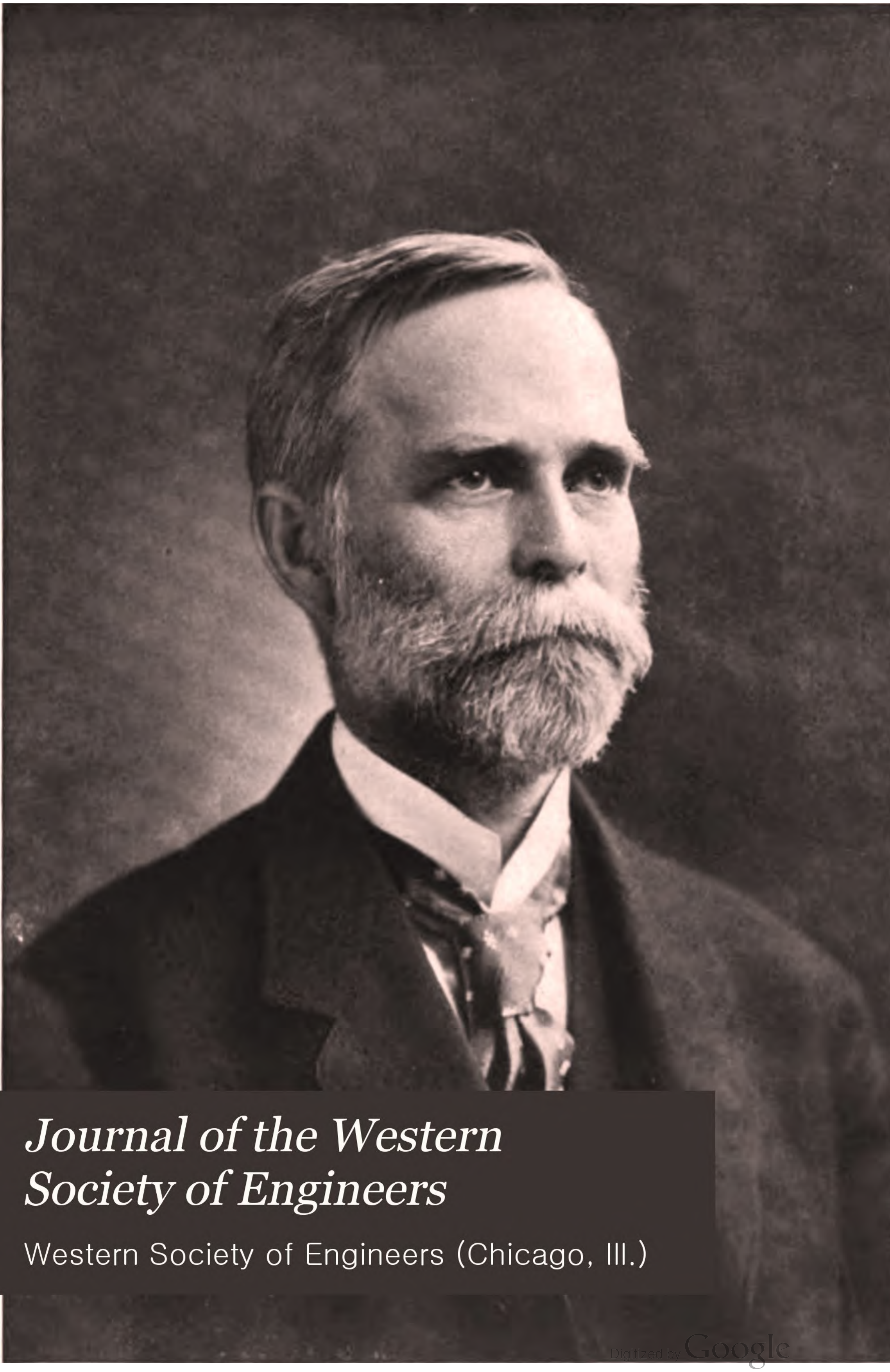

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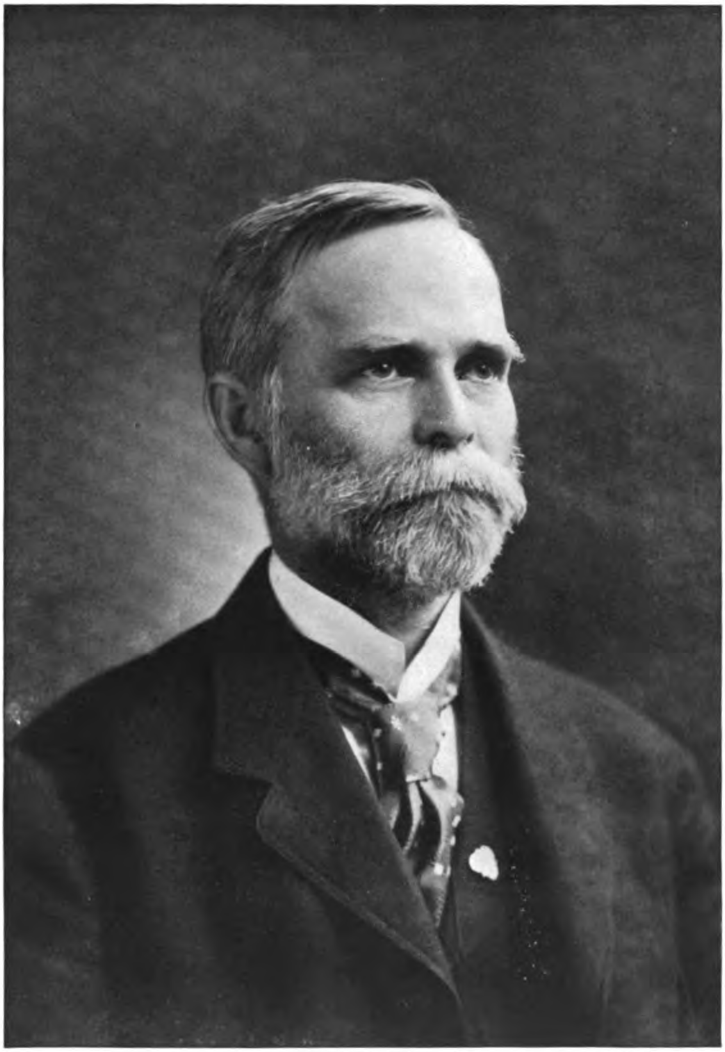

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LXXXIV.

DESIGN OF A 175-FT. COUNTER-BALANCE PLATE GIRDER SWING BRIDGE.

By Albert Reichmann, M. W. S. E.

The bridge known on the official records of the C., M. & St. P. Ry. as Z-6 is a 175-ft. counter-balanced swing bridge on the east side of the river, and a 70-ft. deck span on the west side of the river, situated on the North Branch of the Chicago River, near Clybourn Place, Chicago.

Fig. 1 is a map showing the locations of the old and the new bridges, the old bridge being shown in dotted lines, and the new one in full lines. The structure described replaces a 161-ft. wooden bridge with curved top chords, and is located at a sharp bend in the river, which, during the existence of the old bridge, was one of the most difficult passageways in the river, for boats. The center pier of the old bridge now becomes the west support of the new swing bridge, the new main pier being located on the east bank.

The new bridge was so designed as to materially widen the channel, and reduce the sharpness in the bend of river as much as practicable. It was considered desirable to use a plate girder bridge at this site, because, in that case, a partial through bridge could be used, which would make a very compact structure, take up less shore room and, for a given clear opening, require a shorter span. Besides, this type of bridge requires a smaller roller nest and pier upon which to travel. This design of bridge was particularly well adapted for erection without interference with river and railroad traffic.

This is probably the largest plate girder counter-balanced swing bridge ever built. It was designed for two 160-ton engines, followed by a load of 4,000 lbs. per lineal foot of track.

Fig. 2 shows the general design of the bridge. It is 175 ft. 2 in. long over all, and is on a 66-100 per cent grade, rising to the west. There are double track approaches to the bridge, which are gauntleted. The distance from the center of rotation to the end of the long arm is 141 ft. 6 in., and from the center of rotation to the end of the short arm 33 ft. 8 in. It is 108 ft. from the center of the live roller nest to the end of the long arm, which forms a cantilever when the bridge swings. The main girders are 14 ft. 2 in. c. to c., and 9 ft. back to back of angles, except at the end of the long arm, where they are tapered to 6 ft. The stringers are spaced 7 ft. centers.

The bridge is divided into ten panels, with the floor beams extending from one inch below the base of rail to the bottom of the girders. The laterals are angles, and are in the plane of the bottom flanges of the girders. Their gusset plates connect with the bottom angles of the girders and floor beams.

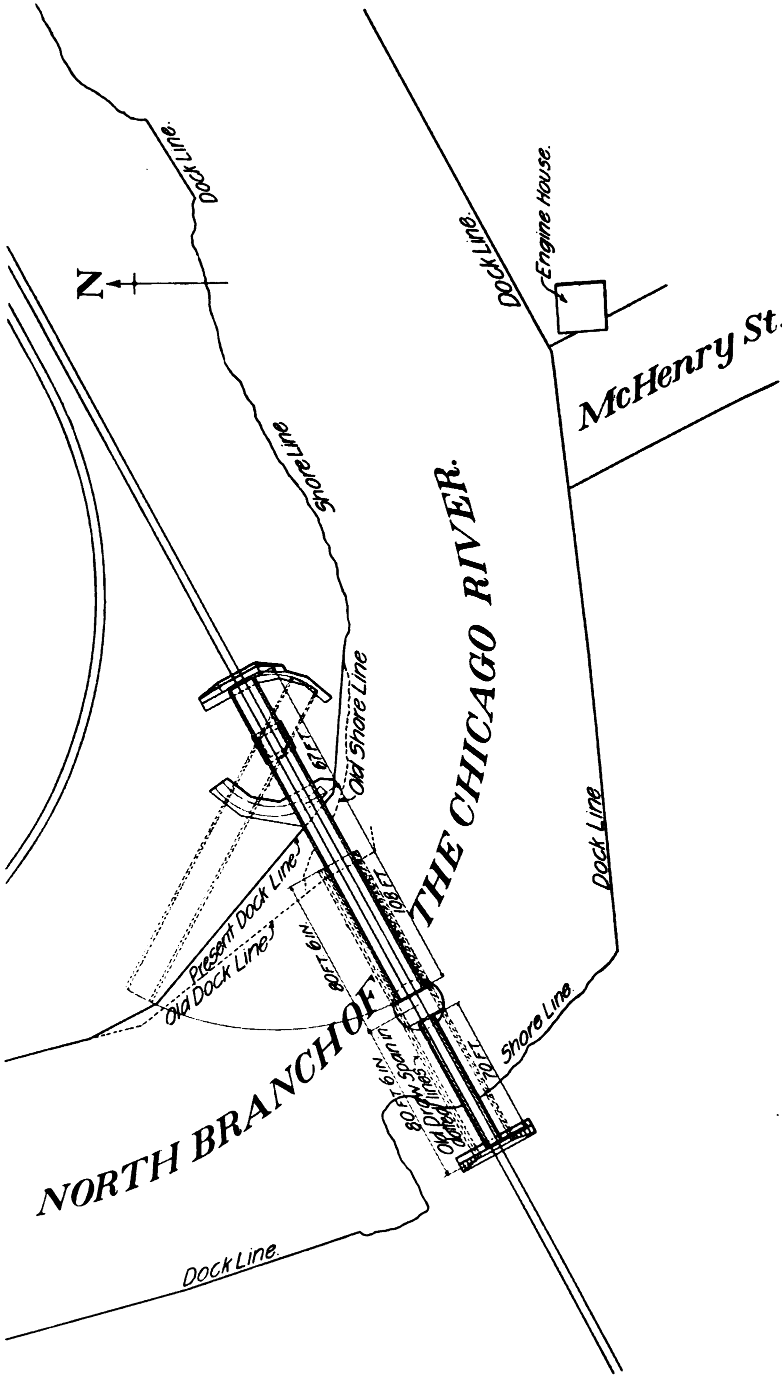

Fig. 1—Showing Location of the Bridge.

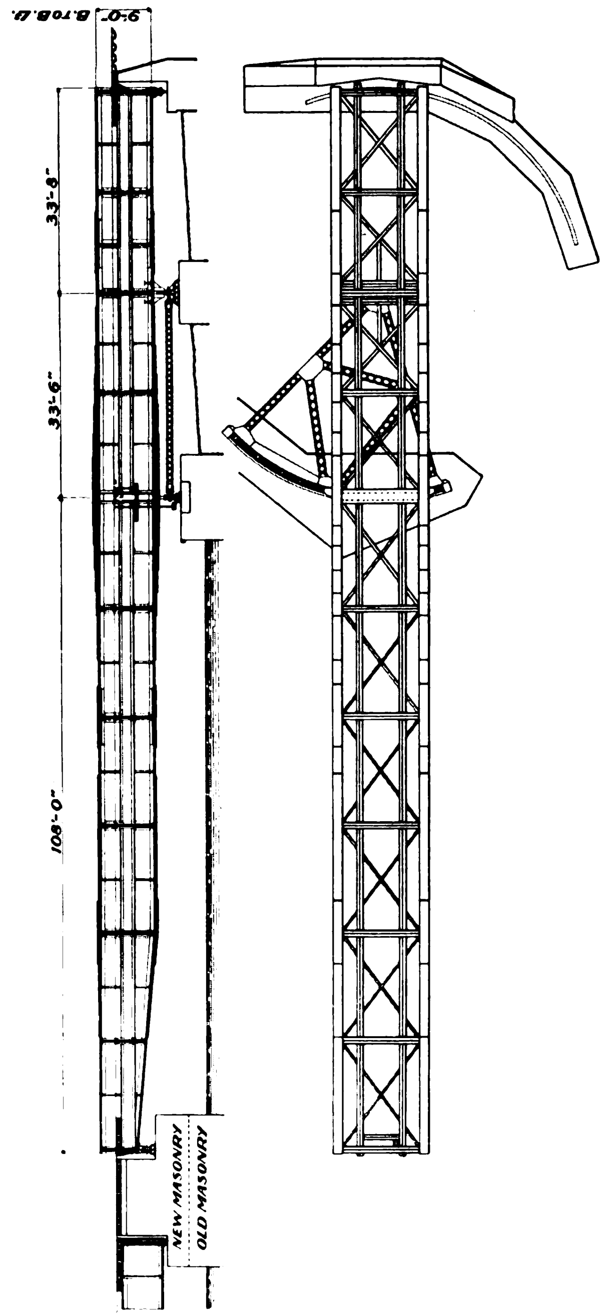

Fig. 2—General Design of the Bridge.

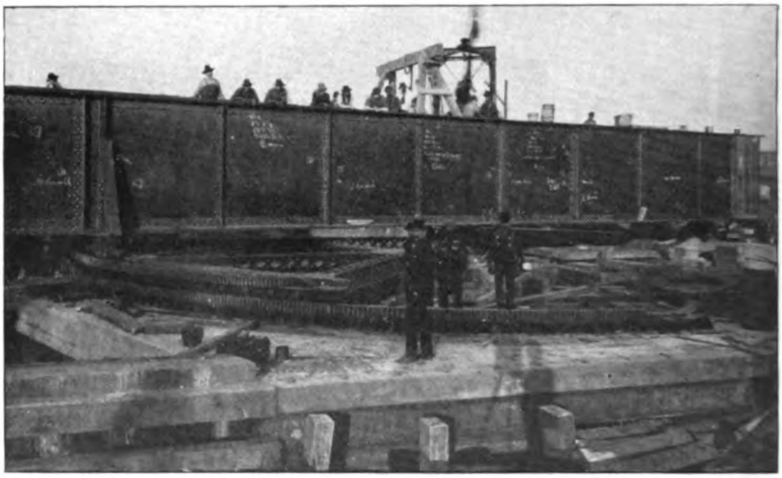

Fig 3.—Shows East End of Bridge and Mechanism to Swing it.

The girder sections were made of 8 x 8 x ¾ in. angles, with 18 in. cover plates. The largest section has seven 18 x ½ in. cover plates, which give a gross area of 85.2 square inches. The webs vary from ⅜ to ½ in. in thickness. The main girders were spliced at two points of least section; the top and bottom splices were placed over each other, and so arranged that the sections of the girder could be slid into place.

Almost the entire dead weight of the bridge is carried by a live roller nest of 24 steel rollers, 18 in. in diameter, and 10 in. face, just enough reaction being provided on the east end support to insure stability. These rollers are held in position by a triangular frame made of 3 x 3 x ⅜ in. angles, and thoroughly braced, as shown in Fig. 3. The struts composing this frame are 15 in. deep. The center about which this radial frame revolves was made so it could be removed at any time without moving the bridge, being made in the following manner:

On a pier, a casting 7 in. high and 4 ft. square was thoroughly bolted to provide for the great strains to which this pier will naturally be subjected. See Fig. 4. On top of this is placed a second casting, which had its connecting holes drilled in the field to insure accurate location. There is a small steel ring on the top neck of this casting to provide a bearing for the small roller nest of the radial frame. The top of this center is bolted together vertically, so the center pin can readily be removed. When this casting was bored, a sheet of iron was put between the two halves, so that when in position a tension could be put on the bolts to hold the pin in place.

As shown in Fig. 5, the weight of the bridge is distributed on the rollers by means of a large box girder, which extends from just below the base of the rail to the bottom of the main girders, and two brackets which are attached to the outside of the main girders. Under these is placed a segmental girder, composed of two 15 in. channels and plates. The bottom plate of this girder has its top planed to take up the grade of the bridge, and the bottom planed to a conic surface to take the roller bearing. It is 19 ft. 3 in. long and 1⅝ in. at the thickest place, and was the most difficult piece of the bridge to make. The wheels are held in position by a circular girder on the inside, and a 6 x 4 x ⅝ in. angle on the outside, upon which was placed a rack of the same size as the rack for operating the bridge.

The bridge opens through an angle of 57° 7′, and in one direction only, toward the north. The live roller nest travels with one-half of the velocity of the bridge, and in order to keep the bridge in the same relative position to the roller nest, a system of gears was introduced. One rack was placed on the tread casting of the bridge, and another on the live roller nest, as stated above. To insure uniform shrinkage, these racks are made alike. One pinion meshes into the rack of the tread casting, and another of the same size meshes into the rack of the roller nest. Its motion is imparted to it by an idler, which in turn receives its motion from a gear on the driving shaft. This gear has one-half the diameter of the gear on the equalizing shaft. The tread is a 1½-in. steel plate, resting on and breaking joints with a casting 10 in. high, to which it is secured by one-inch bolts.

As shown in Fig. 5, the bridge is provided with end lifts on the long arm, the short arm being counter weighted and has an end bearing all the time. The end lift consists of a roller sector, which has an axle with one inch eccentricity, so that when the axle makes a half revolution, the lift raises the bridge two inches. It is particularly desirable to have an end lift on this type of a bridge, since it is quite shallow, and the chords being stiff, they will cause considerable deflection from variations of the temperature of the chords. The roller sector rests on a cast bearing plate, which is provided with shim plates so that its height may be varied. The end lift is operated by a shaft, which runs transversely to the bridge, and which is in turn driven by a shaft running longitudinally to the bridge. It requires one and one-half revolutions of the transverse shaft to raise the lift. To this shaft is geared the rail lift shown in Fig. 6, which is geared in the same ratio as the end lift and is operated by an eccentric.

This style of lift has been in use on the C., M. & St. P. Ry. for many years, and gives entire satisfaction. It works very easily and does not get out of order, and is no more expensive than any other end lift. It also has the advantage of allowing the bridge to expand longitudinally, which is a feature but few end lifts possess. The writer does not mean to say that it is as cheap as a wedge, but the latter can scarcely be classed as an end lift.

The short arm of this bridge is 67 ft. 2 in. long, and is weighted

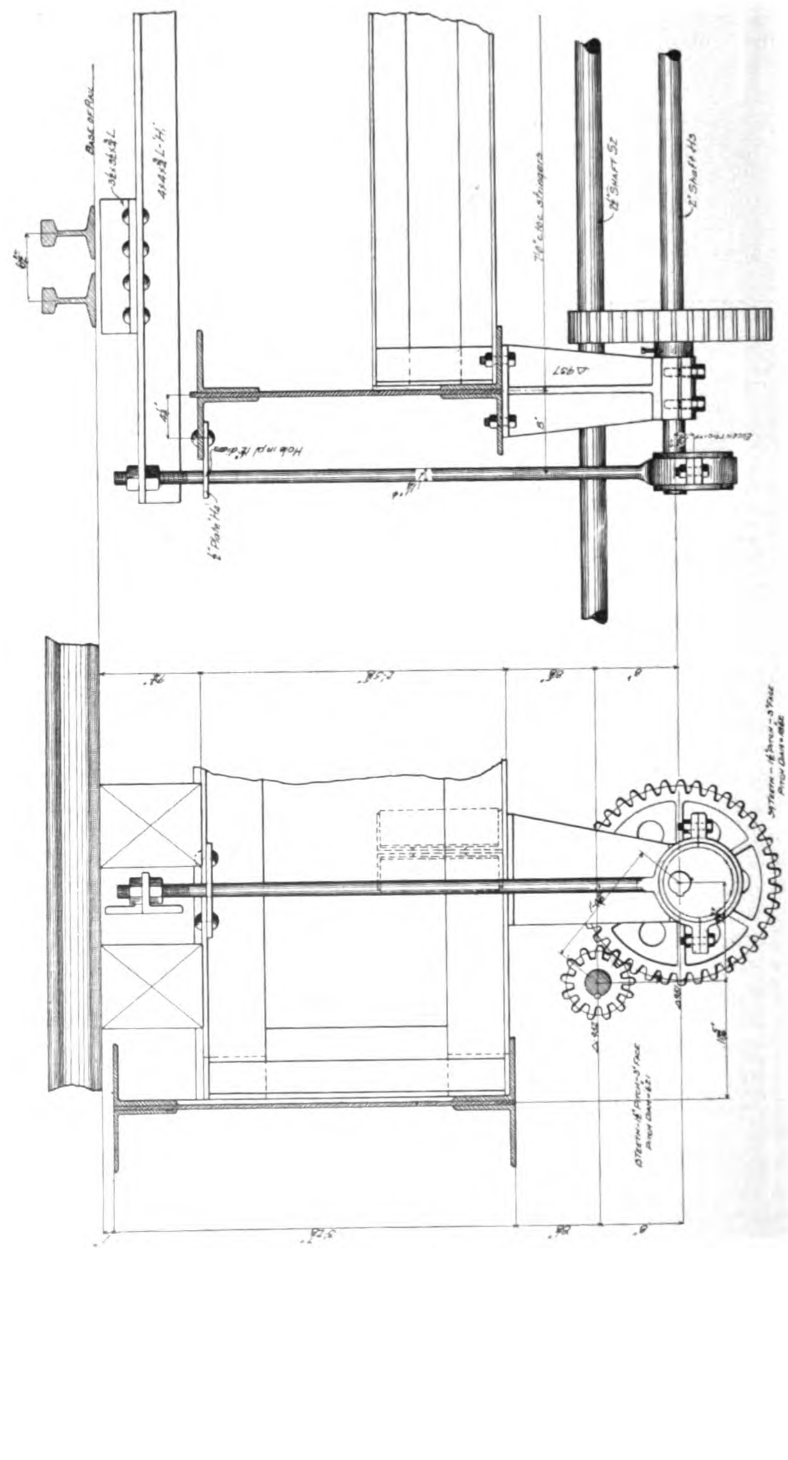

Fig. 6—Shows Rail Lift.

down with 113,300 lbs. of cast iron. Here is where the advantage of using a cross girder, resting on a segmented roller nest becomes apparent. If a complete drum has been used, the effective length of this short arm would have been reduced by nearly the length of the diameter of the drum. The counter-weight was cast in rectangular sections, and placed between the flanges of the main girders, resting over the vertical leg of the bottom flange angles of same. The pieces on the inside of the girders were provided with a projecting shoulder, upon which transverse pieces were laid from the bottom of the girders to the base of the rail. By this means, all the counter-weight was placed in a space 3 ft. 3 in. wide, which made a very compact arrangement. If cast pig or scrap iron had been used, it would have been necessary to build a support of structural steel for the same, and, besides, it would have required considerably more material, as it would have been placed nearer the center. The cost of casting the counter-weight was very small, and it was considered cheaper to use it in this manner.

There are two 18-in. rollers under the outer ends of each of the short arm girders, which travel on an 85-lb. circular rail, resting directly on the masonry, except that that portion of the rail under the wheels when the bridge is in a closed position, rests on a 14 x 1 in. x 2 ft. 4 in. steel plate, which is let into the masonry. The carriage frames of these rollers are made of structural steel, and are provided with shim plates on the top so their height may be adjusted. The bearing of the girders on the carriage is accomplished by a plate beveled 2½ in. from the center, to insure a central bearing on the carriage, and an equal bearing on each of the wheels.

The main girders of the bridge were fitted together in the shop and match marked. The live roller nest rack, tread and center were also fitted together in the shop and match marked before shipment.

The rivet holes in the floor beams and stringers were punched and reamed. All other rivet holes were punched. The structural material was made of steel, with an ultimate strength of from 55,000 to 65,000 lbs. per square inch, which is now being used on all the plate girder work of the C., M. & St. P. Ry. The bearing wheels of the live roller nest, the racks and pinions and gearing on the equalizer, with the exception of the idler, were made of steel, and all other castings, with a few minor exceptions, were made of cast iron. The gearing was cast and not cut.

This bridge will be operated by a 25-h. p. electric crane motor. The motor will be put in the panel of the long arm, just in front of the large box girder. The pinion of the motor engages a large spur gear, which latter is movable on its shaft axis and has a clutch connection on each end of its hub. When this spur gear is moved in one direction, one clutch engages the gearing of the end lift, and when moved in the other direction, the other clutch engages with the gearing of the operating machinery.

The end lift is operated by means of a worm gear and wheels, a very desirable arrangement, as the percentage of friction of the same is over 100 per cent. This causes it to be locked automatically at whatever position it may be left. The latch is an ordinary spring latch, operated by hand.

The draw bridge weighs as follows:

Structural steel	331,281 lbs.
Cast iron, exclusive of counter-weight	30,775 "
Cast iron counter-weight	113,300 "
Cast steel, shafting, etc	19,028 "
	494,384 lbs.
The 70-ft. span weighs	60,435 "
Total weight of both spans	554,819 lbs.

The 70-ft. span on the west end is of the standard C., M. & St. P. Ry. construction of deck plate girder work. The top flange is made with the web projecting ⅞ in. into the ties to insure good alignment of the track, and is composed of two 8 x 8 in. angles, and two 6 x 4 in. angles, with the 4 in. leg of the 6 x 4 in. angles riveted against the vertical leg of the 8 x 8 in. angles. This permits of a top flange with a smooth surface. In larger deck spans the chords are made of two 8 x 8 in. angles and four 6 x 4 in. angles. This permits of an easy reduction of the section and gives simple riveting.

This bridge was built by the American Bridge Works, of Chicago. Complete detail drawings of this work were made by the Bridge and Building Department of the C., M & St. P. Ry., with the exception of the electric machinery, which was designed by G. P. Nichols & Bro.

LXXXV.

CONSTRUCTION OF 175-FT.-COUNTER BALANCED PLATE GIRDER SWING BRIDGE.

By W. A. Rogers, M. W. S. E.

Mr. Reichmann has described in the preceding paper the novel features of the design of the Chicago, Milwaukee & St. Paul Railway Company's counter-balanced, plate girder, swing bridge, recently erected over the North Branch of the Chicago River, in Chicago. The writer will give in this paper a description of its construction.

The old wooden bridge replaced was a 161-ft. wooden span on a masonry center pier, with pile bridge seats at each end. At the west end was a pile approach 25 ft. long, and at the east end a pile approach 41 ft. long. The location of this bridge, just east of Elston Avenue, on our North Chicago line, necessitated the raising of the tracks across it, an average of 4.5 ft. in connection with our track elevation work in this part of the city. On account of necessary delays, it was impossible to get the steel work for the new bridge in time to avoid raising the track on the old structure. Before doing this, various parts of the bridge were strengthened where weakness had developed. Considerable trouble had been experienced on account of both the bottom center casting, and the bridge having shifted their positions; the former about 1½ in., and the latter about 3½ in., in the same direction, so that the top tread was nearly off from the rollers.

It was therefore necessary to remedy this difficulty before adding the extra weight required to raise the track. This was done early in May of this year, by shifting the center casting back to the center of the lower tread, and putting new anchor bolts and oak shores in to hold it in place, and by shifting the upper tread under the trusses to a new position directly over the lower tread on the masonry. This made the center pin slightly off from the center of the bridge, but not enough to be noticed.

On May 19th of this year, the elevation of the track was extended across the structure. The plan followed was to raise the floor of the bridge and leave the truss undisturbed. This was accomplished by stripping off all of the old floor down to the wooden floor beams. On these floor beams a double line of 8 in. x 16 in. stringers, parallel to the trusses were laid, 8 ft. 8 in., center to center. On top of and at right angles to these two stringers, double caps, 12 in. and 14 in. thick, and spaced the proper distance apart vertically to give the required elevation, were placed 16 ft. apart, measured in the direction of the track. On these caps, four 8 x 16 in. x 32 ft. Douglas fir stringers (two under each rail), and then the 6 x 8 in. pine ties were placed.

Fig. 7.—The Old Wooden Truss with Track Elevated Across it.

The pile approaches at each end were raised with pony bents. Fig. 7 shows the old wooden truss with the track elevated across it.

SUB-STRUCTURE.

The location of the new masonry for the draw span was on the east bank of the river, and as shown on the map (Fig. 1), consisted of an irregular shaped pier, with two of its sides forming the new dock line; one pivot pier at the center of rotation, and an east abutment, carrying a very light load. The west end of the draw span, and the east end of the fixed span over the closed channel are supported on the old center pier, raised by cut stone masonry to the required height. The west end of the fixed span is supported by a concrete abutment now in process of construction.

On account of the location of the new masonry on the east shore of the river, it was necessary to build a pile bridge for falsework from the end of the old east approach to a point far enough east of the east abutment to permit of the excavation for the same. The pile bents of this falsework were so located that the east abutment and pivot pier were spanned, but on account of the length of span which would have been necessary, no attempt was made to keep the piles out of the main pier. But one bent was driven inside of the location of this pier, and a bent on each side, just outside of the proposed location of the coffer-dam.

From Fig. 8, it will be seen that the bottom of the footing of the main pier was not all at the same level, but at three different elevations. The deepest was under that part of the pier adjacent to the river, being there at an elevation of —28.2, Chicago City datum. The bottom stepped up to —19.7 and —10.8, the same datum, the latter being under the part of the pier farthest removed from the river. It had been expected that pile foundation might be needed under this pier, but a test pit sunk near the site demonstrated that it was unnecessary.

The surface of the ground at the site of the new masonry was at an elevation of +6. to+8. Chicago City datum, and it was necessary first to excavate the earth to the water level, at that time varying from 0 to —1.0. On account of the fact that there was little room to deposit the excavated material near by, it was loaded on cars and taken across the river and deposited in our rolling mill yards, which we were then preparing to elevate. This was done by means of an inclined runway extending up and over the cars, up which the dirt was taken in wheelbarrows. The loaded cars were taken from the bridge to the yard once a day, and left to be unloaded, and the empty cars brought back. The cars to be loaded stood on a side track at the east end of the bridge.

Excavation was started early in December, 1898, and carried on for a few weeks, when it became necessary to stop for several weeks, after which work was resumed and carried on until the completion of the masonry. The first plan for building a cofferdam for the main pier was to drive a row of guide piles, and after placing a girt, to then drive a row of 6 x 12 in. sheeting, with 2 in. battens, but on trying to drive the guide piles it was found that after getting through the blue clay, which extended to about —15.0, a material was encountered of such a nature that piles could not be driven to a depth greater than —20. to —21.0. This fact, and the knowledge gained from our test pit decided us to use simply 2 x 8 in. sheet piling, driven by hand as the excavation proceeded. The excavation was carried down to 6 or 7 ft. below water level before the sheet piling was started. The pit was started about 1 ft. larger on the deep part of the pier than the bottom footing; 2 x 8 in. dressed and matched sheet piling 18 ft. long was started about a frame of the proper shape, composed of 8 x 16 in. timbers, braced by 12 x 12 in. timbers. No attempt was made to force the sheet piling into the soil, but it was driven down as the excavation proceeded. Great care was exercised to build a tight cofferdam, and good results followed.

Bracing was put in about every 4 ft., in a vertical direction; 8 x 16 in. timbers were used as girts, and 12 x 12 in. for braces. On account of the fact that the sides of the pier were not parallel, it was impossible to brace from side to side. So the horizontal braces were placed against the girts, at right angles to the sides, and extending to a timber, midway between the two longer sides. The members of each horizontal set of bracing were built exactly below that of the set above, thus permitting a dirt bucket to be easily used. When the 18 ft. sheet piling had been driven down full length, another row of 2 in. sheet piling, 16 ft. long, was started inside of the first, and the excavation was carried down to the desired depth. As previously stated, the material was blue clay to a depth of about —15.0. A layer 4 or 5 ft. thick of sand, which became quicksand when saturated, was next encountered. Then there was a strata of coarse gravel from 12 to 18 ins. thick, after which came a very dark, hard sand, extending at least 10 ft. below the bottom of the pit. This sand was of a peculiar nature; it was dark in color, very hard and dry, and required the use of a pick to loosen it. It stood very well in quiet water, but washed away very rapidly if the water was stirred. It seemed to have some clay in it. The water from the river did not percolate through it.

We encountered very little water, in our pit, considering the depth, and the proximity of the river, and were able to keep it pumped out with two 3-in. Edson hand pumps, using one to pump from the bottom into a barrel about 14 ft. below the top when the excavation had been carried below that depth, and the other to pump from the barrel to the surface. It had been the intention to carry the excavation to a depth of about —26.0, believing this to be safe for any future depth of channel, but inasmuch as no great difficulties had been encountered, it was decided to go to —28.0, and make assurance doubly sure.

As before stated, a bent of falsework was driven just outside of the cofferdam, at each side of the pier, and parallel to the sides, and one bent was driven inside of the pier. Four 8 x 16 in. x 32 ft. stringers under each rail extending between the bents on each sides of the piers, were used. The piles in the bent inside of the pier were soon dug out, aud frame bents of the proper length, resting on sills, placed at the bottom of the excavation, first near one side and then the other, of the pit, were used to support the track as the excavation proceeded.

The digging of the foundation of the shallower parts of the main pier, and the pivot pier and east abutment, was a comparatively simple matter, and needs no description. The earth was hoisted from the pits by means of a steam derrick, with a boom of sufficient length to reach all parts of the piers. It was placed as near the center of the pivot pier as it was possible to do and still clear the track. Four steel dirt buckets of ½ cu. yd. capacity each were used.

The general plan of the new masonry built for the draw span is shown in Fig. 8. It was built of concrete; the footing of the east abutment, and the bottom footing of the pivot pier being of Louisville Cement concrete, and the rest of Portland Cement concrete. The Portland Cement concrete was made of the proportions of 1 part of Portland Cement to 3 parts of gravel to 4½ parts of crusher run limestone. The Louisville Cement concrete was made of the proportions of 1 part of cement to 2 parts of gravel to 3½ parts of crusher run limestone. The gravel was composed of about 1-3 pebbles, and 2-3 coarse, sharp sand. The crushed stone was a hard limestone from Hawthorne, Ill., the fine parts of which were sharp and hard. No stone larger than 2 in. in its greatest dimension, was specified.

At several of the swing bridges on this company's lines, more or less trouble has been occasioned by the crowding in of the abutments or piers at the ends of the spans, by the pressure of the filling behind them. Inasmuch as the movement of the main pier of this bridge would cause a great deal of trouble in the operation of opening and closing, it was thought advisable to tie the main pier and east abutment to the pivot pier by means of rods incased in concrete. In case of the movement of the main pier, which was considered extremely improbable, it was believed that the pivot pier and east abutment would then go, too, thus preserving their positions relative to each other.

In order to tie the various parts of the main pier together, horizontal rods and old rails were built in the concrete, as shown on the plate.

On March 17th of this year, concreting was begun on the footing of the main pier. No form was built for the bottom footings, but the concrete was filled out against the sheet piling of the cofferdam. This bottom 4 ft. was placed as soon as the excavation was completed, and as rapidly as possible, in order to hold the bottom of the sheet piling and to prevent any possible leaks developing through the bottom of the pit. The concreting in the bottom footings of the pivot pier, and east abutment was also filled out against the sheet piling in each case. The forms for the neatwork were made of 2 x 10 in. plank, unsurfaced below the water level, and surfaced above.

The concrete was all machine mixed. A gasoline engine furnished power for the mixer, and was housed in a shanty near the mixer. The mixing was carried on during cold weather, and the water, gravel and crushed stone were warmed before mixing. The water was warmed by discharging the exhaust steam from our derrick hoist engine into the supply tank. For heating the gravel and crushed stone, we built two furnaces, each about 35 ft. long, with brick sides 2 ft. high, and 2 ft. in the clear between walls. On the top of these walls, scrap plates ½ in. thick were laid. The furnaces were located along the side track from which the material was unloaded, and were placed end to end and used a common chimney, built up part way of brick and lengthened with wood. The gravel and stone from the cars were unloaded on to the furnaces, and the fires were kept burning continually during cold weather.

The mixed concrete was discharged from the mixer through a chute into steel buckets on a push car, running on a short piece of track, extending out over the pit. The buckets were picked up by the derrick used during the excavation, and swung out over the pit and lowered between the braces of the cofferdam to the proper place and dumped. The buckets were ½ cu. yd. capacity, and took just one charge of the mixer.

The mixer and engine were described by the writer in a former paper before the Society.*

As the concrete was built up from the bottom of the pit, the braces of the cofferdam were taken out. After the top of the lower footing was reached, the sheeting was shored against the concrete which had already been placed.

The rails built in the concrete were scrap, and the rods were old Howe truss rods. The frame bent of falsework inside of the main pier cofferdam was left in place and concrete built around it until

*See Journal Western Society of Engineers, October, 1898.

the top of the first footing was put in, when a frame bent resting on the step of this footing was placed on each side of the pier, and the one inside of the pier cut off at the surface of the concrete.

The concrete in the main pier was carried up to the bottom of the bearing stones, shown on the plan of masonry, when these were set and the concrete carried up on each side to the top. It was thought best to use stone for bearing instead of carrying the load directly on the concrete.

Work on the concrete of the main pier was begun March 17th. On April 8th it was finished up to the bottom of the bearing stone. On April 13th, all of the masonry on the east bank of the river was completed. There were a good many delays due to stormy weather, and to it being necessary to stop concreting while the forms were being built and the bracing taken out. We had some very good days' runs with our mixer on this work. On April 5th we put in 137 cu. yds. of concrete in nine hours, and on April 6th, 150 cu. yds. in 9½ hours.

The masonry in this part of the work is as follows:

	Portland Cement Concrete.	Louisville Cement Concrete.	Bearing Stones.	Totals.
Main Pier.....	802 cu. yds.		16 cu. yds.	818 cu. yds.
Pivot Pier.....	52 " "	39 cu. yds.		91 " "
East Abutmt..	194 " "	117 " "		311 " "
Totals.....	1048 " "	156 " "	16 cu. yds.	1220 " "

A steel plate 2 ft. 6 in. wide was built into the concrete at the top of the main pier on the river side, as a protection from passing boats, as well as to furnish a support for the timber wale. It is held in place by means of ¾ in. bolts, 27 in. long, with 4 x 4 in. plate washers on their ends, built into the masonry. This plate was placed on the inside of the form, and the concrete filled out against it. The use of concrete in this work proved very advantageous, not only from the standpoint of economy, but also from that of speed of construction. The construction of the main pier with heavy bridge stone masonry would have been fraught with many difficulties, not the least of which have been setting the stone between the numerous braces of the cofferdam. The writer has no doubt that to have built this with bridge stone would have doubled the cost. The speed would necessarily have been much retarded as well.

The old center pier which furnishes the west support of the swing bridge was raised to the proper elevation, with cut stone masonry set after the old bridge was taken out, by means of a stiff leg derrick placed on the old protection pier.

ERECTION OF THE SUPERSTRUCTURE.

While the masonry for this bridge was completed early in April of this year, the delivery of the steel work was unavoidably delayed until October, and the erection was not begun until October 6th.

The plan of erection adopted was to set up and rivet the steel work in the open position, as shown in Figs. 1 and 10, on blocking resting on the ground. The girders were erected 2 ft. 6 in. below

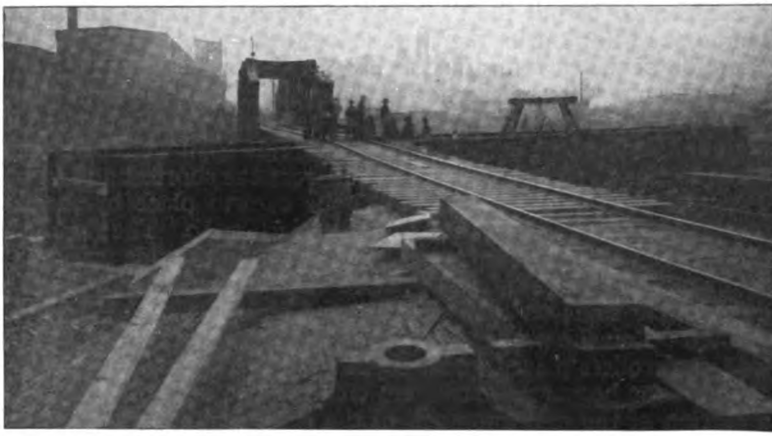

Fig. 9.—View Before Disturbing the Track at 4 P. M.--Looking West and North, Girder Bridge in Position as it was Built.

final grade by omitting the top center casting, live roller nest and triangular spider frame, permitting them to be set up under the falsework, as shown in Fig. 10. About two-thirds of the counterbalance was omitted until it was raised to place. After it was riveted up, the plan was to raise the girders to the proper height by means of jacks, put in the center casting, pin, spider frame and roller nest, and the rest of the counterweight, put on the rails and ties, remove the pile bridge constituting the east approach, swing the old wooden span open, block it up on the protection pier, take out enough of

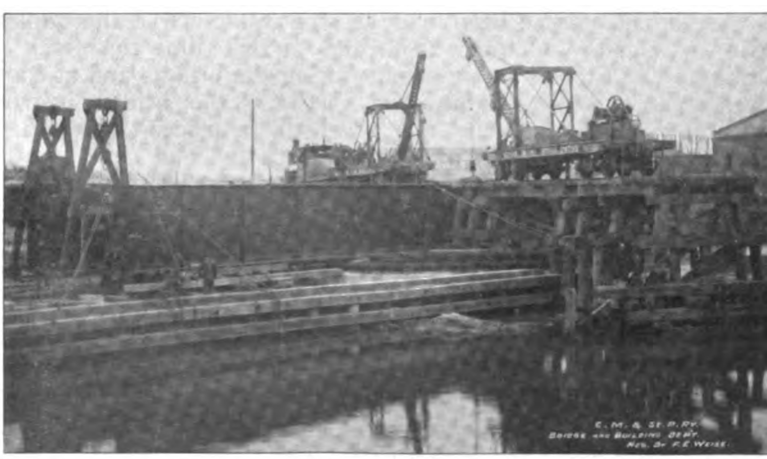

Fig. 10 –Shows Middle Section Just after having been Rolled to Place.

the center to permit the swinging of the new bridge, and build a temporary bridge from the west shore to the center pier. The description of the carrying out of this plan follows in detail:

On October 6th the erection of the steel work of the swing bridge on the temporary blocking which had been previously prepared, was begun. Each of the girders comprising this span were delivered in three sections. The east end sections were the shortest and lightest. They were unloaded directly from the cars to place by means of our bridge erection derrick cars, shown in Fig. 10. The middle sections were unloaded from the cars standing on the side track shown in Fig. 11, to skids having greased rails on top. They were slid down these skids on their sides to the blocking, where they were righted up on the proper center line, but west of their proper position, and rollers placed under them.

The floor beams and stringers were put in, and after taking out a section of the east approach of the right width, this section was rolled ahead to its proper location and connected with the section already set in place.

Fig. 10 shows the middle section just after having been rolled to place. At the left end of the section may be seen the rollers still in position. The Bridge Department derrick cars are shown in the center of the view. The last, which were the longest sections, were unloaded from the cars in the same way as the middle sections, and slided down to the blocking on greased rails, where they were righted and connected.

On October 21st the bridge was all riveted up, ready to be put into service, and on that afternoon the jacks to be used in raising it to the proper elevation were placed ready for use the following morning. The photograph, Fig. 9, was taken at 4:30 p. m. of that day. In the foreground of the view are shown two of the counterweights and the top half of the center casting.

Arrangements had been made to stop traffic across the bridge at 6 a. m., Sunday, October 22nd, and at that time the track was broken. At 6:12 a. m. we began raising the bridge, and at 8:00 it was up to the full height. Fig. 13 shows the bridge just after reaching full height, with the jacks still in place. Nineteen ball bearing jacks of 25 ton and 35 ton capacity, and six 20-ton hydraulic jacks were used. The latter, however, were more or less troublesome at the start and were not used very long. The old draw span was left closed until 7:15 a. m. to be used to run part of the floor timber on to it. It was then swung open and blocked up on the protection pier, and the work of cutting a hole through it over the center pier, and clearing the latter was begun.

The force was divided as follows:

1st: The iron bridgemen engaged in the steel work.

2nd: Carpenters engaged in taking out the east approach.

3rd: Carpenters and laborers engaged in cutting a hole through the old span and clearing the center pier.

4th: Carpenters engaged in building the temporary work from the west shore to the center pier.

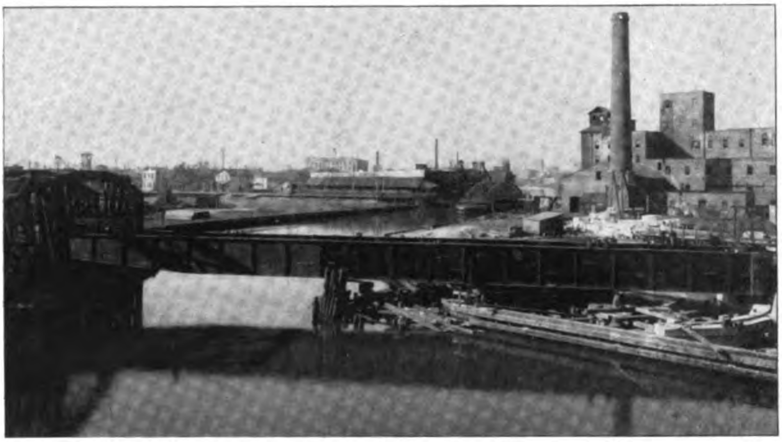

Fig. 11.--Bridge in Place.

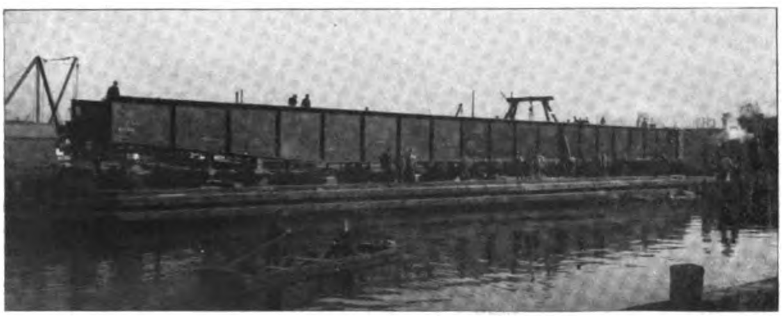

Fig. 12.--Shows Bridge After Reaching Full Height with Jacks Still Under it.

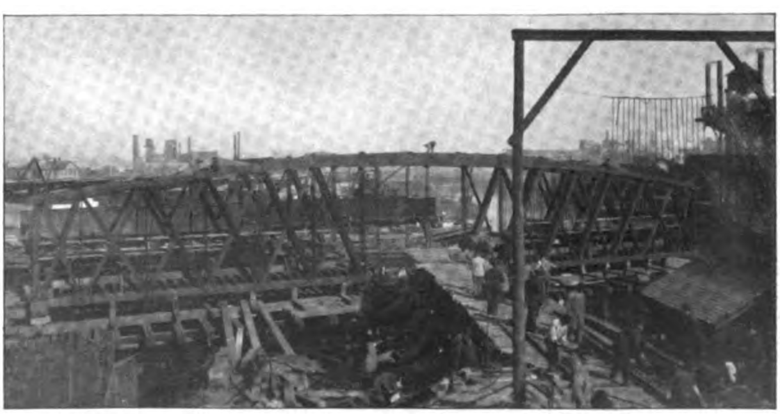

Fig. 13.—Shows False-Workout Nearly to Center Pier.

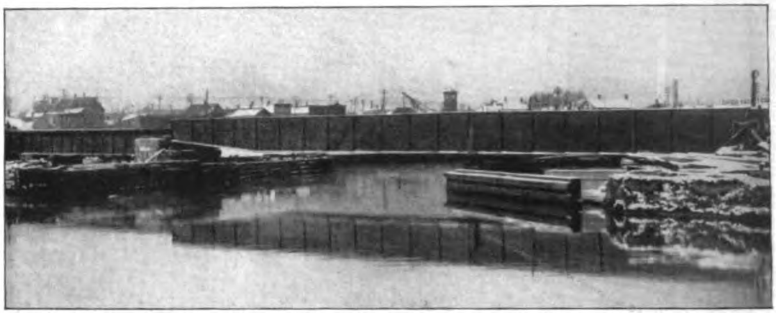

Fig. 14.—New Structure with Improved Channel.

The part of the east approach reaching from the shore to the pivot pier was left to use in running the ties, rails and counterweights out on until they were all in place, when it was cut out. The piles for the falsework to reach from the west shore to the center pier had been previously driven and capped under the old span, and posts of the proper height and all other timbers framed ready to be placed.

After the bridge was raised to the full height, the center casting and pin were placed in position, and the triangular spider frame connected up to the live roller nest, which had been set up outside of the girders several days before. The roller nest was then rolled to place.

Fig. 13 shows the situation at 1:30 p. m., with the falsework out nearly to the center pier, and the latter nearly cleared. The upper chord of the old bridge was left as shown in this photograph for several days, while the rest of the old span was taken down at our leisure later on. The line of track through the old structure was entirely clear at 2:45 p. m.

At 4:05 p. m. the new bridge was ready to swing, and at 5:24 p. m. the bridge was swung to place. From then until 10:20 p. m. the time was occupied in connecting up temporary work and rails at each end, and building temporary blocking under the west end of the new bridge on the old center pier.

At 10:20 p. m. the bridge was ready for traffic. The total time the bridge was out of service was 16 hours and 20 minutes.

The force employed in putting the new bridge into service and taking the old bridge out on this day, was 32 iron bridgemen, 58 carpenters and 15 laborers. The bridge as it was operated for the next few days is shown in Fig. 11.

The fixed span was put in place a few days later. The river channel has since been cleared of the obstructions shown in this photograph. The new structure, with the improved channel is shown in Fig. 14. All of the work in connection with this improvement was performed by employes of the Bridge and Building Department of the C., M. & St. P. Ry., except the dredging and dockwork, which were done by contract.