THE HUDSON RIVER BRIDGE OF THE NEW YORK AND NEW JERSEY BRIDGE COMPANY.

In the engineering history of the world certain bridges seem to occupy the position of milestones of progress, each indicating for its own time the limit of engineering skill and daring, only to be replaced and superseded by the new. Especially is this the case with iron and steel bridges. Fairbairn's and Stephenson's tubular structures excited in their time the greatest admiration, while to-day the system is quite discarded. The Menai Strait bridge, called the Britannia bridge, one of the greatest triumphs of Robert Stephenson, a wrought iron rectangular tube, varying from 30 to 22 feet 9 inches in height and 13 feet 8 inches in width, with two maximum clear spans of 460 feet each, was completed forty-four years ago, and was long regarded as the greatest bridge in the world. The opposite of the tubular type is the suspension bridge, of which the great Roebling left two grand examples as monuments for himself in this country—the Niagara railroad suspension bridge—821 feet from center to center of piers, and the East River suspension bridge, 1,595 feet 6 inches span, connecting this city and Brooklyn. Years of use of these structures have shown what may be expected of suspension bridges.

Next, what is really a very old type, the cantilever, began to come more to the front. The idea of balancing a double truss on its center, and building out to right and left over space, dispensing with false work, was an attractive one, and to-day this is the prominent type of large bridge. The world's greatest bridge, the only one surpassing in span the beautiful East River structure, is a cantilever. This is the Forth bridge, in Scotland, which, some 200 feet more in span than the East River bridge, stands as an example at once of daring of execution and of ugliness of design. For, by concentrating the structure in the cantilevers, and employing a very small central truss, utter disproportion has been brought about.

We illustrate in this issue the proposed bridge of the New York and New Jersey Bridge Company, designed to cross the Hudson River at about the line of Sixty-ninth Street, in this city. In it is found an example of how a cantilever bridge can be redeemed from ugliness, for, though it is in one sense the extreme development of the type, it resembles in its lines a suspension bridge. When this is erected the Forth bridge will have to take second place, the new bridge having a central span over 400 feet longer than that of the Scotch structure. It is the design of the Union Bridge Company, of this city.

Each of the main piers, which are of steel and are two in number, have four main members, rising in parabolic curves from its bases, each of which bases defines a square, measuring from center to center of corner piers 200 feet on each side, up to another square at the top, measuring 80 feet on each side. The bases of these corner members rest on cones, which are carried by four steel tubes, each 80 feet in diameter, and sunk to a sufficient depth in the river bottom. The greatest depth will be about 210 feet from high water level. These tubes, after sinking, are to be filled with concrete, and most of the weight of the bridge is to be carried by eight of them, four for a pier. Each of the main members or risers of the pier, which look so light and graceful in the illustration, is to be 15 feet square, of box girder type, so that each will be about as big in section as the entire tube of the Britannia bridge. Were one of them placed on the ground, a train of cars could pass safely through it. The piers rise 536 feet above high water. The top of the supporting cones are 30 feet above it.

From the piers the main span starts at an elevation of 150 feet above high water, and in three equal bays covers a space of 2,300 feet from center to center of piers, giving a clear span of 2,020 feet. The railroad trains shown on the bridge in the illustration give a good idea of the dimensions of its members. It is enough to state that the bottom chords are to be 15 feet high, and that from the top of the towers the tension bars start off, 48 in number for each side, each bar being 12 inches deep and 3½ inches thick. If these were consolidated, they would give a beam over 12 inches by 12 feet in cross section of solid steel.

The piers, as has been stated, rise with a parabolic curve, concave outward. The floor has a similar curve lying in the horizontal plane, as it narrows from a width of 140 feet at the pier to a width of 80 feet before the central truss is reached. The effect of this is peculiar. It brings the upper tension members into absolute parallelism throughout. These in contour resemble the cables of a suspension bridge, and each occupies a vertical plane. There are other tension members, roughly speaking, of the reverse contour, running from three intermediate points on the pier risers to three points on the bottom chord of the bridge. The disposition is such that each of these members is parallel with the corresponding ones on the other side, starting from points on the pier where it is of widths equal to the widths of the floor at the points where each tension member terminates.

The central truss carried by the cantilevers is 720 feet long and 160 feet in depth.

The eastern main pier is shown placed even with the pier head line of New York City; the western main pier is well out in the river. The eastern abutment pier is located nearly 1,050 feet back from the New York pier head line; the western one is to be even with the pier head line on the New Jersey shore.

The trusses spanning the shore intervals, each of 910 feet in length, center to center of pier bases, are not heavy enough to balance the river span, the central truss going to establish a great excess of weight on the river side. Accordingly the four abutment piers are hollow; the end of the shore trusses are to rest on rollers or some equivalent on the tops of these piers and are to be held down by pig iron weights suspended from their ends and hanging within these piers. An aggregate weight of thirty million pounds will be needed for these weights alone.

The floor of the bridge, which is practically level, will vary in width from 140 feet at the piers to 80 feet at the center. It will accommodate six tracks. It will have no roadway for carriages and no public foot-path.

The total length of the bridge, exclusive of approaches, is 4,120 feet, center to center of end piers.

The small proportions of a railroad train compared to the size of the bridge have already been adverted to. This fact is well brought out in the calculations for the strength of the members of the bridge. Calculated to be self-sustaining, its factor of safety alone is enough to take care of any cars running over it. Its construction by the regulation methods will be an impressive spectacle, after the two center span cantilevers will have reached their limit and the parts of the center truss begin to close the gap. At one time there will be overhangs of 1,000 feet each from both sides.

The approaches on the New York side will be commensurate with the size of the structure. Facing on Seventh Avenue at its intersection with Broadway, with a total front of 462 feet, will be two hotels with the station entrance between them. From Seventh Avenue the hotel and station buildings are to be run to the westward, diminishing in width until a total length of 1,700 feet is attained. Running parallel with Forty-third Street to Seventh Avenue, then curving up toward Forty-sixth Street, and running parallel with it until near Eleventh Avenue, the tracks are to go north parallel with the last named avenue until they sweep around upon the bridge.

It is a somewhat striking fact that of the many travelers who go to the westward from New York City daily, all have sooner or later to cross the Hudson River. At present it is crossed by inconvenient ferries at this city and by a bridge at Albany nearly 150 miles to the north. The Poughkeepsie bridge does but little for travelers. The new bridge with its six tracks and with the great terminal station will enable the traveler to start directly from New York City by rail for all points to the south and west, to Philadelphia, New Orleans, Chicago or Yokohama, without going north 150 miles to cross the intervening waters of the Hudson River.

On June 5 the United States Senate passed an amended bill, authorizing the construction of the bridge, and placing the matter in the hands of the Secretary of War, as regards approval of the recommendations of the Board of Engineers. On June 6 the House of Representatives passed it, and it has been signed by the President. A period of ten years is allowed for the completion of the structure.

Novelties in Photography.

In the course of an article recently contributed to *Le Monde Illustré*, the *Photographic News* says the writer, M. Henri Coupin, makes the following remarks concerning the work of M. Marey and others:

We know what a change M. Marey, the learned professor in the College of France, has brought into physiology, physics, and art by chronography, which consists in photographing a moving object at almost imperceptible intervals. After having studied in all its details the progress of a man and horse, as well as the flight of birds, M. Marey has applied himself to animals more difficult to handle, such as serpents, eels, insects, spiders, scorpions, etc. For each of these it was necessary to take instantaneous photographs, and even more important to have recourse to peculiar conditions of light. This consists in lighting the creature above and below in such a manner that in the separation from its silhouette the insect throws its shadow forward on the track that it is crossing. This shadow gives us some information about the position of the claws; when they are placed on the ground, the representation of the claws themselves and the shadows touch each other at the extremities. We can also see that the insect always rests on three claws, while the three others are moving, the claws resting on the ground forming a triangular base formed by the first and third claws on one side and the middle claw on the opposite side

Notwithstanding the difference of the medium in which they live, the eel and the adder progress in the same fashion; there is no difference, only in the amplitude of the undulations.

With the toad a curious fact is observed: as long as it is in the tadpole state, that is, while it has a tail, the feet move more by successive expansions. Later, when the tail has fallen off, the hind feet move exactly as a man's limbs do when he is swimming.

M. Marey has not confined himself to the study of animals: he has set himself to a more arduous task—photographing the movement of liquids. For this he uses an elliptical tube whose walls for a part of their length are rectilinear and formed of glass. Water is put into this spout and a black cloth is placed in the center of the receiver; the camera has been previously united to the receiver by a hollow pyramid of dark curtains. By lighting the receiver from below, the edge of the water alone is luminous, and can consequently be photographed. By agitating the water, the movements of the surface of the water can be given. "When," says M. Marey, "we wish to photograph the movements which are going on in the interior part of the liquid, we make them visible by means of little shining bodies in suspension in the water on which the solar light shines brightly. For this purpose we have wax melted in suitable proportions; its density is less than water, and we add resin, whose density is greater; then with this plastic material a great number of little balls are made and silvered by a process used in pharmacy. These brilliant pearls must be a little denser than fresh water, so that if we put them in it, they go slowly to the bottom. It is sufficient then to add gradually in the tube a certain quantity of salt water, so that the shining pearls are suspended in the mixture; the equilibrium or disposition is not important. When this is accomplished, miniature tempests are provoked in the receiver, and photographs are taken rapidly. This has not been applied to any practical purpose, but we must never despair in matters of science. While studying the angles of the crystals of tartaric acid, Pasteur was led to a cure of hydrophobia and many other diseases; perhaps while studying the liquid waves some one may learn to conquer tempests, or at least to control seasickness.

The inmost recesses of the eye are of much interest to a physician. M. Guilloz has just found a simple way of photographing it with sufficient clearness. The difficulty consists chiefly in eliminating the reflections produced by the cornea and the crystalline humor of the eye; this is got rid of by putting a lens before the eye. The head of the patient is kept immovable by means of a head rest. In the dark room an inclined mirror is arranged which reflects back the image on a piece of ground glass placed on the upper part. The sensitive plate is placed behind the mirror so as to shield it from all light. When the reflection shows clearly on the ground glass, the mirror is raised. This movement uncovers the sensitive plate; at the same moment an explosive cylinder of magnesium is fired, which produces a dazzling effect. The inmost part of the eye is photographed with all its details. The eye being the mirror of the soul, these photographs may be of use in showing the character and disposition of individuals; possibly with fortune tellers they will take the place of the lines of the hand or tea grounds.

How can you find out whether a postage stamp has been used or not? Photograph it. If the postmark has been obliterated, the blue or green color will not make any impression on the plate, while the black traces of the obliteration will appear with great clearness. Even when the stamp has been well washed and no trace of the obliteration can be seen by the naked eye or through the microscope, the photograph will show very clearly the two concentric circles of the stamp, the date, and even the name of the locality.

There is another way, which does not belong to photography, but it is more precise. "It consists," Messrs. Renard and Lebarre write, "in plunging the stamp for a few seconds into a boiling solution of five grains of caustic potash in one hundred cubic centimeters of a mixture of equal parts of water and alcohol. The blue or green color disappears completely; it is then washed in water, next in water acidulated with acetic acid, then in water again, and lastly, carefully dried. On the discolored face of the stamp the marks of the obliteration can be discerned very plainly." This process is more sensitive than the preceding. Two stamps, which indeed had not disclosed anything by the photographic method, showed after the treatment by potash traces of the obliteration. The only inconvenience of this method is that it changes the stamp, which the experiment by photography does not disturb; so it is wise not to try this unless the photographic trial has given no result. When the stamp proves to have been a good one, we shall certainly regret our curiosity.

In closing this review, let us cite M. Zenger's experiences. He had the novel idea of photographing darkness. Two hours before midnight he placed himself before a window opening on the Lake of Geneva, and pointed his camera at—what he did not see. In developing the plate, he perceived with astonishment that the lake and Mont Blanc were reproduced. M. Zenger probably did not know the fact that for some time stars invisible to the naked eye had been photographed, and that microscopic photography reveals everyday details that visual acuteness would be incapable of discovering.

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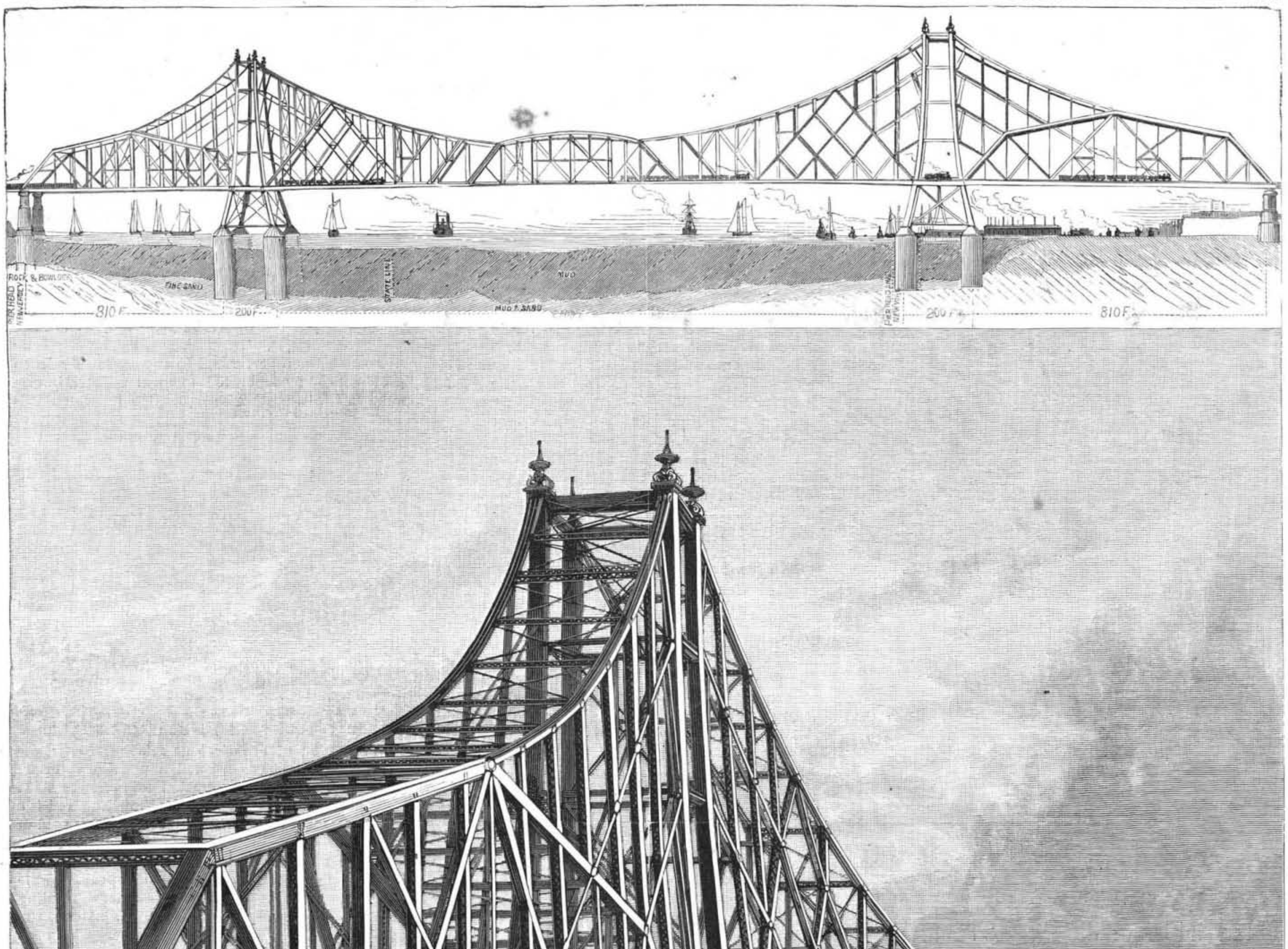

PROPOSED BRIDGE OVER THE HUDSON RIVER, AT NEW YORK.—[See page 375.]