour, lethargizes birds and small mammals in half a minute. Wherever stricken, they are apt to collapse in sight, if not in direct reach of their assailants, whose keen eyes detect the slightest commotion in the neighboring weeds, but who would find it a very long time between meals if they had to rely on the hypnotic power of those eyes.

Aluminium is increasingly used in machine construction, as in crank cases and gear boxes for motor cars, for paneling insides of underground railway cars, for electric wire, and for new alloys, pigments, and metal plating; and the aluminium cell as a lightning arrester has proved to be a valuable addition to lightning-protecting devices. During recent years the price of tin has been very high, and since adequate new supplies of ore have not been discovered, substitutes for tin must be used in manufactures. Aluminium is regarded as probably the most available substitute for tin in the great majority of uses to which that metal is put, owing to the diminution in the price of aluminium, the practically limitless supply of the raw material, and the favorable physical properties of the metal. As the production of aluminium is cheapened, so will the uses for it increase. The demand steadily keeps ahead of the supply.