piece of hardened steel at its bottom. The pivot carries at its upper extremity a brass ring in whose center is hung on two horizontal pivot points a brass ball through which the supporting arm of the gyroscope passes. This arm may be fastened in any desired position by a blind setscrew. The best adjustment for the frame is that which gives it an angle of about 45° with the vertical, when the axis of the disk is horizontal. The arm is prolonged several inches to the rear of the central mounting, to serve in the usual experiments requiring the use of the counter-balance, which is seen standing upon the base of the apparatus.

A tall vulcanite column at the right of the instrument carries at its top a horizontal brass arm terminating in a knob exactly over the center of the gyroscope vertical support. In electrical communication with this knob is one end of the flexible cord attached to the large receiver. The lower end of a similar cord depending from the smaller receiver is held nearly in contact with a stationary electrified brass sleeve on the rubber standard of the gyroscope; the cord being fastened to the lower end of a slender vulcanite rod carried by the revolving pivot stem of the instrument. A metal bar extending horizontally from the sleeve through the column at the right ends in a brass ball, which, with a similar one at the top of the pillar, are the points of connection with the opposite poles of the static machine; the upper one being made *positive*.

The wheel of the gyroscope has cemented upon each face, close to the edge, three round pieces of sheet aluminium 1¼ inches in diameter; the two sets of pieces being arranged in such relation to each other that the disks of one set come between those on the opposite face of the wheel. These pieces act as carriers for the electricity.

Experimenters with the gyroscopic top have observed that if the instrument's circular movement about its point of support be retarded, the gravity-resisting power is impaired, and the device falls rapidly. Conversely, if this orbital motion be accelerated slightly by the application of some gentle outside force, increased lifting power is at once apparent, and the horizontal plane of rotation of the system can be made to remain at a given level or even to rise, instead of gradually falling, as is the natural action of all overhanging gyroscopes not subject to the aforesaid outside influences, even when provided with power-driven disks; unless the axis of the disk be given a *very pronounced* upward inclination at the beginning. In the present case such an extra force as is mentioned above is conveniently supplied by the mechanical reaction produced by a current of electrified air—"electric wind"—emanating from a number of electrified metallic points at the end of a laterally curved horizontal wire sweep, carried by a vertical shaft passing loosely through the charged brass knob above the apparatus. The very mild torsional force thus secured is communicated to the vertical spindle of the gyroscope by a slender vulcanite rod, extending downward, and entering the top of the brass pivot ring. There is a position of maximum efficiency for the sweep to occupy in relation to the body of the gyroscope; this position being fairly indicated in the engraving. The points, which are of tinsel wire, are turned in a direction contrary to that of the natural motion of the system about its vertical axis.

A regulator for controlling the strength of this force is placed upon the base of the instrument between the two standards. Its operation depends upon the circumstance that the grounding of one pole of an influence machine greatly increases the electrical activity at the other; consequently, air currents from points attached to one pole of a generator will be made stronger or weaker, according as the opposite pole is more or less completely grounded. The regulator is a vertical sliding earth-connected brass rod with a ball at its top, which by being lowered or raised forms a longer or shorter spark-gap between itself and the horizontal supply-rod above it; thus grounding more or less perfectly, as desired, the negative side of the generator, and causing increased or diminished potential at the other pole. Like the pneumatic gyroscope of Mr. Hopkins, this machine raises itself automatically from its lowest position, by a spiral movement, into a horizontal plane of rotation, whose altitude above the base becomes constant at a point determined in the present instance by the adjustment of the regulator and by the speed of the generator.

A continuously acting Bohnenberger apparatus is shown in the second illustration. This arrangement utilizes the same base and supporting standards as are used in the preceding experiment; but instead of the overhanging gyroscope we have the disk revolving in a horizontal vulcanite frame at whose ends are located large balls of foil-covered wood. The frame is pivoted at its extremities so as to balance accurately in any position. The two vertical supports for the frame, which are of brass and vulcanite, respectively, rise from the ends of a horizontal metallic bar mounted at the top of the vertical pivot on which the apparatus turns. The ball at the left of the disk receives positive electrification through a stiff curved wire, rising from the top of the vulcanite support; the upper end of the wire terminating in a knob just below the charged conductor above the instrument. The other ball obtains negative electricity from its metal supporting connections, which are charged through a traveling conducting rod attached to the vertical pivot and reaching down very near to the excited brass sleeve below the gyroscope. Owing to the accelerative effect of a reactionary air current upon the azimuthal rotation of the apparatus, as in the preceding experiment, the small weights usually hung upon the side of the frame for throwing it out of balance in exhibiting the composition of rotations are continuously sustained. However, as these weights may be made as light as desired, the use of the regulator for intensifying the air jet is unnecessary; and the tinsel brush is fastened by a short piece of wire directly to the lower right-hand corner of the supporting frame of the instrument in such a manner as to admit of being turned in either direction.

INSHORE END OF THE STIFFENING TRUSSES OF THE NEW EAST RIVER BRIDGE.

The means by which the rotation of the disks is effected is in itself interesting, and affords a pleasing illustration of the law of electrical attraction and repulsion. The wheel is first given a slight impulse with the hand. As the aluminium carriers pass the oppositely charged receivers they gain from each one its own particular sign of electrification, and repulsion between carriers and receivers ensues. Rotation proceeds, and as each carrier approaches an oppositely excited receiver attraction between them results until, coming near enough, their electrification is reversed; repulsion replacing attraction as they pass by. Each receiver attracts the carriers on that half of the disk which is approaching it; repelling those on the half which has passed—a swift continuous motion being soon established. It is found that the direction in which the disks revolve most rapidly in both instruments is that in which their top edges approach the positively excited receivers. In dry weather, when other experiments in static electricity succeed, the action of these curious machines is very gratifying and instructive; and much might be said of the beautiful and intricate system of delicately correlated forces —electrical and gravitational—which their operation illustrates. They may be used with any static machine having four or more 22-inch revolving plates.

Several towns in West Virginia have free telephone service on account of competition between local and Bell companies. At Huntington, W. Va., the Bell company gives its service to all subscribers free until further notice. The home company has not cut its rates, and the number of telephones has increased.

CONSTRUCTION OF THE NEW EAST RIVER BRIDGE.

Now that the actual work of constructing the cables of the new East River Bridge is under way, it is opportune to consider both the cables and the broad and massive suspended roadway, the completion of which will mark the completion of the whole structure. The cables will be four in number, and each will consist of thirty-seven strands of wire, with 281 wires in each strand. There will, therefore, be in each cable 10,397 wires, or 41,588 in the four cables. The wire will be 0.165 inch in diameter, and it will have a breaking strength of 100 tons to the square inch. Before its acceptance from the manufacturers it must stand the test of being coiled cold around a wire of its own diameter without cracking.

In designing the cables and in the specification for the manufacture of the wire, particular care has been taken to protect the wire from rusting. At the mill the wires are passed through hot linseed oil. When the 281 wires of each strand have been laid parallel with each other and banded at intervals of every 5 feet to hold them temporarily in place, the interstices will be filled with a special, anti-oxidation filling. Then again when the 37 strands are assembled in the complete cable, the wire wrappings will be removed, and the interstices between the strands will be similarly filled with a non-corrosive preparation. As the strands are assembled in the cable the whole of the 10,397 wires will be drawn snugly into cylindrical form, the main cable bands being put on at intervals of 20 feet, and screwed up so as to take a firm grip upon the cable. In addition to the protective preparation, which thoroughly fills up the interstices between the wires, the whole cable will be protected by 1-16-inch steel cover-plates, which will extend from main band to main band, with ends overlapping, so as to shed the water.

The floor system of the new bridge is by far the widest and stiffest ever carried by a suspension bridge. Its extreme width is 118 feet, and its depth measured at the stiffening trusses is 40 feet. These dimensions may be compared with those of the Brooklyn Bridge, whose total width is only 80 feet and the depth of the trusses 17 feet. Moreover, the carrying capacity of the floor system is much greater, provision being made for six railroad tracks, two roadways for vehicle traffic, two 11-foot footways for pedestrians and two 10-foot bicycle tracks. The framework or skeleton of the floor system, or what we might call its backbone, are two massive latticed trusses, 40 feet in depth, which extend from end to end of the bridge. These trusses possess great vertical stiffness, and should there be any uneven loading, such as would be caused by a bunching of the elevated trains and trolley cars, and a crowding of people and vehicles at one particular spot, the trusses will take care of this load and distribute it indefinitely throughout the full length of the span and prevent any sagging of the cables at that particular point. Intersecting the bottom chord of the two trusses at right angles, at every 20 feet of their length, is a series of deep, plate-girder, floorbeams, which extend entirely across the bridge for its full width of 118 feet. Each floorbeam is suspended from the four cables overhead by 1¾-inch steel wire cables, which pass up and over curved saddles, formed in the main cable bands. These cables at their lower ends pass under a cast-steel saddle, from which four heavy bolts pass down and are bolted beneath the covering plate of the bottom chords of the trusses. At every 20 feet of the length of the trusses, and in the same plane as the suspenders, the top chords are connected by transverse steel trusses, from which two plate-steel suspenders are carried down and riveted to the floorbeam at two points intermediate between the trusses. These overhead trusses relieve the girders of the great concentration of the load due to the six railroad and car tracks, thereby permitting the floor beams to be much shallower than would otherwise be necessary, and gaining several feet of valuable head-room between the under side of the bridge and the water level of the river. The 20-foot gaps between the floorbeams are bridged over by plate-steel stringers which are so distributed that they will come approximately beneath the lines of the rails of the street car and elevated railroad tracks. The two roadways for vehicles will be carried on the cantilever extensions of the floorbeams outside the trusses. Immediately inside of each truss will be two tracks for street railway cars, while between these will be two tracks for the elevated railway lines. Immediately above the street car tracks, and carried by the trusses and the intermediate suspenders of the floorbeams, will be

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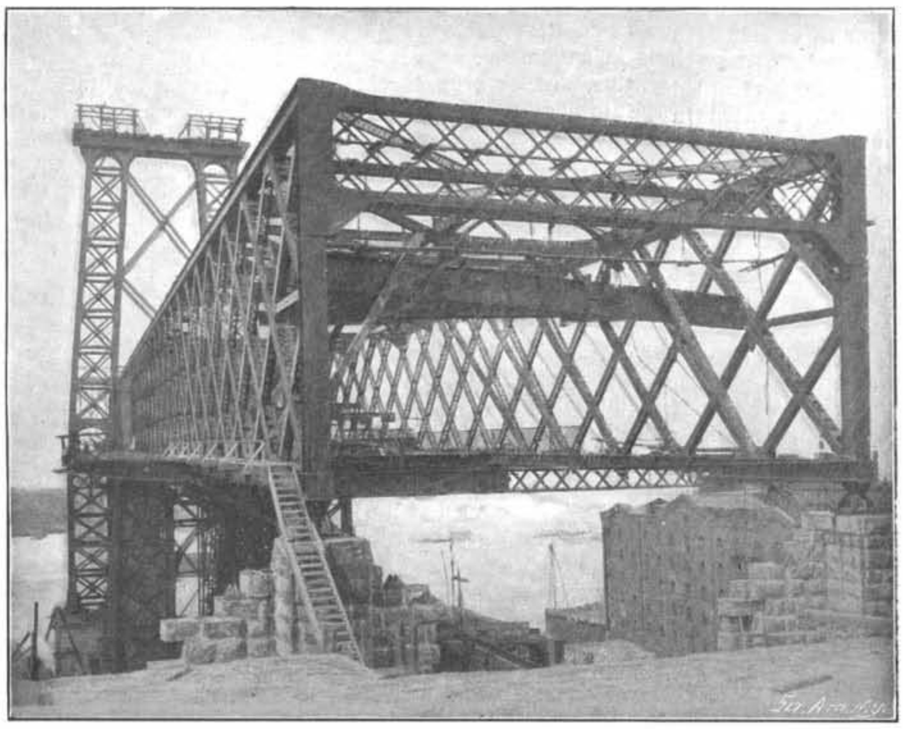
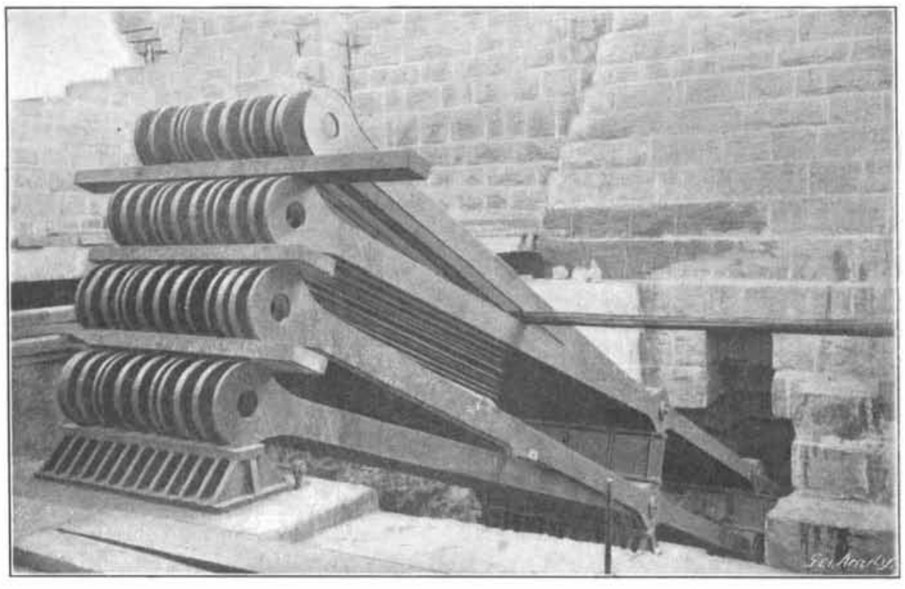
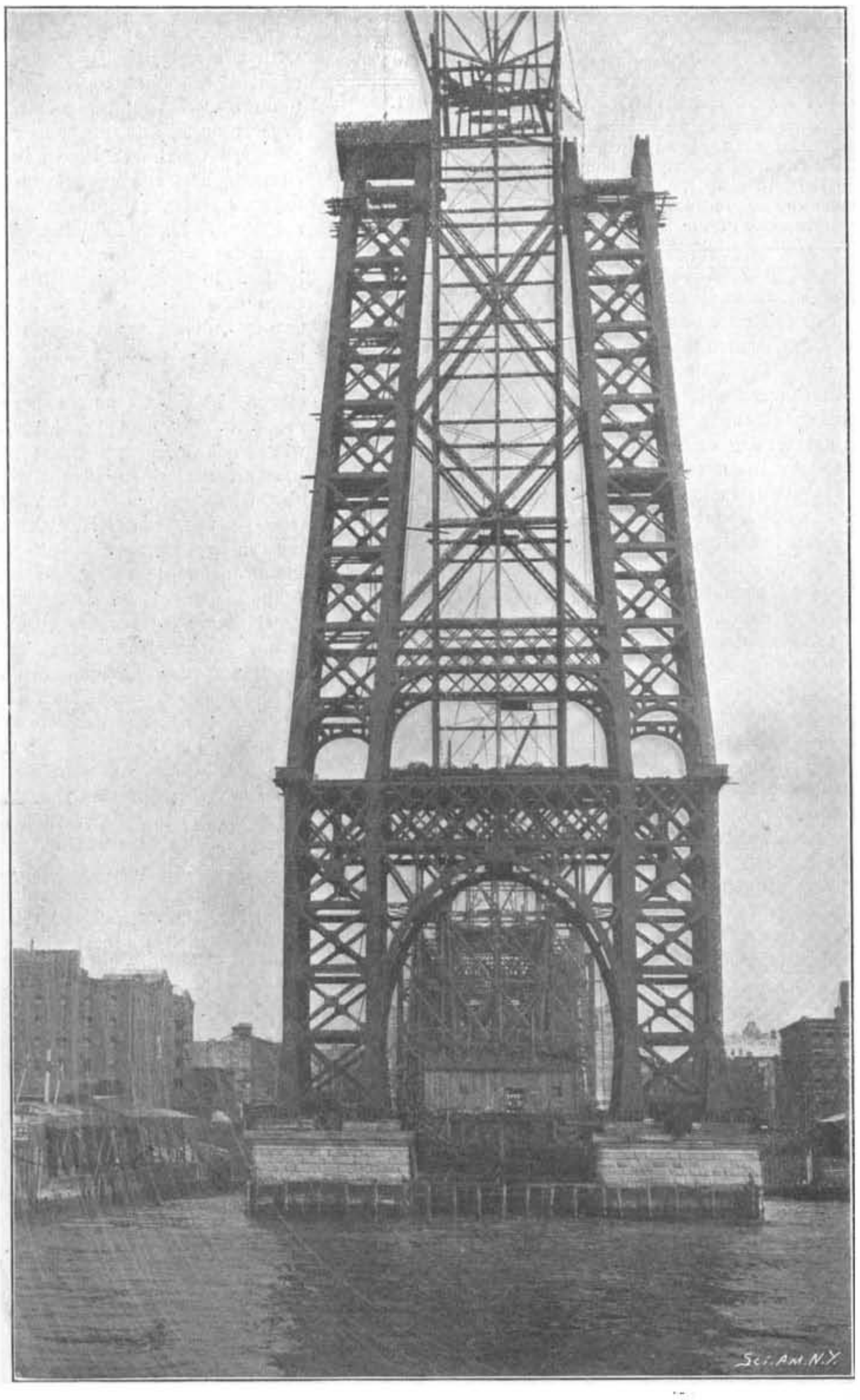


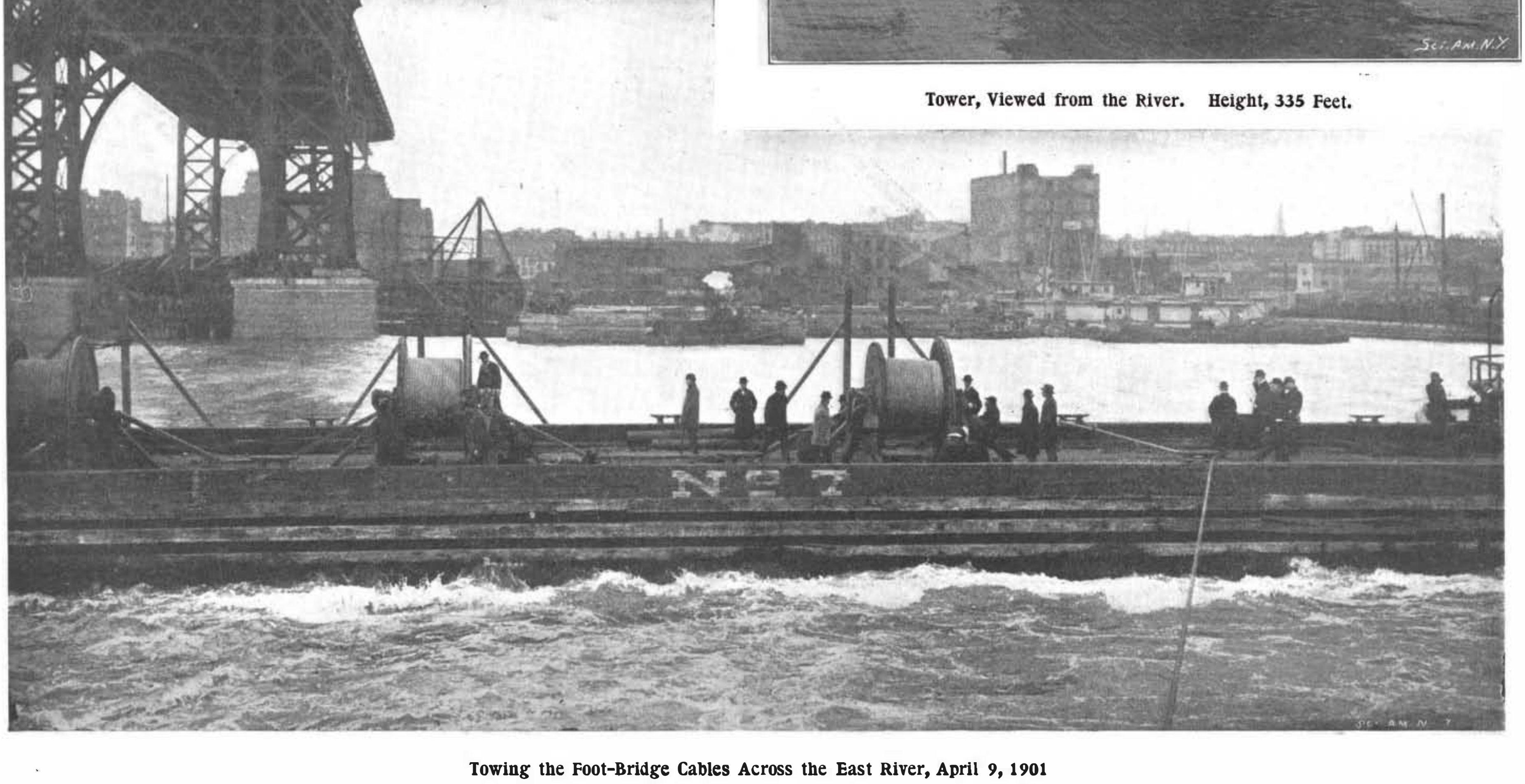
Shore Span from the Brooklyn Anchorage.



Group of Anchor Chains, Brooklyn Anchorage.



Tower, Viewed from the River. Height, 335 Feet.



Towing the Foot-Bridge Cables Across the East River, April 9, 1901

CONSTRUCTION OF THE NEW EAST RIVER BRIDGE.—[See page 246.]

the platforms for pedestrians and bicycle traffic, an iron hand-rail serving to separate the two. As compared with the Brooklyn Bridge, it will be seen that the convenience of the public, as regards the latter form of travel, has been consulted by providing separate roadways for east and west bound traffic.

The stringing of the main cables will be carried on from two temporary footbridges. These footbridges will each be carried upon two cables, each cable consisting of three 2¼-inch cables. On April 9 the first of these cables was carried across the river, the method adopted being different from that followed in the case of the Brooklyn Bridge. The ends of the cables were first carried up over temporary saddles on the top of the New York tower and drawn down to the New York anchorage, where they were made fast. The drums containing the rest of the cable, say about 1,900 feet, were placed abreast upon a large scow which was towed sideways across the East River to the base of the Brooklyn tower. During the passage all river traffic was stopped, and the cables were allowed to sink until they rested upon the bottom of the river. The next step was to hoist the Brooklyn ends of the cables over the tower, carry them down to the anchorage and draw them taut until the desired curve had been obtained.

In conclusion, it may be well to recapitulate some of the leading dimensions of the bridge. Its entire length between terminals is 7,200 feet; length of main span, center to center of the towers, will be 1,600 feet; the foundations of the towers are timber and concrete caissons sunk to bed-rock. On these are masonry piers which are carried up to 23 feet above high water. The steel towers extend 335 feet above the river and 442 feet above the lowest foundation. The anchorages for resisting the pull of the cables measure 182 feet in width, 158 feet in depth and 120 feet from the foundations to the coping. Forty feet of the mass will be below the street level, above which it will extend some 80 feet. Each anchorage contains 44,597 cubic yards of masonry, and its total weight is 125,000 tons. The total pull of the four cables upon each anchorage is 20,250 tons.

Automobile News.

A very handsome automobile has been made for King Leopold II., of Belgium, by Panhard & Levassor, of Paris. The carriage-work of this machine is of the most elegant design and construction. The body, of aluminium, is finished in red, with the truck in blue. The wheels are of blue, relieved with red. All the wood parts which are visible are of polished mahogany. The seats are of a new design and very comfortable; they are covered with red morocco. The motor, of the petroleum type, is rated normally at 20 horse power, but will give as high as 30 at full capacity. It has four speeds, 12, 24, 36 and 48 miles an hour and a back movement, all controlled by a lever. The ignition is by spark, with Basée & Michel induction coils. The machine has been lately delivered to King Leopold at Nice.

An interesting experiment with an automobile upon a snow-covered route has been lately made in France. The Baron Xavier Reille, Deputy of Tarn and the Mayor of Lacanne-les-Bains, in an 11-horse power machine, made a trip of 32 miles in 2 hours and 35 minutes over a hilly road covered with 10 inches of snow, which proved impracticable for ordinary vehicles. This road leaves from Castres, at 600 feet altitude, and then mounts to 1,200 feet, ending at Lacanne-les-Bains at 2,700 feet altitude. As the old system of diligences had considerable difficulty over this road, especially in winter, it was desired to replace these by automobiles, and the present trip was made with this end in view. The experiment has proved conclusive, and this spring a line of automobile vehicles will travel over the route.

M. Serpollet, the constructor of steam automobiles, had a rather amusing experience not long ago. He had just finished a new disposition of one of his machines, and as it was a fine moonlight night, decided to try it at once, without waiting for the next day. So he started, with a mechanic, to make a tour in Vincennes Park, but as the machine went at a great speed they found themselves at the end of half an hour at Pont-Carré, a considerable distance from Paris and much farther than they had thought of going. As they had only a small supply of petroleum this soon gave out, and the question of the return trip was somewhat of a problem. They succeeded, however, in overcoming the difficulty. Stopping at the edge of the forest of L'Echelle, they modified as well as possible the receptacle of the petroleum burner and placed in it small pieces of wood to heat the water; this lasted for about a mile and a half, when they were obliged to stop and collect a new supply of wood. This operation was repeated over a distance of 12 miles, which they covered with great difficulty in three hours. Finally arrriving at a farmhouse they obtained a supply of petroleum, and the remainder of the trip was quickly made.

Electrical Notes.

More than ten thousand telephones in Detroit, Mich., were rendered useless on March 10 by the rain, which fell and froze during the entire morning. The thirty miles an hour wind which accompanied the rain raised havoc with the wires, weighed down as they were by ice. Officials of the Michigan Telephone Company estimated their total loss in the State at $20,000. Street-car service was greatly impaired during the morning by the ice. The storm was general throughout the southern part of the State, wires suffering everywhere.

Important experiments in electric traction are being carried out by the German government with a view to the possible introduction of electricity on some of the state lines. On an experimental line at Lichterfelde it has been found possible to convey directly to the locomotive currents of high tension which are transformed to the required working pressure on board the locomotive itself. Experiments on a considerable scale will be made on the Mariendorff-Zehlendorff line, which is about 14 miles long. The cars will be 87 feet long, will have 60 seats, and will be heavy. It is expected that a very high speed will be developed.

Mr. T. O. Moloney, in The Electrical Review, says that a piece of the best India mica was placed between two planed surfaces, and withstood an insulation test of 16,000 volts alternating current without fracture. The current was then removed, and the surface of the mica lightly coated with paraffine oil, and it was again placed between two planed surfaces. Under this condition it was found that it would break down at 9,000 volts alternating current. Another piece of India mica tested at lower voltages and under the same conditions as above was found to withstand 8,000 volts alternating, dry, and when oil was applied to break down at 4,000 volts alternating current. Tests were made, using three different grades of oil, paraffine, linseed, and lubricating, and all gave approximately the same results. The surface of the mica can be coated with water, and the insulation of the mica will not be lessened. A series of tests on mica immersed in oil showed the effects to be same as when coated.

Marconi is experiencing some trouble with the British Post Office department regarding the introduction of his system into the United Kingdom. By means of an Act of Parliament, passed in 1863, the government has a monopoly over any telegraph systems used in the country, since in this Telegraph Act it is stated that "the term 'telegraph' means a wire or wires used for the purpose of telegraphic communication, and any apparatus connected therewith." In view of the fact, however, that Marconi dispenses with wires, this act is quite inapplicable in his case, but as if anticipating the possibility of ethereal communication, the act was amended in 1869. It now reads: "The term 'telegraph' shall in addition to the meaning assigned to it in the Telegraphs Act of 1863, mean and include any apparatus for transmitting messages or other communication by means of electric signals." As an additional precaution against private enterprise, the Postmaster-General is accorded the sole privilege of transmitting telegrams within the United Kingdom.

Several attempts have been made from time to time to test the fairness and validity of the government's monopoly, but in every instance the latter has triumphed. Therefore it will be realized that Marconi is placed at an unfair disadvantage, and the scope of his experiments is exceedingly limited. If the postal authorities feel so disposed, they could compel the inventor to close all his experimental stations, since Marconi has never received the official permission for their erection. Two years ago the company which has the control of the patents applied to the Postmaster-General for the necessary license to use the system on land in England. The government has not yet replied to the application, probably under the impression that the granting of such a license would have been tantamount to submission on the part of the Post Office. Yet, although the government possess such a monopoly, they are unable to adopt Marconi's invention without awarding him compensation, either by purchasing the system outright, or by the payment of a royalty. Marconi is amply protected by the Patents Act. By this means the government is placed in the same position as a private individual. Marconi has patented all his inventions, and should the government utilize any of them, an infringement is committed, and the inventor can obtain redress in the usual manner. The result of this controversy is that at present a deadlock exists between the government and Marconi, the solution of which can only be obtained by the former awarding the inventor satisfactory financial compensation for the use of his system. This arrangement has been adopted by the Admiralty department, regarding the installation of the instruments in the navy. Doubtless some such arrangement will shortly be concluded between the government and the inventor, the effect of which will facilitate the introduction of wireless telegraphy into the postal system of the country within the near future.

Correspondence.

American Naval Construction.

To the Editor of the Scientific American:

In your issue of February 9 you were kind enough to discuss editorially my method of determining the military value of warships.

I thank you for your considerate article; since an international discussion of the question would do much to clear away present difficulties, and would lead to results which would be of value, not only to the constructor and naval officer, but also to the financial department of every government.

I have concluded my work in the March number of the Marine Rundschau, so that anyone can now carry out the mathematical calculations necessary to determine a vessel's fighting efficiency. In the periodical in question, I have also ranked American ships very high in the list of war vessels, and given the "Alabama" the value:

13.05 PA or 1.1 PAD.

I consider these values correct. Perhaps they would be still higher if I had better data at my disposal. So far as the comparative constructional fighting values are concerned, or, in other words, the values per ton of displacement, the "Alabama" must stand high in the list. For the naval constructor these comparative values are of the utmost importance.

I cannot too highly compliment your worthy and famous Chief Constructor, Rear Admiral Hichborn, on his skill in giving to a vessel of the small displacement of 11,525 tons so large a fighting value as 1.1, especially when it is considered that the "Mikasa," a vessel of 15,200 tons displacement, has but a fighting value of 1.0.

With the last sentence in your editorial I cannot agree. I hope that my last published essay may do much to clear this very important question of many obscurities, and that the possibility has been shown of constructing a fighting ship on mathematical and scientific principles. Otto Kretschmer,

Chief Naval Constructor, German Imperial Navy.

Berlin, March 19, 1901.

Armored Cruiser Discussion.

[We have received a lengthy communication from Mr. Paul D. Emmons replying to criticisms which appear in our issue of April 6 of his proposal to substitute 7-inch guns for the 6-inch guns in the batteries of our new armored cruisers. The letter which is too long for insertion in the Scientific American will be found in the current issue of the Supplement. —Ed.]

Explosive Effects of Bullets.

The question investigated by C. Cranz and K. R. Koch in Ann. d. Physik, was whether the "explosion" of tissues produced by a high-velocity infantry bullet takes place while the bullet is still within the body, or after it has already left it. To imitate the action of blood-vessels while having recourse to a clearly defined physical structure, the authors employed tin cylinders filled with water, and closed at one end with parchment, and at the other with an indiarubber membrane. The rifle experimented with was a new 6 millimeter model made by Mauser at Oberndorf, and having a muzzle velocity of 100 meters in excess of any hitherto used. The method of taking the photographic records was a modification of that devised by Mach. The circuit of a battery of Leyden jars was interrupted by two spark-gaps. One of them lies within the liquid, or in its immediate neighborhood. Its knobs are covered with glass tubes, so that the spark can only pass when they are shot through. The other spark-gap lies in front of a concave mirror in such a position that its image falls on the shutter of the recording camera. This gives a silhouette of the water-vessel on the sensitive plate. In some of the experiments, the bending aside of the bullet by the water made it necessary to have another method of making the circuit. This was then done by the mechanical action of the issuing water-jet in bringing one electrode into contact with the other. The general result of the experiments is that the "explosion" takes place some time after the bullet has left the body. The authors discuss the various theories framed to account for the phenomenon. It is not due to evaporation, as the temperature of the bullet in no case exceeds 150 degrees. The introduction of large masses of gas into the body has no evidence to support it. The rotation of the bullet is too slight to produce the effect, and the deformation of the bullet cannot be the main cause, as explosive effects are produced when there is no deformation. The only remaining theories are those based on sound waves and on the acquired velocity of translation. The authors favor the latter. Part of the kinetic energy of the bullet is transferred to parts of the body in the vicinity of the path of the bullet, and takes some time to produce its effect. But when this takes place a considerable portion of the body is torn away from the anterior portion.