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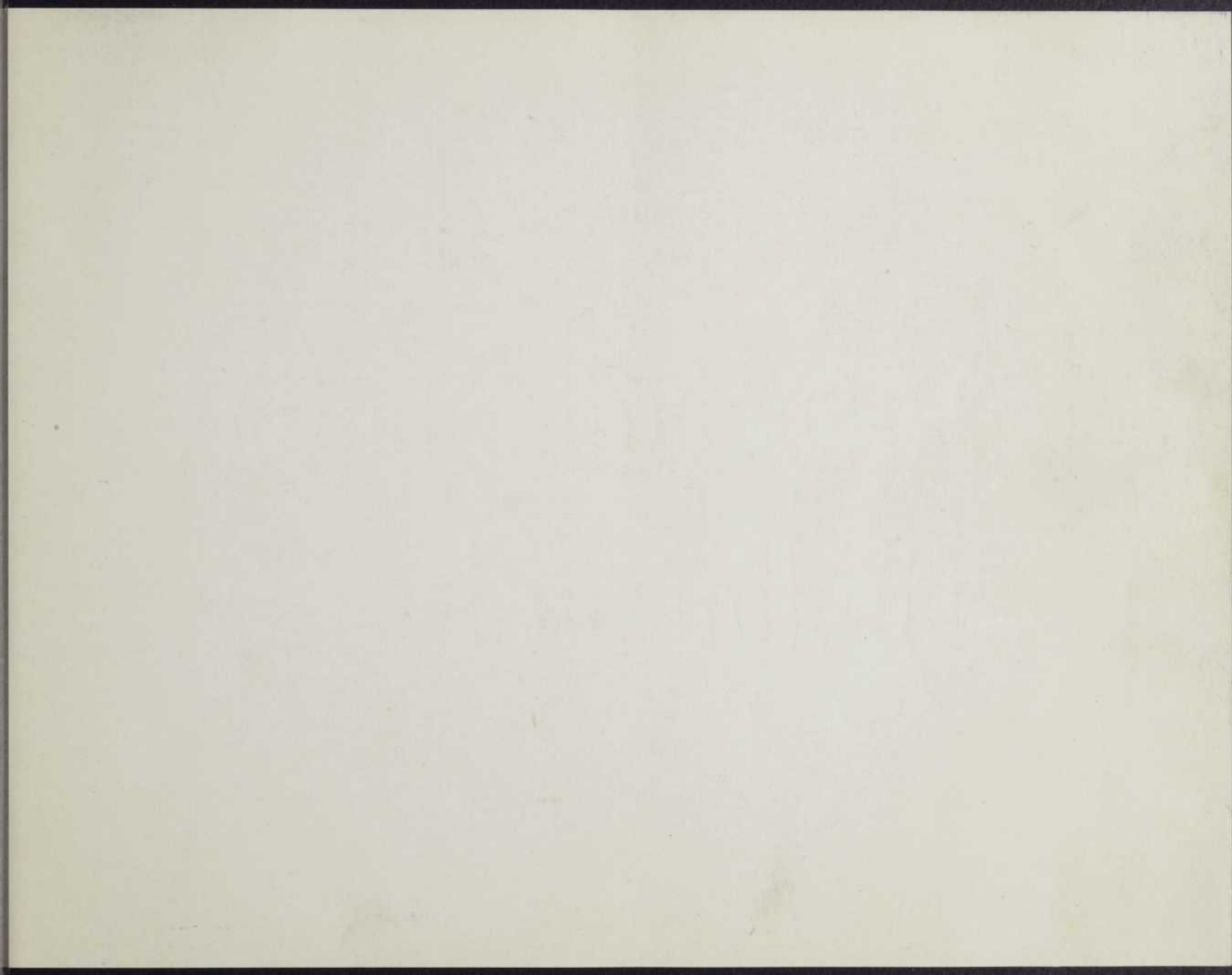
The
Quebec
Bridge

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THE QUEBEC BRIDGE

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THE QUEBEC BRIDGE & RAILWAY COMPANY

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A. B. MILLIKEN,
Superintendent of Erection

P. L. SZLAPKA,
Designing Engineer

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THE QUEBEC BRIDGE

THE LONGEST SINGLE SPAN BRIDGE IN THE WORLD
CROSSING THE ST. LAWRENCE RIVER SEVEN
MILES ABOVE QUEBEC, CANADA

BUILDING FOR

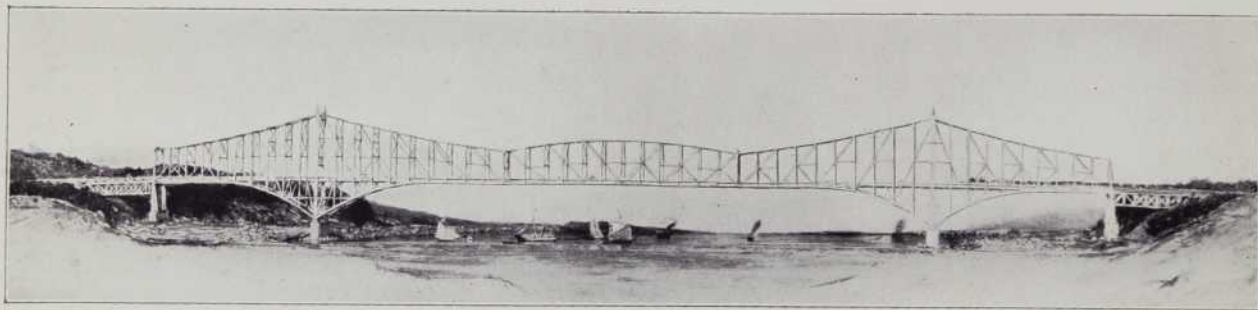
The Quebec Bridge & Railway Company



P R I N T E D F O R

E. R. KINLOCH AND N. R. McLURE

NEW LIVERPOOL, P. Q., CANADA



QUEBEC BRIDGE AS IT WILL APPEAR WHEN COMPLETED.

Copyright, 1907

By E. R. KINLOCH and N. R. McLURE

DIMENSIONS AND POINTS OF INTEREST

Type of bridge, cantilever.

Total length of bridge between abutments, 3,220 ft.

Consists of: two deck truss approach spans, each 210 ft. long; two anchor arms, each 500 ft. long; two cantilever arms, each 562½ ft. long; one suspended span, 675 ft. long, the longest simple truss span ever built.

Central span, center to center of main piers, 1,800 ft., the longest in the world.

Type of trusses, pin-connected.

Width, center to center of trusses, 67 ft.

Depth of trusses varies from 97 ft. at the portals to 315 ft. over main piers.

Clear headway over high tide, 150 ft., for a width of 1,200 ft.

Height of peaks of main posts above the river, 400 ft.

Capacity, two railroad and two electric railway tracks, two roadways and two foot walks, all on same level.

Total weight of steel in bridge, 38,500 tons.

Weight of heaviest single pieces handled, 100 tons.

Longest single section shipped to bridge site, 105 ft.

Eyebars, the largest yet used, with a maximum of 56 on one pin.

Diameters of pins from 9 in. to 24 in., and up to 10 ft. in length.

Total number of field rivets to drive, about 550,000.

Type of traveler used for erecting anchor and cantilever arm trusses, gantry, running outside of trusses, on tracks at about floor level, and spanning highest point of bridge.

Weight of gantry traveler, fully rigged, with all accessories, 1,000 tons.

Steel wire cable on traveler, 7 miles of ¾ in.

Manila rope on traveler, 13 miles of 1-in., 1½-in., 1¾-in., and 2-in.

Grade of 1% on each end, connected at center by vertical curve, 1,125 ft. long.

Most complicated shop work was on the main pier shoes, the detailed drawing for which took one draughtsman six months to make. These shoes weigh 73¼ tons each.

Main piers built of concrete, faced with massive, rock-faced granite, were sunk with pneumatic caissons 150 by 49 ft. and 25 ft. high. The tops of these piers measure 133 by 30 ft. and they contain 35,000 cu. yds. of masonry.

Anchor piers, built of concrete, faced with granite, are 30 by 111 ft. at the base, 56 ft. high from bottom of anchorage metal, measure 24 by 105 ft. at the coping, and contain 14,400 cu. yds. of masonry.

Abutments, built of concrete, faced with granite, are 80 ft. wide, 40 ft. deep, and contain 4,000 cu. yds. of masonry.



ALL of the steel work for the Quebec Bridge was designed and fabricated by the Phoenix Bridge Company at Phoenixville, Pa., and is being erected by the same company.

The two 210-ft. deck truss, approach spans were erected on falsework in 1902 and 1903, but erection of the main structure was not actually begun until July, 1905. From that time until the end of November of the same year, six panels of the south anchor arm were erected on the falsework, as shown in the top view on the opposite page, a total weight of 5,346 tons.

The steel falsework was especially designed and fabricated by the Phoenix Bridge Company for the support of the anchor arms, during their erection, and weighs 950 tons. The yellow pine timber falsework, placed under the anchor arms for the temporary support of tracks for delivery of metal to be erected, is built of specially selected stock, furnished by George Warner, of Philadelphia, and consists of transverse bents of five 12-in. by 14-in. vertical posts spaced 50 ft., and braced in both directions.

During the season of 1906 the south anchor arm was completed and the south cantilever arm erected, a weight of 10,423 tons. The lower view opposite shows the bridge in this condition, as it was left during the winter of 1906-7. Most of the falsework seen in the first view has been removed, and its erection started on the other side of the river, where it will be used in a similar manner for the erection of the north anchor arm.

On account of the severity of the climate, it is necessary to suspend work on erection from December 1 to April 1 each year.



THE WORK AT THE END OF SEASON OF 1905. LOOKING WEST.



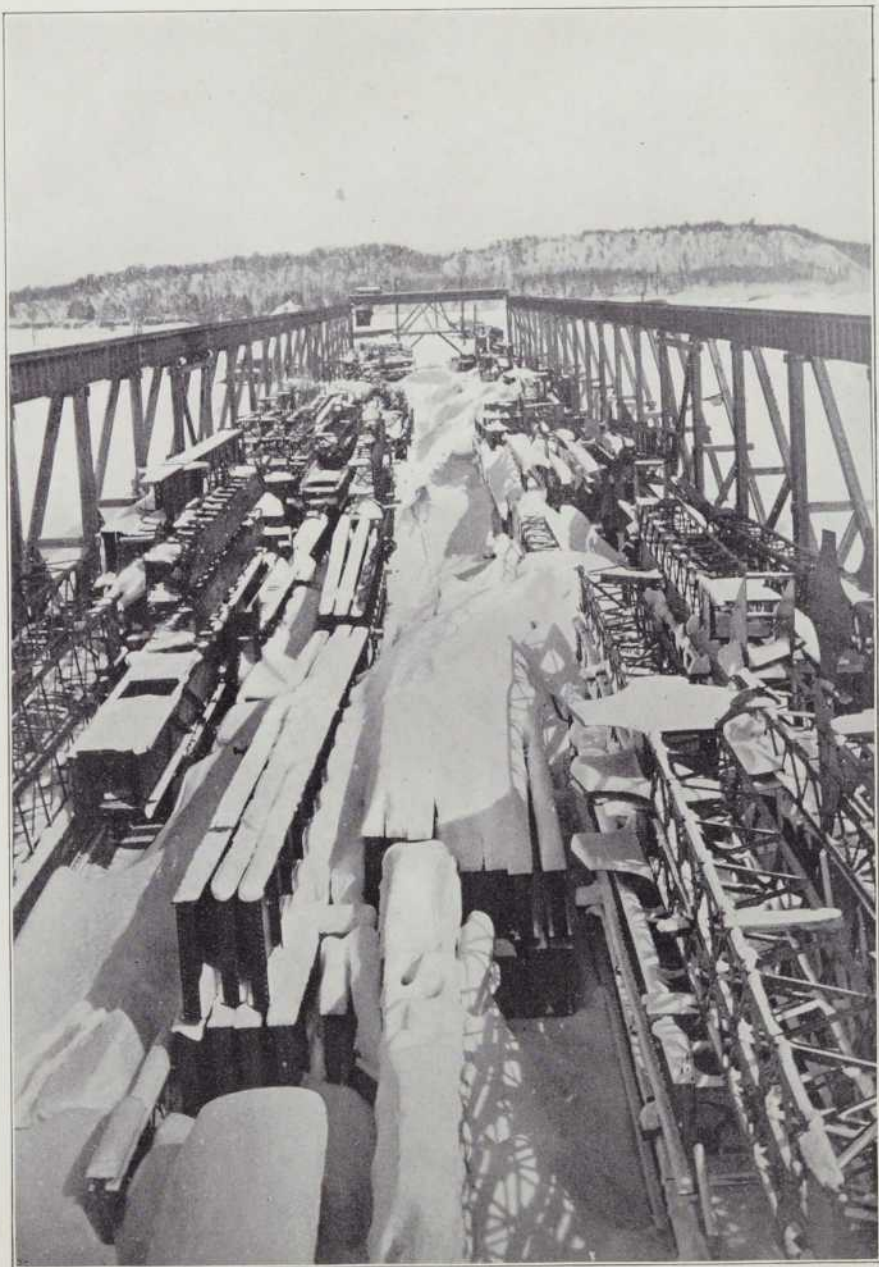
END OF SEASON OF 1906. LOOKING EAST.



LL metal, and other material, for the construction of the bridge is shipped to the storage yard, a view of which is here shown, and which on the south side is located one mile from the bridge site. Here all material is temporarily stored under a crane runway 990 ft. long and 67 ft. wide, through the center of which runs a single delivery track. The members are handled from the cars by two 55-ton electric cranes, like the one seen in the background, and again loaded on flat cars by these cranes, and shipped to the bridge when needed.

Current for the operation of the storage yard cranes, as well as for all work done on the bridge, is furnished from the Chaudière Falls Plant of the Canadian Electric Light Company, about three miles distant, as a 2,400-volt alternating current, and transformed at a sub-station on the ground to a 550-volt direct current for use in the crane motors.

A similar storage yard will be used on the north shore to handle the other half of the bridge.



STORAGE YARD.

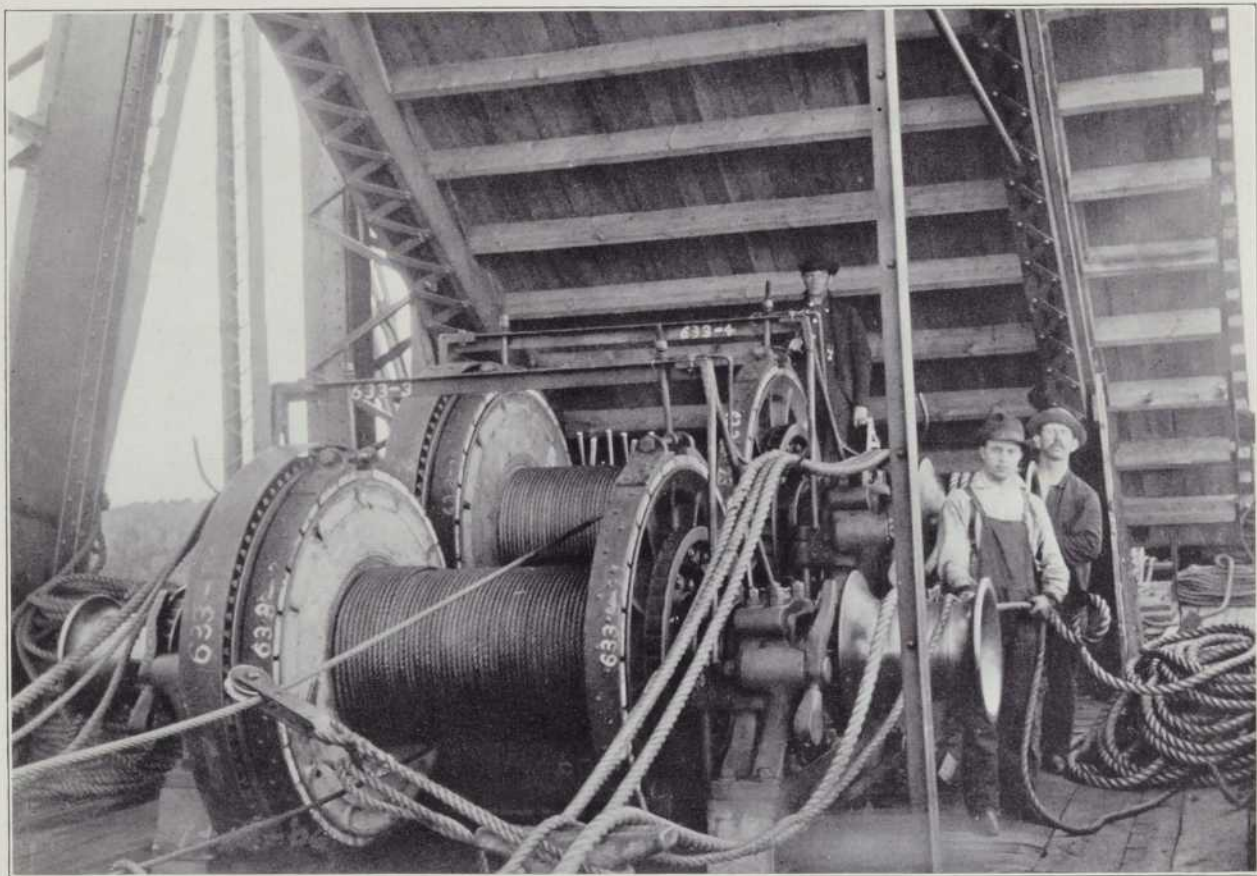


ALL members of the anchor and cantilever arms are lifted from the cars run out under its overhang, by the big steel traveler, and swung into place. Operating on this traveler are four 125-horse-power, double-drum, four-spool hoisting engines, designed and built by the Lidgerwood Manufacturing Company, of New York, especially for this work. Each engine is driven by a direct current motor, made by the Canadian General Electric Company, of Toronto, Ontario, which runs by current delivered from a sub-station, to be mentioned later.

One of these engines is here illustrated. Two drums on each handle the eight sets of thirteen part falls, of $\frac{7}{8}$ -in. steel wire rope made by the John A. Roebling's Son's Company, of Trenton, N. J. The nominal capacity of these sets of falls is 55 tons each, and the total length of the wire rope, 7 miles. In order to properly handle the loads, special steel sheave blocks, with sheaves 24 in. in diameter, and weighing 3,800 lbs. each, were specially designed and built by the Boston & Lockport Block Company, of Boston, Mass., and furnished through their Philadelphia agents, Uhler & English. These blocks are the largest and heaviest ever used on erection work.

The manila rope on this traveler, from $1\frac{1}{2}$ to 2 in. in diameter, in single lengths of 2,800 ft. and less, aggregates about 13 miles in length. This rope, made by the Plymouth Cordage Company, and furnished also by Uhler & English, is used in four- and three-sheave wooden blocks with capacities of 22, 17 and 10 tons each, which blocks the same firm also secured for this work from the Boston & Lockport Block Company.

With this equipment, there has been no difficulty in handling all of the truss members, the heaviest of which reach 100 tons, and very often members for both trusses are raised and placed simultaneously, as illustrated in the case of top chord eyebars, further on.



ONE OF THE 125-HORSE-POWER HOISTING ENGINES.

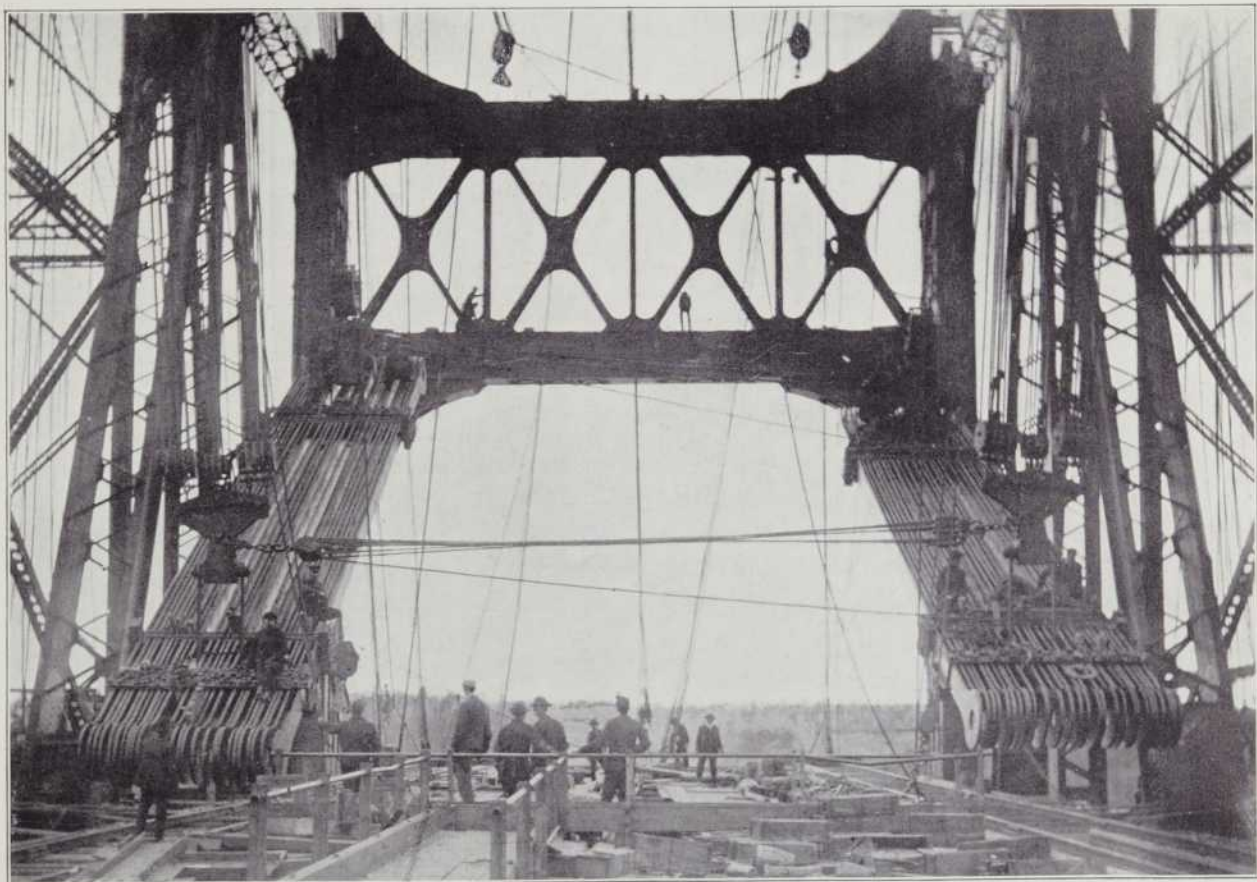


AN interesting feature of the Quebec Bridge is the eyebars, used for all tension members. These were rolled at the mills of the Central Iron and Steel Company, of Harrisburg, Pa., and forged by the Phoenix Iron Company, and, with the exception of the 10-in. anchorage bars, and a few 12-in. top chord bars, are of a uniform width of 15 in., from $1\frac{3}{8}$ to $2\frac{1}{4}$ in. thick, and up to 76 ft. in length. Owing to these heretofore unheard-of dimensions in eyebar manufacture, unusual care was required in the handling and shipping of these important parts of the structure, and the results obtained reflect great credit upon all concerned.

The erection of the eyebars necessarily required special attention, and in order to save both time and liability to injury, a scheme was devised by the contractors by which all bars constituting a single member were spaced properly, securely clamped together in this position, and raised into place in a bunch.

The raising of two top chord panels of 28 eyebars each, is here shown, a total weight of 160 tons, the requirement being to place them in position, at a considerable angle with the horizontal, 300 ft. above the river.

The falls attached to the far ends of these bars are those of steel wire rope previously mentioned, in the special 3,800-lb. blocks. The ones on the near ends are the 2-in. and $1\frac{3}{4}$ -in. manila falls.



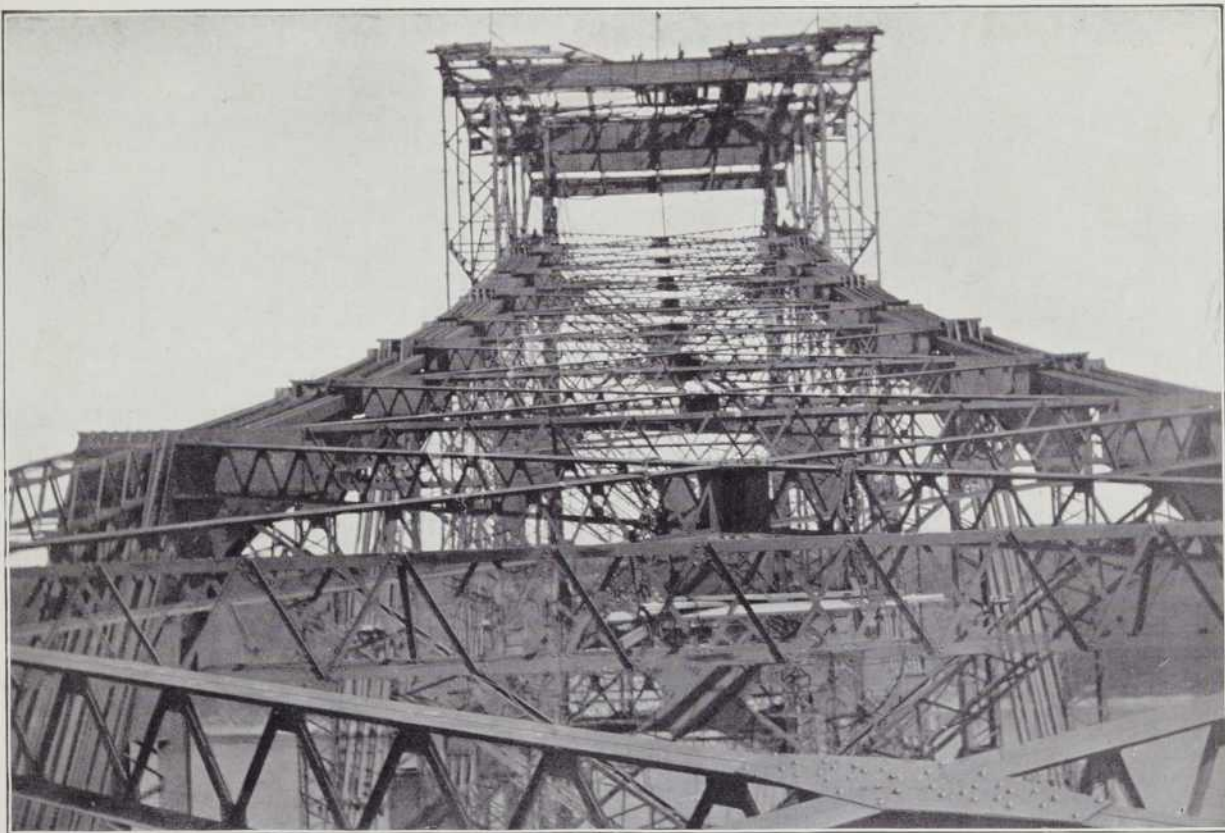
RAISING TOP CHORD EYEBARS.



ALTHOUGH the thorough work in the draughting rooms of the Phoenix Bridge Company, at Phoenixville, Pa., where the whole structure was detailed, cut down the number of field rivets to a minimum, there still remained 550,000 to be driven, from $\frac{3}{8}$ in. to 1 in. in diameter, and many through plates aggregating over 7 in. in thickness, and in spaces exceedingly cramped and narrow. To make this possible, the Chicago Pneumatic Tool Company, whose tools are used quite extensively on this work, designed special, short, automatic hammers. The particular work for which these hammers were designed was the driving of 1-in. rivets on the inside ribs at bottom chord splices, which it would have been impossible to do with the ordinary pneumatic hammer.

In this view, taken from the top of the south portal, looking over the lateral bracing, an idea can be gained of the network of transverse bracing necessary to hold the great trusses against wind pressure. Here the south anchor arm is almost completed, and the panels of top chord eyebars are seen gradually widening out as they approach their connection with the main posts.

The top of the big traveler looms up in the background.



VIEW OVER TOP OF SOUTH ANCHOR ARM.



ALL main connections on the anchor and cantilever arms of the Quebec Bridge are made with pins, from 9 in. to 24 in. in diameter, and up to 10 ft. in length. The driving of all of these pins has been a matter of great interest, and has been accomplished as illustrated here, by the swinging of a 4,000-lb. ram from the top of the traveler, and operating it with a gang of from six to eight men, in the usual manner, on a working platform suspended under it. The picture given illustrates the driving of the last pin connecting the trusses of the south anchor arm, which is 12 in. in diameter and 10 ft. 1¼ in. long, holding the 28 top chord eyebars to the massive 12-rib caps surmounting the main posts.

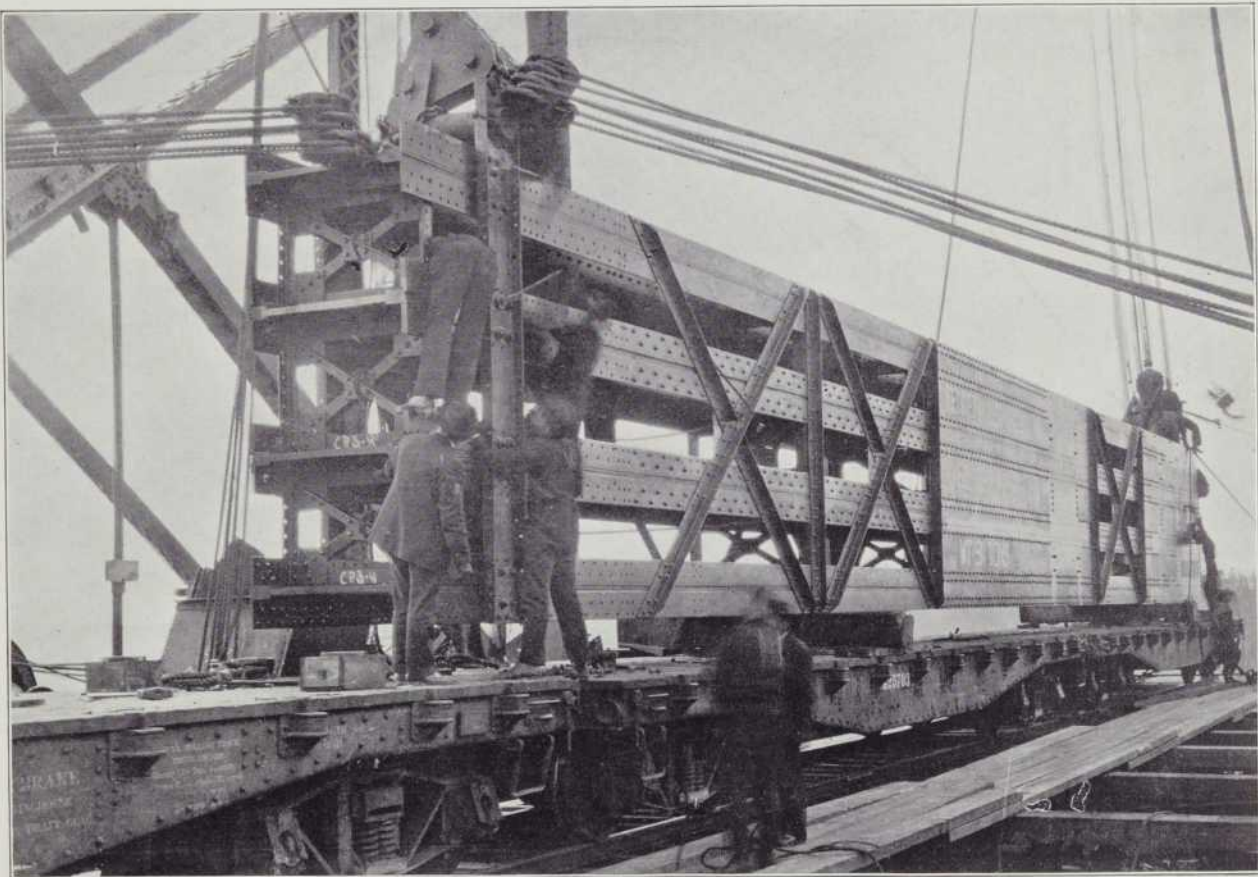


DRIVING A 12-INCH TOP CHORD PIN.



THE most difficult part of the erection work has been the handling of the sections of the main posts, especially those which, when in position, reached very nearly to the traveler clearance line on top. The section of these posts, here seen on the cars that brought it from the storage yard, is the heaviest one, and weighs almost 92 tons. The men are at work, bolting on the special attachments for raising this section, which, in its final position before lowering on to the section below it, was suspended from the very tip of the traveler overhang.

An idea can be gained from this picture, of the amount of detail that was worked out by the contractors in the office before the erection of any part of the bridge was started, for every important member in the trusses has had designed for it special attachments and rigging for lifting and handling, made necessary on account of the unprecedented sizes and weights to be provided for.



SECTION OF MAIN POSTS.



THE highest points on the bridge are the peaks of the main posts, reaching from the tops of the big masonry piers to a height of 400 ft. above the water.

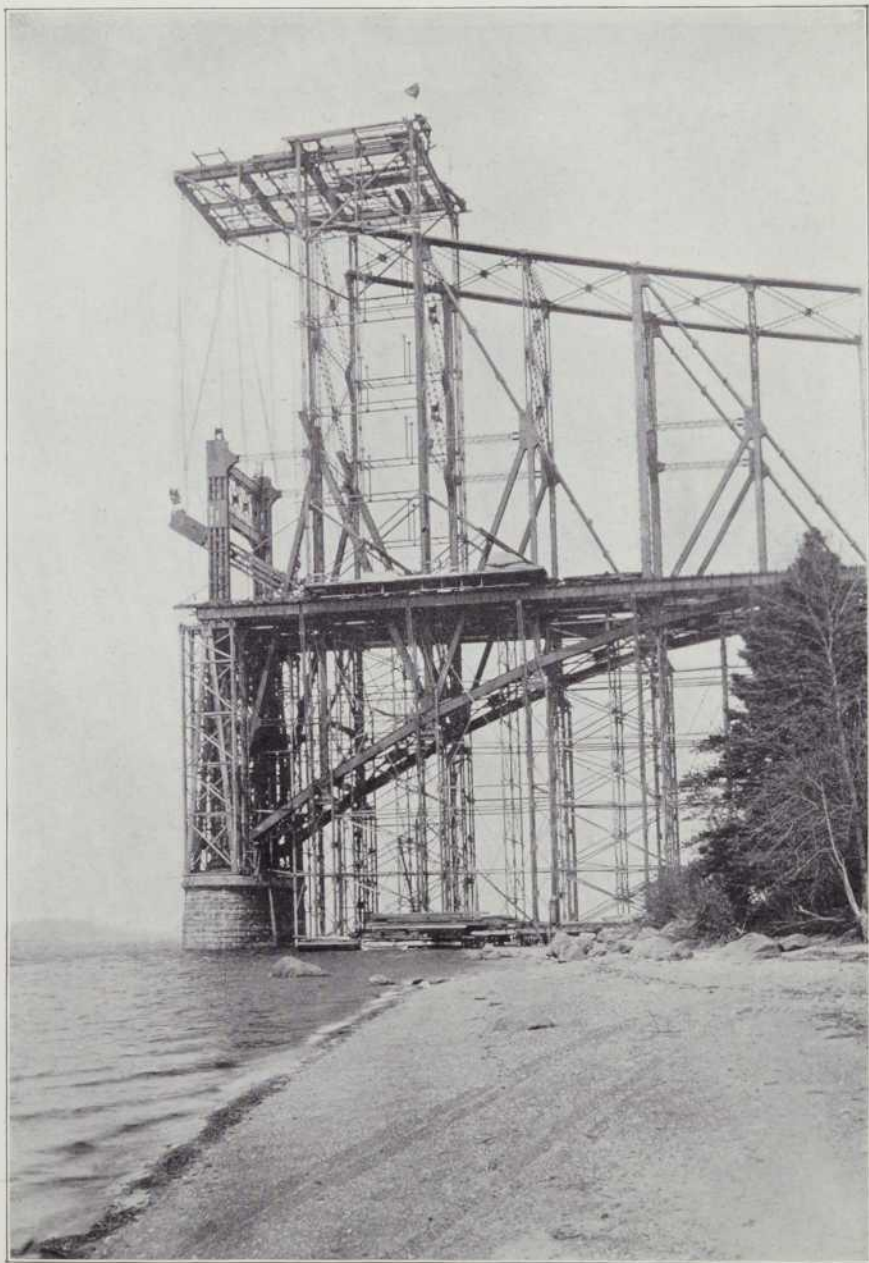
The traveler is shown here lifting one of the sections of this post, weighing 80 tons, to place it on top of the one already in position and shown on cars on preceding page.

The absence of smoke, noise and confusion is especially noticeable to a visitor at the bridge site, due chiefly to the admirable electric installation for handling all lifts.

As at the storage yard, previously described, a 2,400-volt alternating current is delivered by the Canadian Electric Light Company to two sets of motor-generators, made by the Allis-Chalmers-Bullock Company, of Montreal, in a sub-station on the approach span, and sent from them a 550-volt direct current, to the engines on the traveler, and all other motors on the work. The high tension current, as before mentioned, comes from the Chaudière Falls, where two General Electric and one Allis-Chalmers-Bullock turbo-generators are installed in a plant taking its power from one of the most beautiful waterfalls in America.

This being one of the first times electric power has been used on structural steel erection work of any magnitude, the outcome of the experiment has been watched with interest, and the fact that no delays or breakdowns have yet been experienced speaks well for this power for such use in general, and for this installation in particular.

All riveting, drilling and reaming is done by compressed air, furnished by two Herron & Bury compressors, made by the Bury Compressor Company, of Erie, Pa., and also driven by General Electric motors. The air is delivered through a 3-in. main, at a pressure of 90 lbs., to branches that reach all parts of the work.



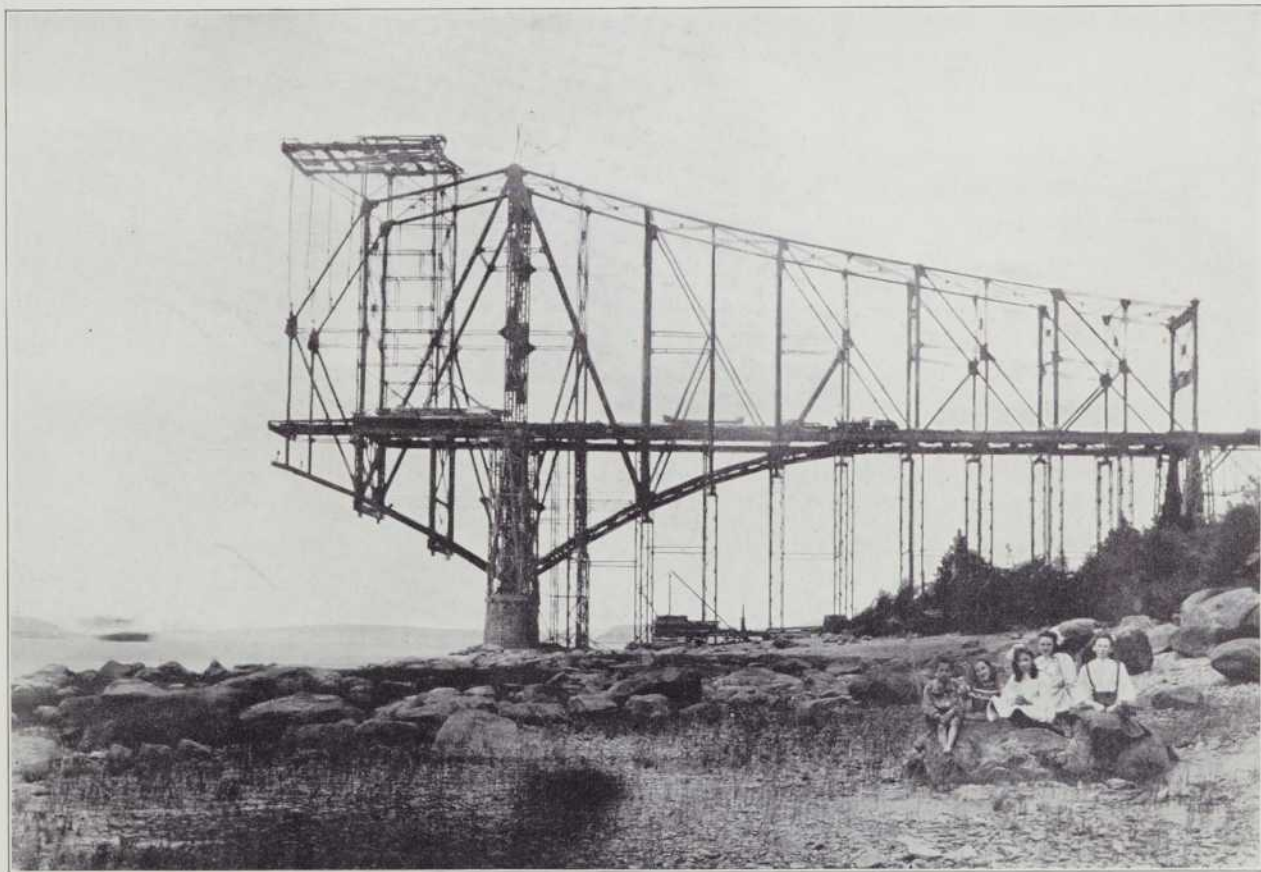
RAISING SECTION OF MAIN POST.



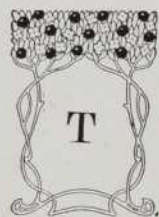
AFTER the completion of the south anchor arm, the timber falsework, before mentioned, for the temporary delivery tracks, was no longer necessary, and in the view here given it has been almost entirely removed and transferred to the north shore for use there. The erection of the 562½-ft. cantilever arm has been started in this view, but the steel falsework still remains under the anchor arm points to give them the necessary support, until sufficient weight has been erected beyond the main pier.

In order to facilitate some of the connections in the cantilever arm trusses, provision has been made to raise or lower each anchor arm panel point, as necessary, by powerful 500-ton hydraulic jacks, made by the Watson-Stillman Company, of New York, and placed between the special, steel camber blocks, which rest on a grillage of "I" beams and timber on the top of each tower of steel falsework.

Two of these 500-ton jacks, placed under a point, are sufficient to raise or lower the weight over them in every case.

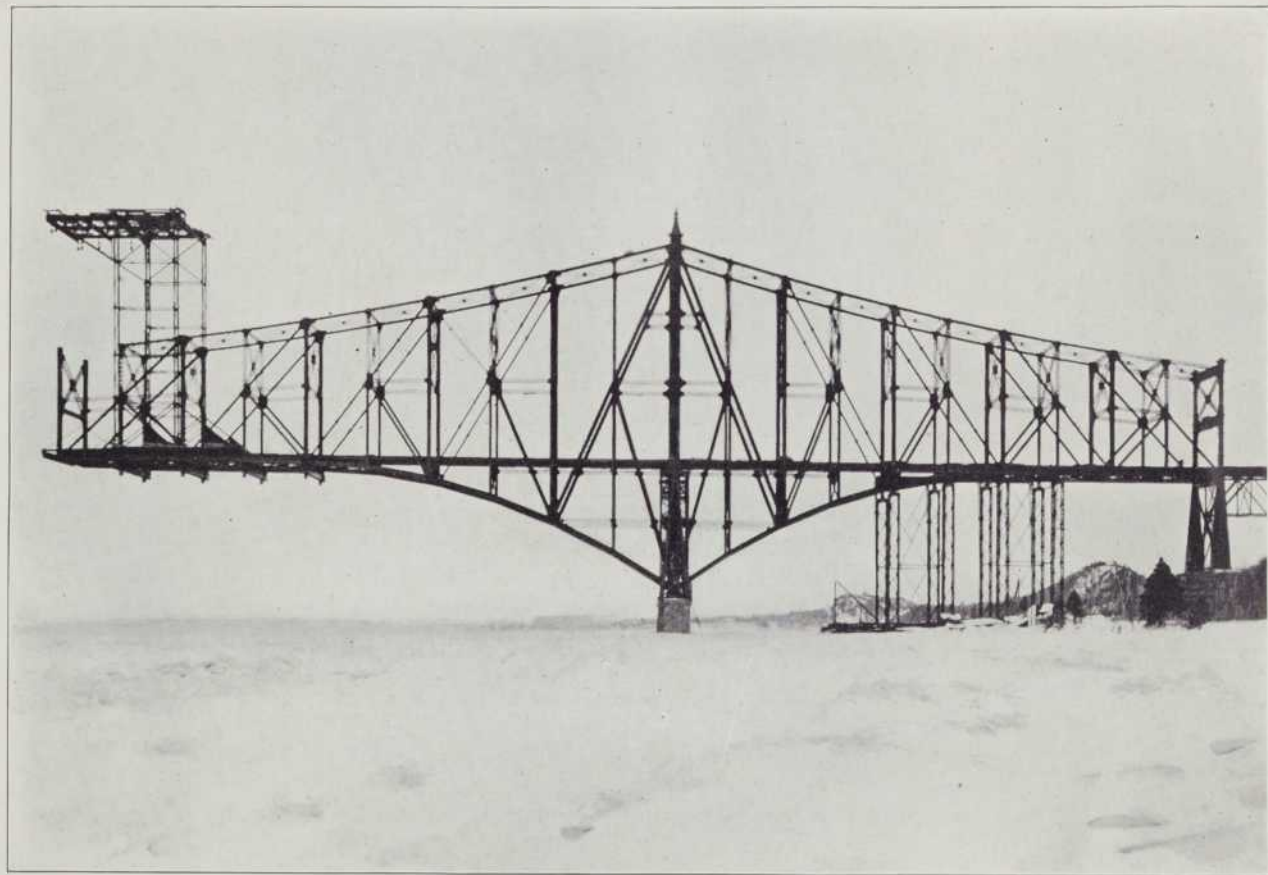


ERECTING SOUTH CANTILEVER ARM.



WHEN the erection work was suspended in November, 1906, on account of the winter weather, the south anchor and cantilever arms were erected complete, as here shown. A greater part of the steel falsework had been removed and transferred to the north shore for a similar use there, and the entire weight of the anchor arm had been lifted from all of the falsework towers by the action of the cantilever.

From the vertical posts at the extreme left of this view, one end of the 675-ft. suspended span will swing. Half of this span will be erected from each side, and during erection, each half will be adjusted by an arrangement of four 1,250-ton hydraulic jacks in the bottom, and four 500-ton hydraulic jacks in the top chords. The unusual capacity of these jacks involved special difficulties, and their manufacture was undertaken by the Watson-Stillman Company, of New York.



SOUTH ANCHOR AND CANTILEVER ARMS COMPLETE.



THE projection of the cantilever arm over the river with apparently no means of support, and carrying the big gantry traveler on its very tip, affords opportunity for numerous and varied theories to those who navigate the St. Lawrence River near Quebec.

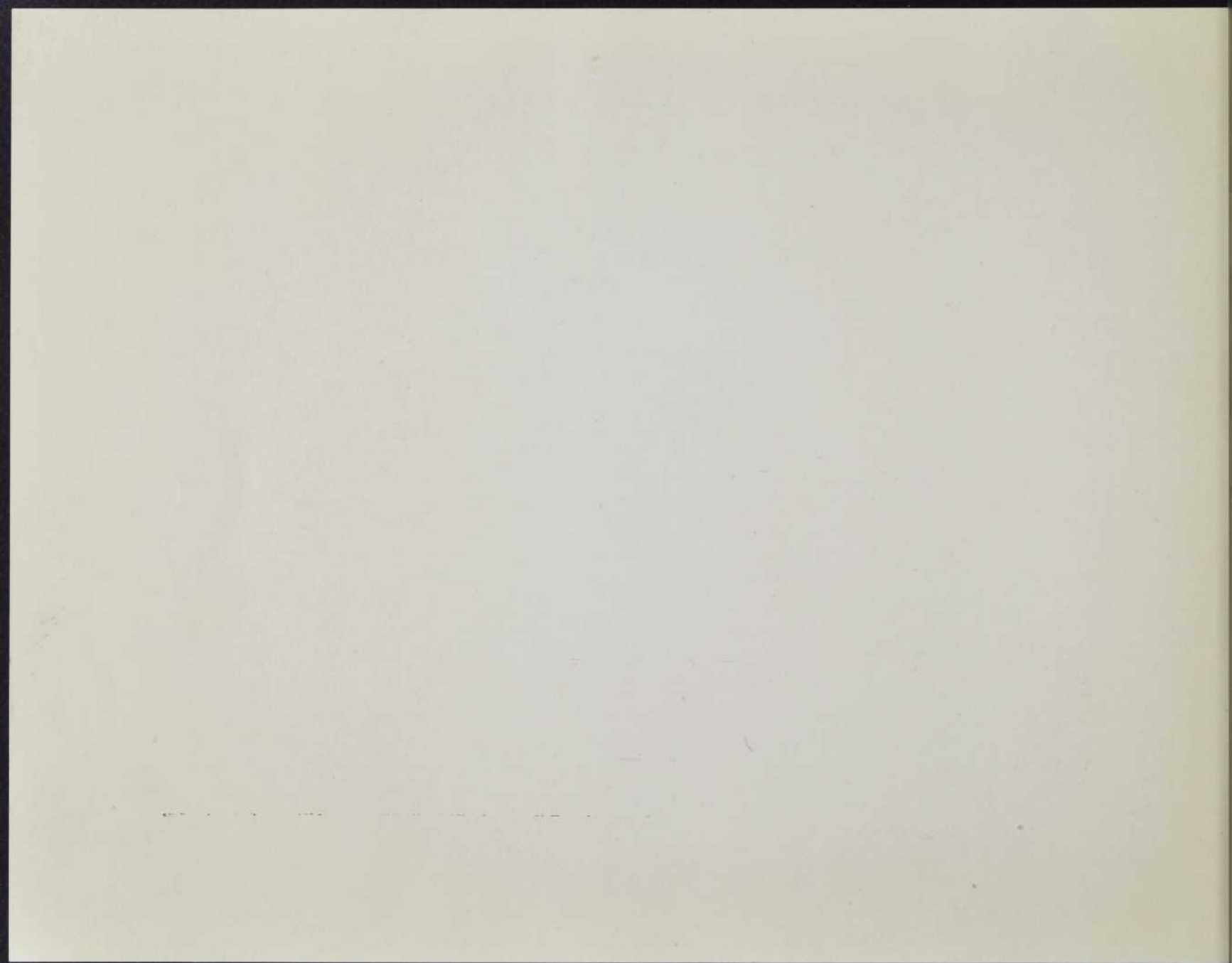
The picture here shown was taken from the ice in the winter time, and shows the same stage of completion as the one on the preceding page.

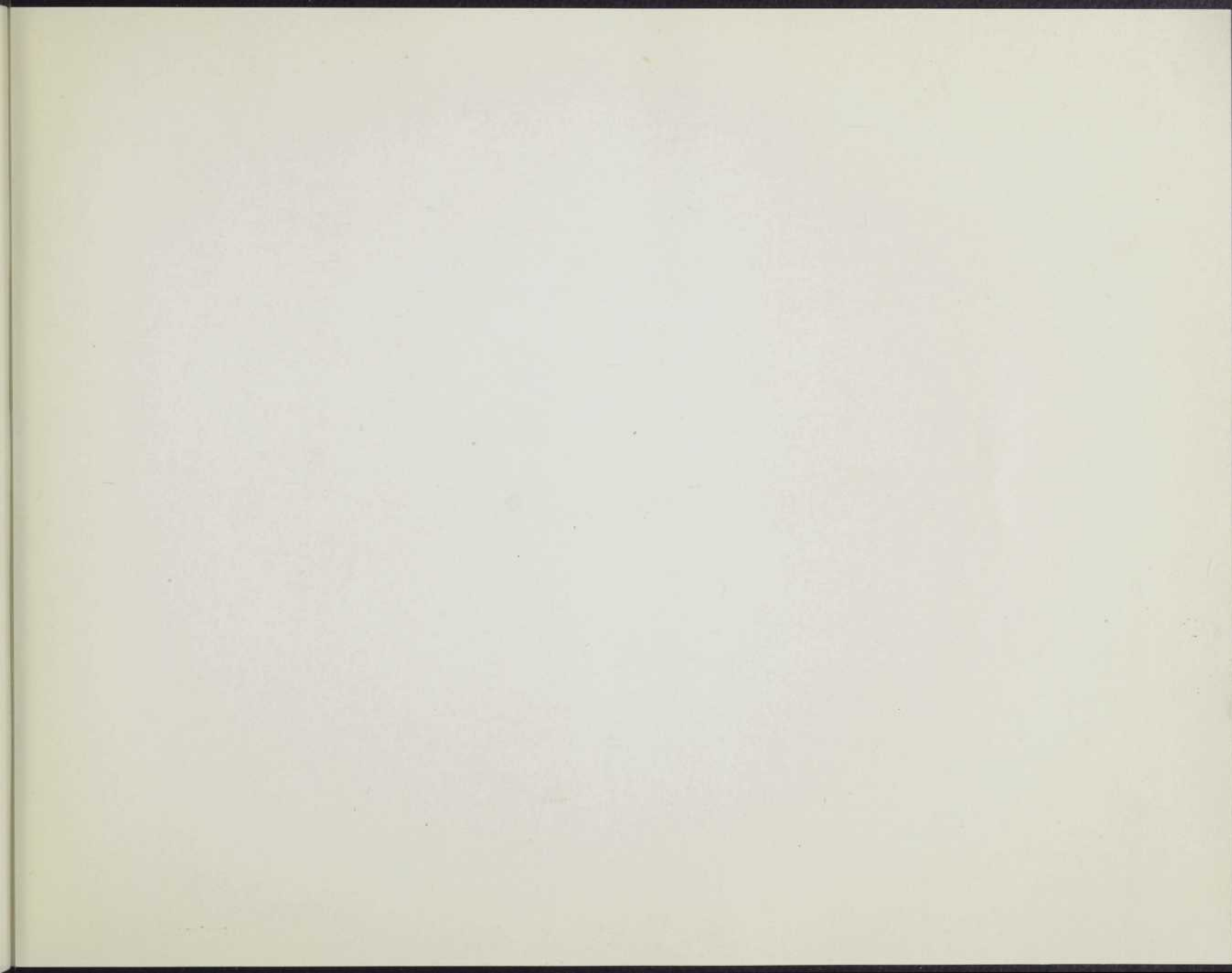
The St. Lawrence River ice is the source of a great deal of trouble and anxiety in connection with the bridge work, and special provision has been made to protect the false-work standing under the anchor arms on both sides of the river, from the destructive action of the great chunks, as they are carried back and forth by the high tide and swift current.

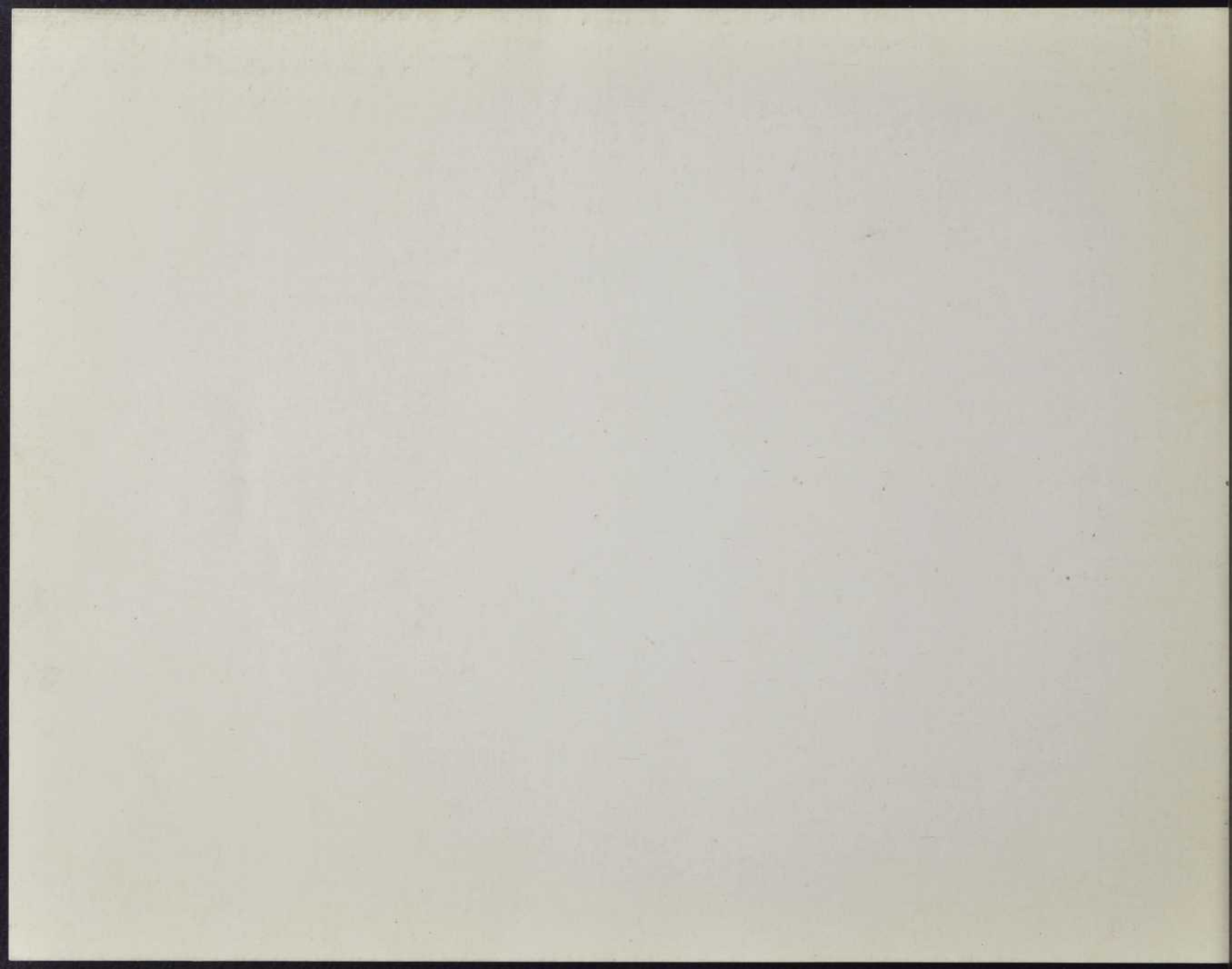
By the time the south half of this gigantic structure will have been completed, the work on the north half will be well under way, and the meeting and connection of the bridge over the center of the river will be watched with great interest.

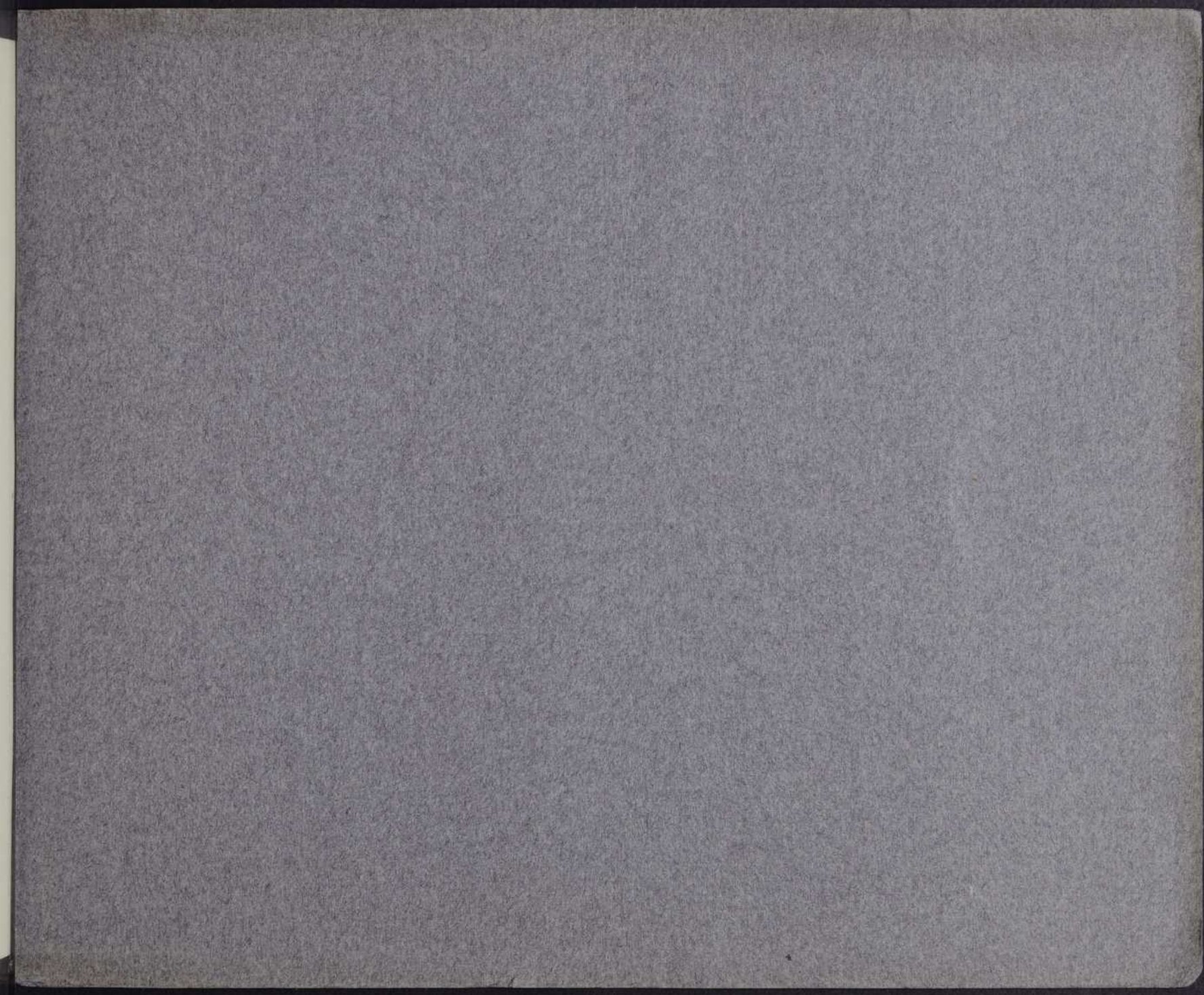


SOUTH CANTILEVER ARM FROM RIVER.









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