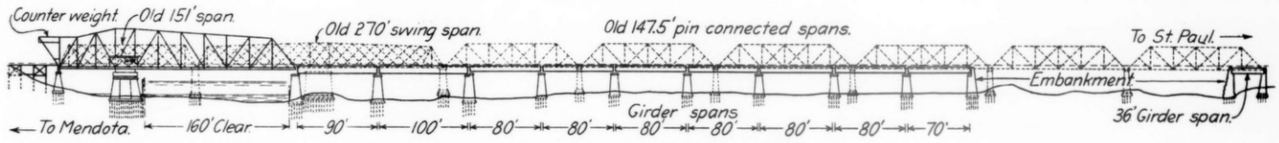
A New Bridge Over the Mississippi River

Structure Was Rebuilt Under Traffic, Involving Interesting Erection Methods and Largely Eliminating Falsework

INCREASES in the weight of equipment operated have made necessary the reconstruction of the bridge over the Mississippi river on the line between the Union depot at St. Paul, Minn., and Mendota, which is owned and operated jointly by the Chicago, St. Paul, Minneapolis & Omaha and the Chicago, Milwaukee & St. Paul, and the rebuilding of this structure has recently been completed. The project involved a change in the location of the draw span and the replacement of through truss spans by deck girder spans of shorter length. The work is of special interest because of the methods used in the erection of the superstructure, no interruption to traffic occurring during the progress of the work. Also except in the case of the swing span the erection was accomplished without any falsework.

The new structure is the third to be built at this site. The original bridge was constructed in 1869 by the Milwaukee & St. Paul railway, the superstructure consisting successively from east to west of six 147½-ft. Howe truss spans, a timber swing span 270 ft. long and a 151-ft. Howe truss span, with a pile trestle 1,698 ft. long at the west end. The spans were supported on a limestone masonry substructure resting on pile foundations and timber grillages with the footings for the piers slightly below the river bottom. In 1874 the name of the Milwaukee & St. Paul was changed to the Chicago, Milwaukee & St. Paul and an adjustment was made whereby the St. Paul & Sioux City became an equal owner of the portion of the line on which the bridge is located. In December, 1880, the last named company was absorbed by the Chicago, St. Paul, Minneapolis & Omaha, which assumed the maintenance of the joint track and bridge. In 1885 the timber swing span was replaced by an iron span 270 ft. long having double intersection riveted trusses and in 1887 and in 1888 all of the Howe truss spans were replaced by iron spans, the 147½-ft. spans by pin connected Pratt truss spans and the 151 ft. span by a riveted double intersection truss span. This second superstructure was erected on the original substructure and the work was done under the supervision of C. W. Johnson, then chief engineer and at the present time consulting engineer of the Chicago, St. Paul, Minneapolis & Omaha.

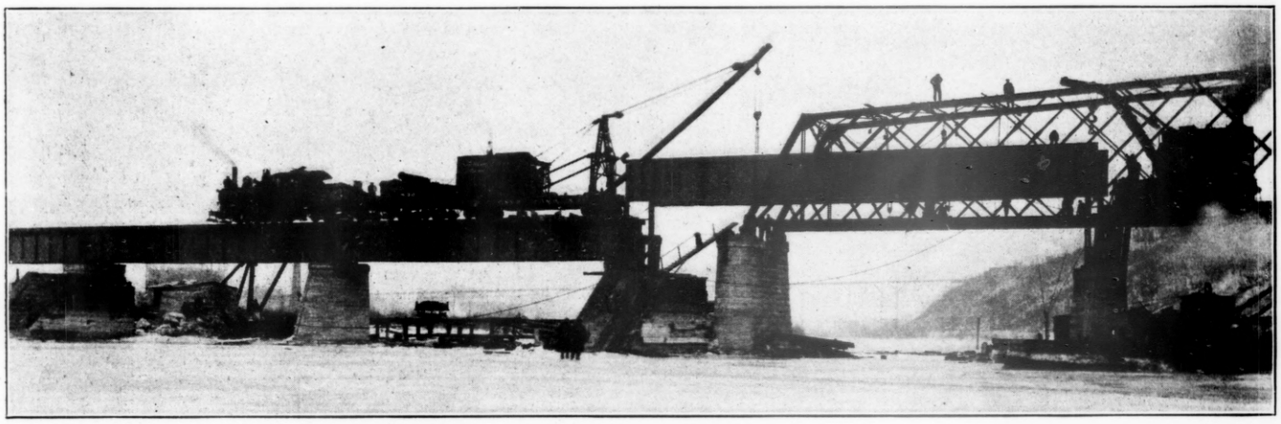


General Elevation of the Bridge

The New Bridge

The layout of the new structure is shown on the accompanying drawings and differs materially from that of the structure it replaced, the principal change being required by the War Department which demanded a clear channel opening of 160 ft. at a location approximately 200 ft. west of the old one. The substructure was entirely replaced and the span lengths were made considerably shorter, permitting the use of girders in place of trusses. It was also found desirable to fill in portions of each end of the old bridge. The design adopted by the railways and approved by the Secretary of War provided for a length over all of the river bridge proper of 1,002.5 ft. The embankment back of the east abutment is continuous save for an opening at the old east abutment. On the west end a new 760-ft. embankment has been provided which is pierced to allow for undercrossing at Tuttle avenue. The bridge is designed for Cooper's E-60 loading.

As seen in the general elevation, the new bridge consists of one 70-ft., six 80-ft., one 100-ft., and one 91-ft. deck plate girder spans and one counterbalanced swing span 185 ft. long. The opening adjoining the old east abutment is made by a 36-ft. plate girder span with a reinforced concrete ballast floor. A pile bridge was constructed over Tuttle avenue with a 20-ft. I-beam span over the roadway. The remaining opening west of the west embankment is provided for by a pile trestle.



Girders of 100-ft. Span Resting on Temporary Bents While Intermediate Pier Is Being Cut Down

The Draw Span

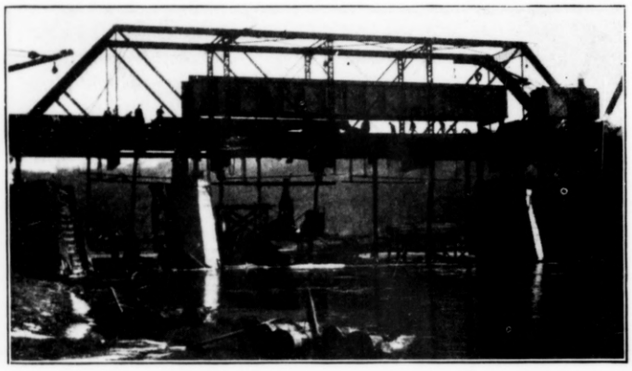
The swing span is of the unsymmetrical or counterbalanced type, consisting of a channel span 175 ft. long and a counter-

weight span 64 ft. 6 in. long joined by a tower over the pivot pier 18 ft. 6 in. long, the distances being measured center to center of panel points. The trusses are riveted throughout except for the eye-bar connections at the top of the tower.

The arrangement of the counterweight is unusual. As shown in one of the accompanying drawings, it consists of concrete arranged in the form of a portal around the end panel of the counterweight arm. Triangular shaped slabs in the plane of each truss were built in place around steel framework in the end panel. A concrete lintel encloses the end strut, thus completing the portal effect. In addition a part of the weight is provided in the place of the top laterals in the form of precast beams and small blocks equipped with handling stirrups to facilitate placing them with a derrick. The small blocks served for final adjustment of the counterweight.

The weight of the span is transmitted to the drum by a system of four loading girders, two directly under the trusses and fabricated as a part of the bottom chords and two running transversely in line with the tower posts. These four loading girders transmit the weight to the drum at eight points in its circumference. The side loading girders are 5 ft. 6¾ in. deep and the drum is 3 ft. 11½ in. deep. The total weight of the draw span is about 500 tons.

The swing span is operated by electric power, which is furnished by the Northern States Power Company as 3-phase,



Erecting One of the 80-ft. Girder Spans

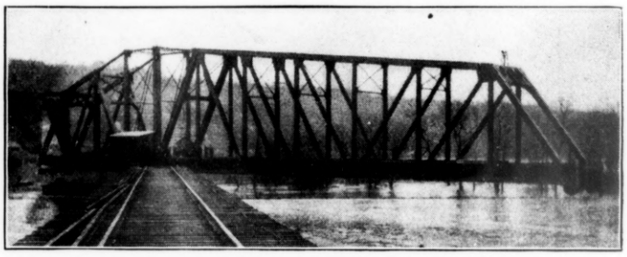
60-cycle, 220-volt alternating current. The bridge is turned by two operating pinions working on a circumferential rack. Each of the pinions is connected through a train of gears to a 30-hp. motor operating at 840 r.p.m. The combined power of the two motors is sufficient to open the bridge in 75 sec. after the ends have been released, but either motor working alone can do this in 1¾ min. Each separate motor has a controller but the two controllers are interlocked so that one lever may be used to operate both motors to deliver equal pressure to the two pinions, or either motor may be used alone.

The end lifts are of the rocker type operated by a cam shaft. The rail locks are of the mitre joint type, the rails being raised and lowered by cams, and are operated by the end lift machinery so that a single 10-hp. motor at each end of the bridge operates both the rail locks and the end lift. The operator's house is located on the track floor on the north side of the bridge.

Construction Methods

The substructure presented no particular difficulties. The piers and abutments are of mass concrete supported on piles 24 ft. long. The foundations of the new structure were constructed along lines similar to those used in the old bridge but were carried to a somewhat greater depth. The design of the new substructure was based on a knowledge of the conditions in the old and on the results of a series of test holes which showed coarse sand and gravel to a depth of 80 ft. overlying rock. With the use of a liberal amount of riprap around the piers and abutments erosion is believed to be a rather negligible factor. It was necessary to jet the piles into place.

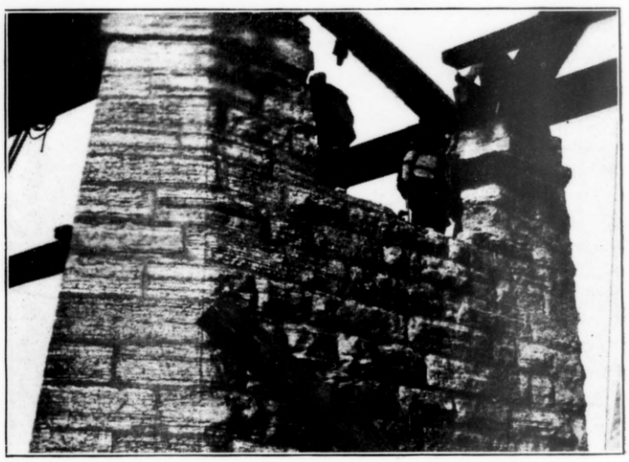
Actual work on the substructure started on August 1, 1915, having been delayed for nearly two months by an unusually high stage of the river. High water again prevailed during September and October and greatly interfered with founda-



The Draw Span in the Open Position

tion work of the piers adjoining the river channel, so that the substructure was not entirely completed until February 1, 1916. Some of the concrete was placed in extremely cold weather, but proper precautions were taken and no damage resulted because of freezing.

The dismantling of the old structure and the erection of the girder spans were handled by the railway company's iron bridge crew. No falsework was used for the erection of the girder span. With the exception of the 91-ft. and 100-ft. spans, the girders of which were placed separately, the two girders of each span were assembled and riveted complete before being put into place. According to the erection program the completed girder span was placed on two flat cars with a derrick car at each end and was hauled out to the final position. The girders were then hoisted a sufficient amount to clear the cars and permit the placing of the cap for a bent or gallows frame under each end of the span. The girders

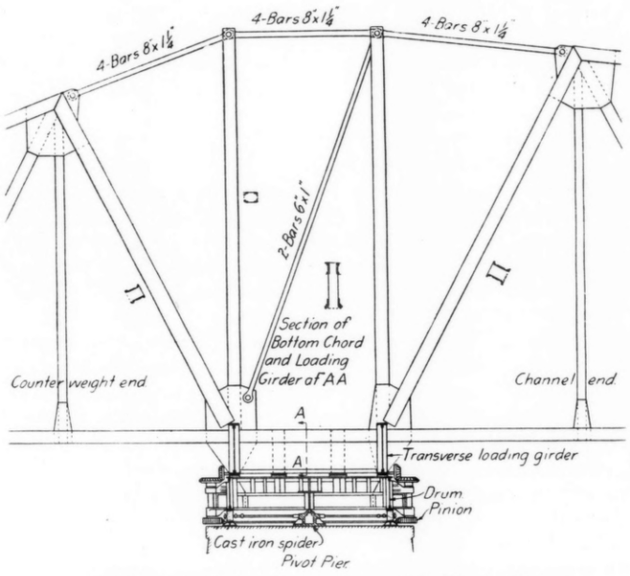


Old Pier Notched to Clear New Girder Span

were then allowed to rest on these bents while the cars were released and the floor of the old span was disconnected and lowered to the ground beneath the bridge. After the completion of this work the derrick cars returned and lifted the span clear of the bents and upon the removal of these bents the span was lowered into place on the piers. The placing of these girder spans consumed an average of two hours and ten minutes, with the addition of one hour and twenty minutes in all cases where the girder spans fouled one of the old piers which had to be notched down to clear the new

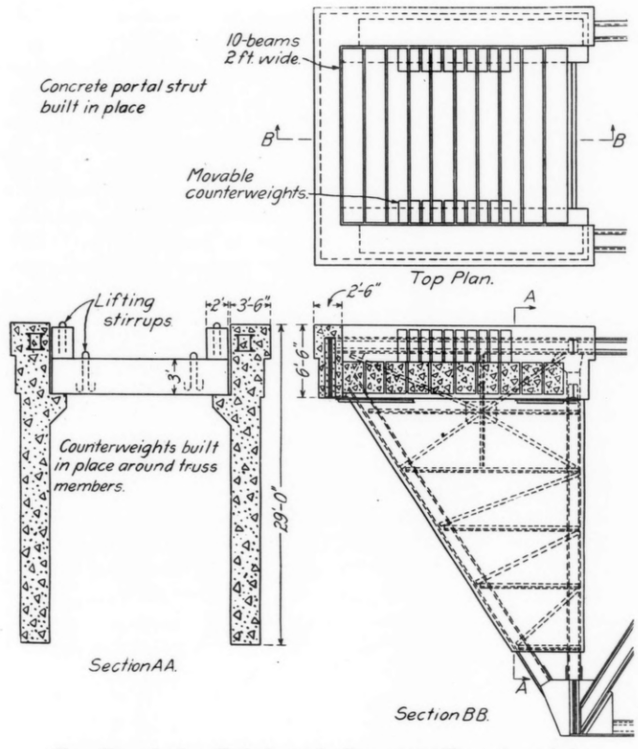
girders as shown in one of the accompanying photographs.

The placing of the new girders was followed by the removal of the old truss spans. This was accomplished with a minimum amount of falsework by supporting the old



Section of Swing Span Over the Pivot Pier

trusses, during the time that they were being cut apart, on cross timbers suspended from the new girders by means of U-bolts. Girders 1 to 7 inclusive were erected between October 24, 1915, and December 6, 1915. Spans numbers



Details of the Reinforced Concrete Counterweight

8 and 9 could not be erected until February, 1916, because the substructure had not been completed. The dismantling of the old spans was started in September, 1915, and completed in March, 1916.

The draw span was erected on falsework consisting of four and five-pile bents spaced from 12 ft. 6 in. to 17 ft. 6 in. center to center. These bents were capped at an elevation low enough to support the bottom chord of the new trusses, the track being carried on pony bents.

Other Features

A sheer fence was erected on the west side of the river channel, extending north and south for the length of the long arm of the swing span at an angle of 45 deg. with the shore at the upstream end. Breaking ice cut a considerable gap in the corner of the fence in the spring of 1916 and the upstream portion has since been filled in solid with riprap to a height of eight feet above the normal river stage. This additional protection is now considered sufficient safeguard against destruction by ice; in addition the corner of the fence was protected with old rails placed horizontally.

Material for filling the east and west ends of the old bridge as described was obtained from the river bed, north of the bridge by means of a suction dredge. The total amount of filling was 48,000 cu. yd.; the embankments were heavily riprapped on all sides up to a few feet above high water line.

The general design of the bridge was selected jointly by C. F. Loweth, chief engineer of the Chicago, Milwaukee & St. Paul, and H. Rettinghouse, chief engineer of the Chicago, St. Paul, Minneapolis & Omaha, the latter having charge of the preparation of plans and of the construction work. The swing span was designed by I. F. Stern, consulting bridge engineer, Chicago; T. E. Van Meter was assistant engineer in direct charge of the work. The girders were fabricated by the Chicago Bridge & Iron Works, Chicago, and erected by the railway company's forces, who also placed the deck on the entire bridge, these forces being under the direct charge of J. D. Moen, superintendent of bridges and buildings. The swing span was fabricated by the Milwaukee Bridge Company, Milwaukee, which sublet the erection to the Strobel Steel Construction Company, Chicago. The filling of the embankments was contracted for with the LaCrosse Dredging Company, Minneapolis, Minnesota.

WASHINGTON CORRESPONDENCE

Washington, D. C., January 10, 1917.

Railroad Legislation in Congress

The controversy over the demands of the train service brotherhoods, who are again talking about striking, took a new turn this week. While arguments on the constitutionality of the Adamson law were being argued in the Supreme Court on Monday by counsel for the railroads and for the government, Chairman Adamson of the House Committee on Interstate and Foreign Commerce was beginning a fight in Congress for a new Adamson law, which he said was for the purpose of making the eight-hour law "court-proof," but which presents an entirely different situation from that created by the law which is now before the court. The new bill, which he introduced in the House on Saturday, is not only intended to prevent strikes but to establish a real eight-hour day, with such exceptions as may be permitted by the Interstate Commerce Commission. It carries out the President's recommendations for a law to prevent strikes by providing that in event of failure to settle a wage controversy by mediation the President shall appoint a board of inquiry to investigate the facts and report a recommendation within 90 days. Pending such report a strike or a lockout would be made unlawful. The bill would also empower the president to take over railroads for military purposes. The provision as to hours of service is proposed as an amendment to the hours of service act and provides that it shall be unlawful to require or permit any employee subject to the act to remain on duty for a longer period than eight hours in any period of 24 hours, but such eight hours' service need