THE ERECTION OF THE QUEBEC BRIDGE.

We present illustrations showing the progress of the highway and railroad bridge across the St. Lawrence River at Quebec which, when completed, will be in some respects the most monumental structure of the kind yet erected. The bridge will have a total length

Raising the Top Section of the First Main Intermediate Post of the Cantilever Arm, Quebec Bridge.

from center to center of anchorage piers of 2,800 feet. It will consist of two 500-foot anchor spans, extending from the anchor piers to the main piers of the towers; two 562½-foot cantilever arms, reaching out over the river, and carrying between them a central suspended span, measuring 675 feet between centers of end pins. This span is one of the striking features of the bridge, and illustrates well its huge proportions; for it is longer than any simple pin-connected truss span that has yet been erected. Ordinarily such a span would be supported on masonry towers, and it would form, say, the main channel span of some river crossing; but in this case its abutments are the end pins of two giant arms each reaching out over half a thousand feet from its point of support. The cantilever arms and the central span together form a channel span 1,800 feet in length, or 90 feet longer than the cantilever spans of the Forth Bridge.

The under side of the channel span is 150 feet above high water of the St. Lawrence River, and the depth of the cantilever trusses over the main piers is 350 feet. The total height from low water level to the highest point of the cantilevers is 414 feet. This bridge is by far the most massive trussed structure yet erected for any purpose, and the great size and weight of the individual members is due, not only to the great length of the span, but to the width of the roadway and the exceedingly heavy live and wind loads which it must carry.

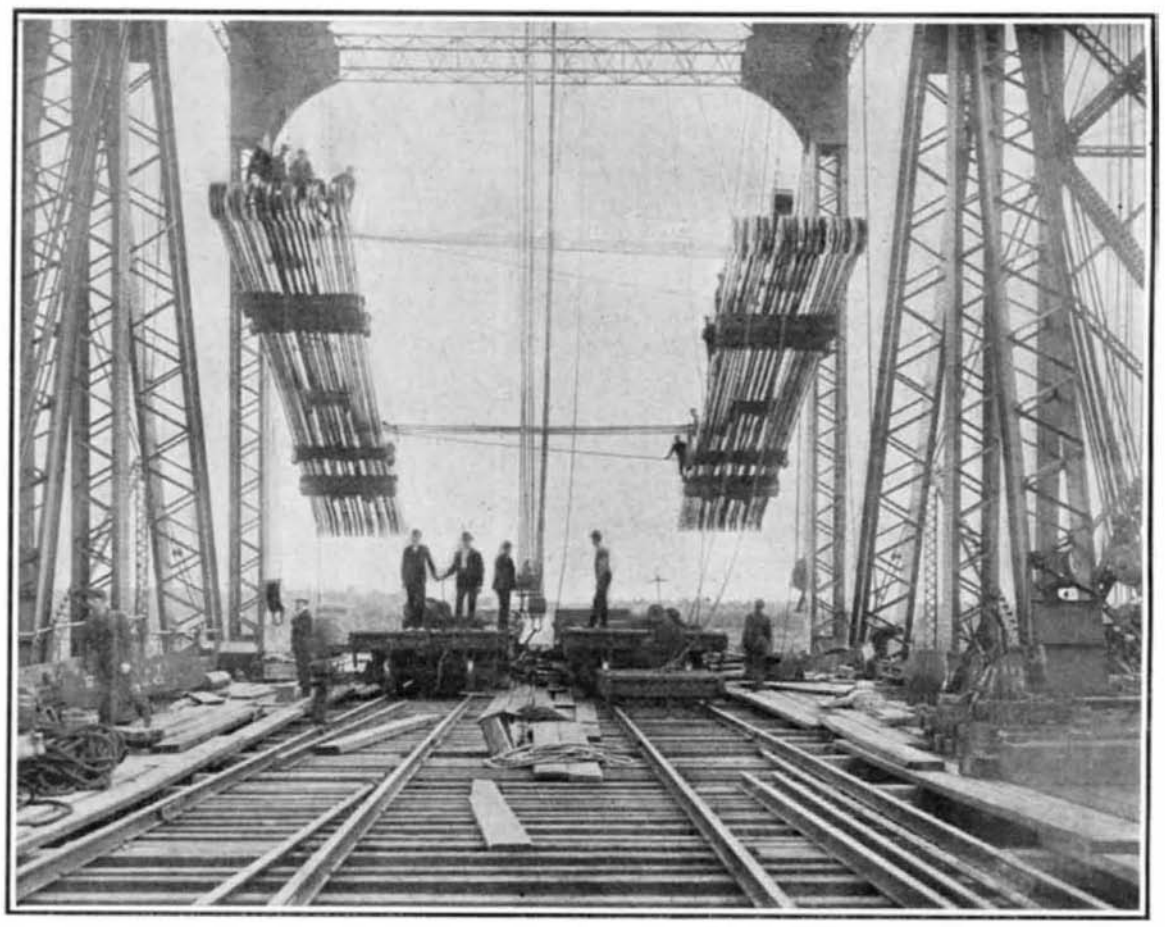
The two trusses stand in vertical parallel planes, placed 67 feet apart, center to center. Between these trusses is supported a floor system capable of accommodating two steam railroad tracks, two electric car tracks, and two highways for vehicles, all of which are placed between the two trusses, while outside of the trusses are two sidewalks. In making calculations for the train loads provision was very wisely made for an increase in the future of 50 per cent over present weights. These accumulated live loads, together with the wind loads estimated at 25 pounds on every square foot of surface of the structure, have to be added to the dead load of the structure itself, which amounts to a total of 40,000 tons. The calculations of sizes of members have been so made that when the bridge is completed, loaded to its maximum capacity, and exposed to the fiercest gale that will blow upon it, the maximum stress in the tension members will never exceed 17,000 pounds to the square inch in the I beams, or 20,000 pounds per square inch in the secondary members.

One of the most important problems to be solved, both in designing and erecting the bridge, was to keep the weight and size of the individual members down to a point at which they could be transported from the shops of the Phoenix Bridge Company to the site of the bridge, and lifted into position and connected up by the erecting gangs. In many cases the members were so large that they about reached the limit of capacity of the tools by which they were made in the shops.

Our illustrations show the work of erecting the south anchor arm, which has recently been completed. The trusses are 96 feet 9⅜ inches deep over the anchor pier and 315 feet deep over the main pier, and they are divided into five main panels of 100 feet span, or ten sub-panels of 50 feet span. The diagonal compression members have riveted connections at the intersections, but the vertical posts and the top and bottom chords have pin connections, the pins ranging in diameter from 12 inches to 24 inches. The two main vertical posts over the piers are heavily braced transversely, and form, in fact, a vast transverse truss 67 feet wide, 315 feet high, and weighing 1,500 tons. For convenience of transportation the vertical posts were made in two or more sections, which were riveted together as they were erected. The bottom chord is 4½ feet deep by 5½ feet wide and is built up of four webs, having a maximum cross section of 842 square inches. The eye-bars are 2½ inches thick by 15 inches deep. They have a maximum length of 76 feet. Some of the 12-inch pins used at their connection are over 10 feet long. The main shoes at the bottom of the tower posts weigh 46 tons. The floor beams at each panel point are 10½ feet deep and weigh 30 tons apiece. Each top chord is made up of twenty eye-bars, and the maximum stress of dead, live, wind load, and impact reaches the enormous figure of over 8,000 tons. The total cross sectional area of the top chord to take the stress is 711 square inches.

For erecting the anchor span, whose great load had to be entirely carried by the false work, it was necessary to put up eighteen steel falsework towers ranging from 127 to 160 feet in height, which were braced together to form transverse supporting bents, one under each panel point. The bridge members, as they reached the site of the bridge, were stored in a special yard, whence they were reloaded on delivery cars and run out over the falsework to the desired point on the bridge. Here they were erected by a 54 foot wide by 103 foot long steel traveler, which is 212 feet in height. This traveler is provided with 54-foot and 66-foot cantilever extensions forward at the top and to the rear at the bottom, which give to it the Z-shape contour which will be noticed in our illustration. The traveler runs on tracks at the level of the roadway, and between the trusses, which, of course, it clears. It is provided with 33 tackles of from 12 to 55 tons capacity, which are operated by four electric hoisting engines of special design. The whole traveler with its engines complete weighs about 1,125 tons. The largest pieces handled thus far have been the center sections of the main vertical posts which weigh each about 95 tons. These posts have a cross section of 5 feet by 10 feet with four transverse webs.

In hoisting the heavy members into position, they were slung in the tackles, approximately at the angle at which they were to be built into the bridge, and hoisted into position and the pins inserted in no more, and in some cases less, time than would be necessary in a bridge of smaller proportions, the celerity of erection being due to the fact that practically the whole of the work was done by electrical power. One of our front-page illustrations shows the method of hoisting the top chord eye-bars. As a single top chord panel is made up of as many as twenty-eight 15 x 2 1-16-inch eye-bars, weighing altogether 140 tons, it was decided to assemble such a set of bars for one panel complete in the storage yard, space them to position by wooden fillers, and clamp them together with yokes and heavy bolts. The set of bars was then hoisted, as shown in our illustration, and when it reached the top of the bridge, some 350 feet above the water, the eyes were sure to be in perfect alinement, and the work of matching them with the other connections and pinning the whole together greatly facilitated. Our thanks are due to the Phoenix Bridge Company for information and photographs furnished in the preparation of the present article.



Raising Two Complete Panels of Upper Chord Eyebars, Weighing 140 Tons, to Position in Quebec Cantilever Bridge.

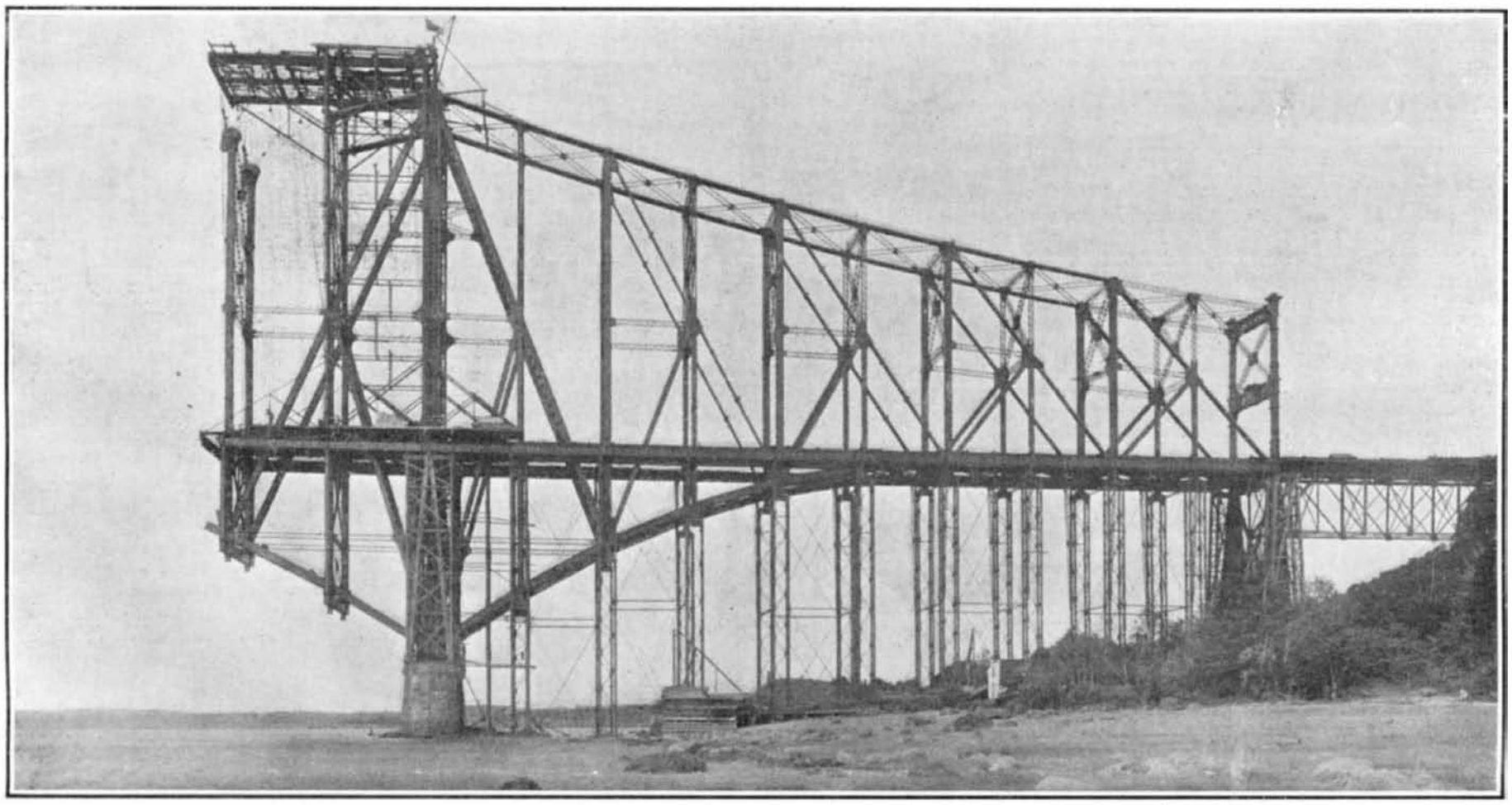
ERECTING THE QUEBEC BRIDGE—THE LONGEST-SPAN BRIDGE EVER BUILT.

Stephenson's old "Invicta" locomotive, which seventy years ago used to run between Canterbury and Whitstable, was formally unveiled at Canterbury recently by Sir David Salomons, who presented this interesting railway relic to the town council.

SCIENTIFIC AMERICAN

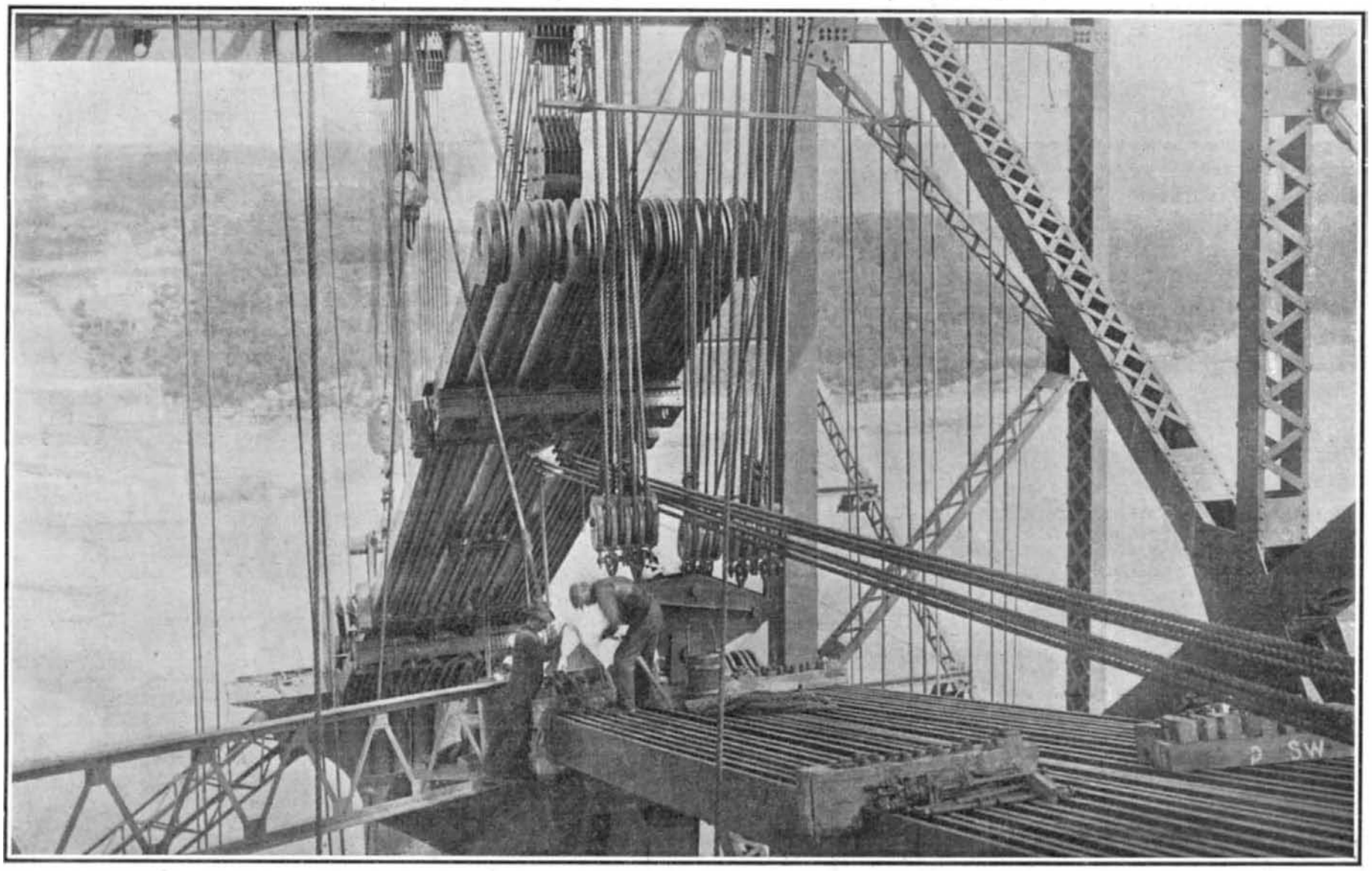
[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1906, by Munn & Co.]

Vol. XCV.—No. 13. ESTABLISHED 1845. NEW YORK, SEPTEMBER 29, 1906. 10 CENTS A COPY $3.00 A YEAR.



Note the erecting traveler, from the projecting arm of which the heavy members, weighing from 30 to 90 tons, are lifted and swung out into position.

Side View of the Completed South Anchor Arm and Two Panels of the Cantilever Arm.



The set of eyebars on which men are standing is in position and forms the chord of the first panel. The suspended set is being slung into position by tackles attached to projecting arm of the traveler.

Connecting the Second Upper Floor Panel of the Cantilever Arm.

ERECTING THE QUEBEC BRIDGE—THE LONGEST-SPAN BRIDGE EVER BUILT.—[See page 228.]