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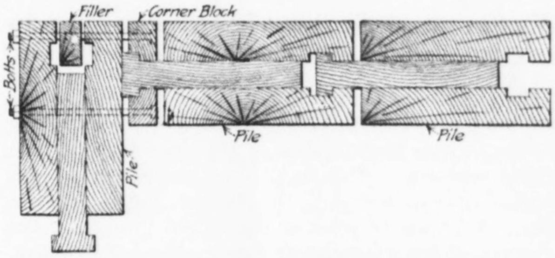

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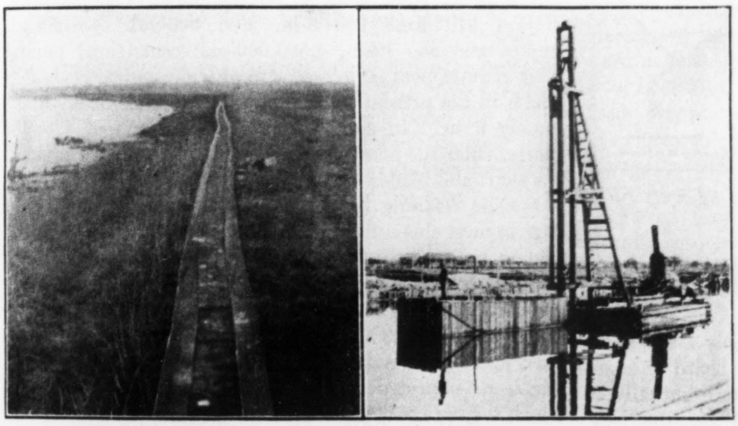

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Reconstruction of Mississippi River Bridge at Keokuk

SYNOPSIS—The old single-deck spans are being replaced with double-deck spans having a railway track below and highway and sidewalk above. The reconstruction is of special interest in that the bridge has to be kept open for railway and roadway traffic during the progress of the work.

The reconstruction of the long steel bridge crossing the Mississippi River at Keokuk, Iowa, by placing a new superstructure on the old piers, is complicated by the necessity of keeping the bridge open for railway, street-railway, team and pedestrian traffic.

The bridge has a 380-ft. swing span, two fixed spans of 254½ ft. and eight fixed spans of 149 to 162 ft. The old bridge had a single lower deck for all traffic, teams being excluded while trains were crossing, as there was not room for them to pass. The new bridge has a lower deck, with single track for steam and electric-railway service, and an upper deck, with 18-ft. roadway and a 4½-ft. walk (on the south side only) carried by cantilever brackets. The approaches for the upper deck are 600 ft. long on the Keokuk side and 360 ft. on the Hamilton side. The new bridge was described in *Engineering News*, Aug. 5, 1915. Fig. 1 shows the condition of the work on Dec. 1, 1915.

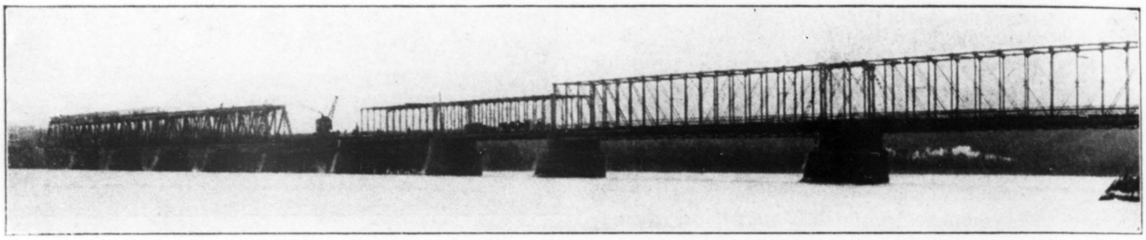

FIG. 1. RECONSTRUCTION OF MISSISSIPPI RIVER BRIDGE AT KEOKUK, IOWA (DEC. 1, 1915)

Five of the new 160-ft. double-deck spans at the east end have been erected. The locomotive crane is standing on the falsework of the sixth span, and the seventh span is partly dismantled. The next short span and the two 254-ft. spans have the old trusses still in place. The drawspan is next to the long span at the right

Alterations to Piers

The piers are of stone masonry, resting on the bed-rock that forms the river bottom. Owing to the greater depth of the floor system of the new bridge, with tracks at the original level, the tops of the piers were cut down about 5 ft. and capped with reinforced concrete. This work was done during the erection of the steel, the new shoes being suspended from the trusses (on falsework) just clear of their final elevation and lowered to a bearing as soon as the concrete had set.

A small concrete mixer was run out on the bridge, and the concrete was spouted through the floor. As the trusses of the new bridge are spaced 16 ft. 7 in. c. to c. while those of the old one were spaced 21 ft. 6 in., there was plenty of room to place the mixer on a platform over the end of the pier, the old outside walks having been torn up. One pier is in bad condition and will be rebuilt from above the low-water line. Until the completion of this work, the ends of the spans to be carried by this pier will remain supported on the falsework.

The river bottom is limestone bedrock, with little or no cover, so that no piling can be used. The falsework consists of 6-post bents carrying the working platform. In placing the bents each post was driven to a firm bearing on the rock and then cut off at the proper elevation for the cap.

For the shorter fixed spans—149 to 162 ft.—each span had 7 bents connected by longitudinal struts, with diagonal bracing connecting one pair of bents at each end. This construction is shown in Fig. 3. Each of the two longer spans—254 ft.—had 12 bents, with the end bents parallel with the piers and the others at right angles to the bridge. These were spaced about 23½ ft. apart and braced together in pairs to form five braced towers under each span (Fig. 4).

For the drawspan a different arrangement was used (Figs. 2 and 4), owing to the swift current in the navigable channel and the desirability of leaving ample passageway for drifting ice. This precaution is specially necessary in view of the fact that the falsework simply rests on the river bed, so that pressure against it is to be avoided. Under each arm of this span there are 8 bents, braced in pairs to form 16-ft. towers spaced 25 to 28 ft. apart. The longitudinal bracing of the towers is in the plane of the outer vertical posts, as shown in Fig. 2.

In all falsework bents the posts are 10x12 in., the outer posts being battered. The caps are 12x12-in., 28 ft. long, not driftbolted, but secured by splices bolted to the sides of the cap and posts. Along the ends of the caps are stringpieces 12x12 in. The sway-bracing of the bents is of 3x10-in. planks, and the tower struts 6x12 in.

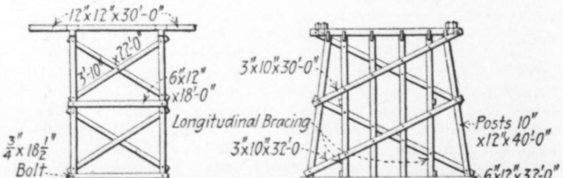

FIG. 2. FALSEWORK TOWERS FOR THE 380-FT. DRAW SPAN

Falsework was built for three spans at a time. As soon as that for the first span was completed, work on the steel was commenced, while at the same time the falsework was being put in under the next span. In each of the eight shorter spans plate-girder stringers for the 254-ft. spans were used as falsework stringers, braced by horizontal and diagonal transverse timbers. The same arrangement was used for one of the longer spans, while for the other there were six lines of the old trussed floor-beams to serve as stringers. For the drawspan falsework the towers had four lines of 15-in. I-beams, from the approach, while between the towers were six of the old floor-beams.

With the falsework in place the first work was the renewal of the floor system. The old floor construction consisted of trussed floor-beams spaced about 12 ft. c. to c. and carrying wooden stringers to which the deck planking was spiked. The rails rested directly upon two of these stringers. The two sidewalks, outside of the trusses, were carried by extensions of the floor-beams.

The new steel stringers, mentioned before as being used for falsework, are placed in elevation somewhat below the new floor-beams, and the old stringers are supported on them. The old trusses and overhead bracing are then dismantled. The old floor, consisting of paving, subplanking and ties, is left until all the spans are erected.

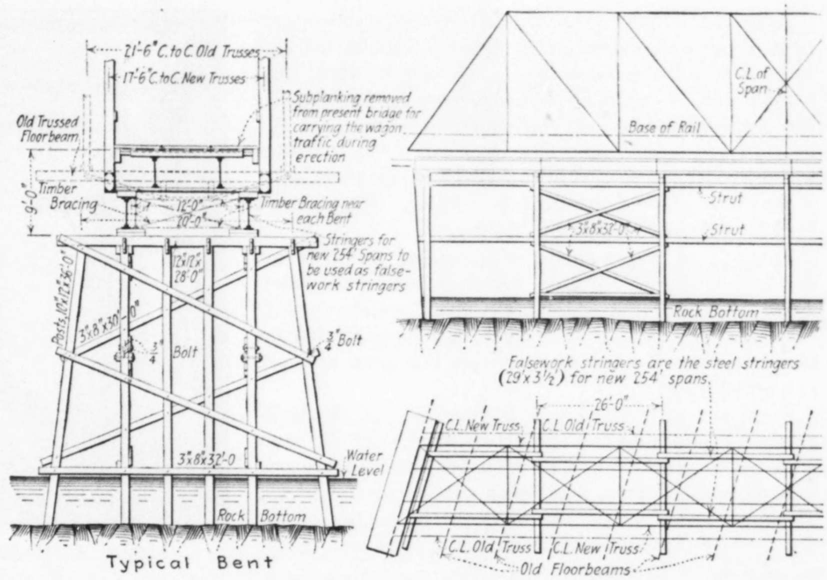

FIG. 3. FALSEWORK AND METHOD OF ERECTION FOR THE 160-FT. SPANS

In erecting the new floor system slots are first cut crosswise in the floor, to allow the new floor-beams to be slipped in place; then the old wooden stringers are removed and the new steel stringers inserted under the old ties. This work is done piecemeal, or panel by panel, the floor-beams and stringers being removed as the replacement work reaches them.

When all the spans are erected and the roadway on the upper deck is finished, the team traffic will be diverted to this roadway. In the intervals between trains the old deck will be torn up and replaced with an ordinary railway deck with rails and guard timbers on crossties.

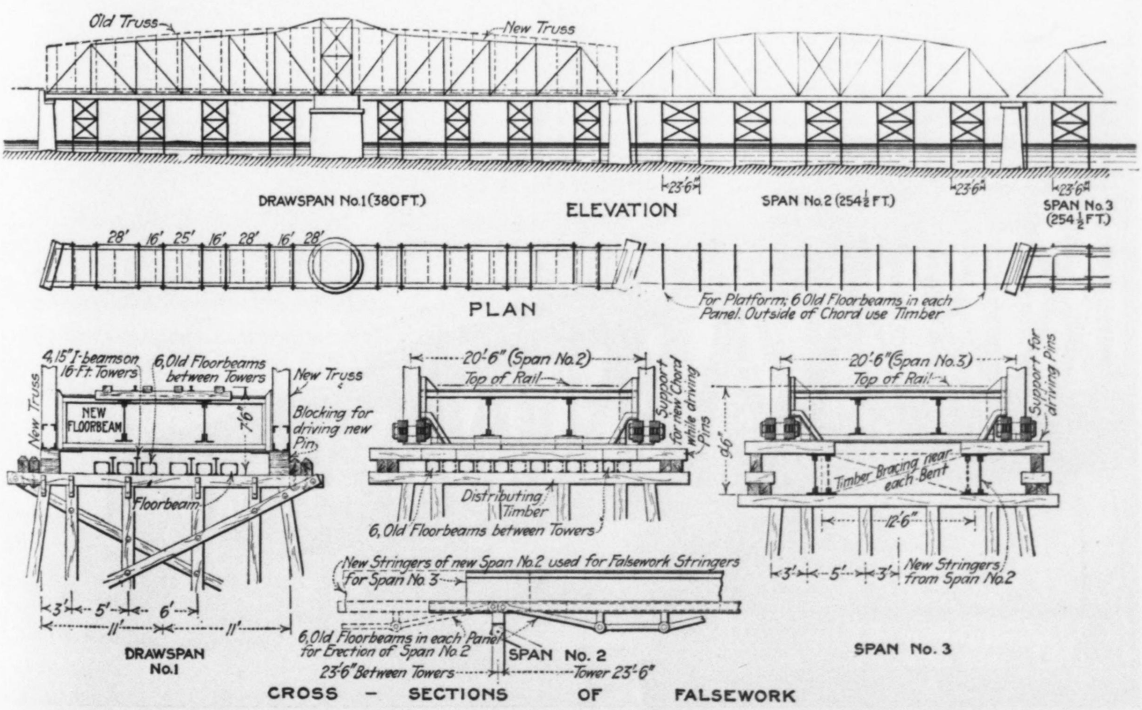

FIG. 4. FALSEWORK AND PLATFORMS FOR THE 380-FT. DRAWSPAN AND TWO 254½-FT. FIXED SPANS

After the completion of the falsework the old trusses were dismantled, commencing with the span at the east end. This work was done with a 25-ton four-wheel locomotive crane standing upon the railway track (Fig. 1). The material was loaded upon flat-cars that were handled by a dinkey locomotive. The steel for the new trusses was delivered and erected in the same way, the posts being riveted to the floor-beams already in place. The material yard is at the east end of the bridge.

In the two longer spans, with eye-bar members for the bottom chords, blocking was built up on the falsework to support the ends of the chord members while the pins were driven. The entire span was riveted up complete upon the falsework, which was then removed to another span.

Fig. 5 is a view of the work in progress. In the background is a train on one of the new spans. An old span is in the foreground, and between this and the new one is a dismantled span with track carried on falsework. The brackets extending out to the right on top of the new span are for the sidewalk on the upper deck. These are also shown in Fig. 6.

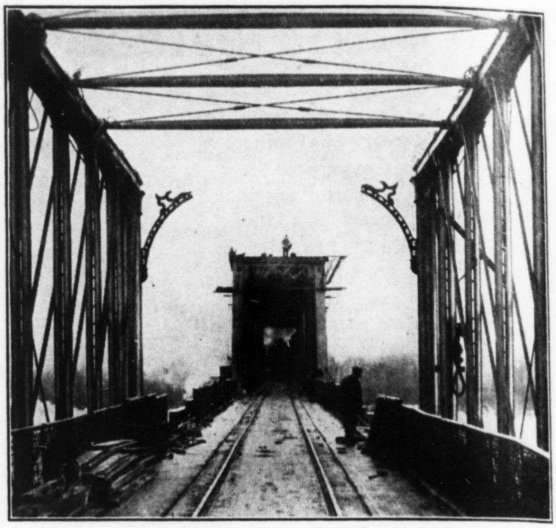

FIG. 5. DISMANTLING ONE OF THE SPANS

Handling Traffic Over the Bridge

While there are not many steam trains crossing the bridge, there is a half-hourly service of electric cars. To provide for their passage, the contractors remove the locomotive crane to a siding at the material yard and clear the bridge every half-hour. The cars and any waiting teams then cross, first in one direction and then in the other. This arrangement involves a delay averaging 10 min. from the time of stopping work until its resumption. As electric wires cannot be maintained across the bridge, the cars are hauled across the bridge by the contractor's dinkey locomotive.

The work of renewing the first span was commenced in September, 1915. On Dec. 6 five spans had been completed, the new sixth span was partly erected and the old seventh span partly dismantled, while falsework was being placed under the eighth span. Falsework was also being placed under the drawspan. Fig. 1 shows the condition on Dec. 1, and Fig. 6 shows some of the completed double-deck spans.

Navigation was closed officially on Nov. 18, but boats were allowed to pass until Dec. 4. The new drawspan must be ready for the opening of navigation this season. The weight of the new spans is about 190 tons for each 160-ft. span, 400 tons for each 254-ft. span and 680 tons

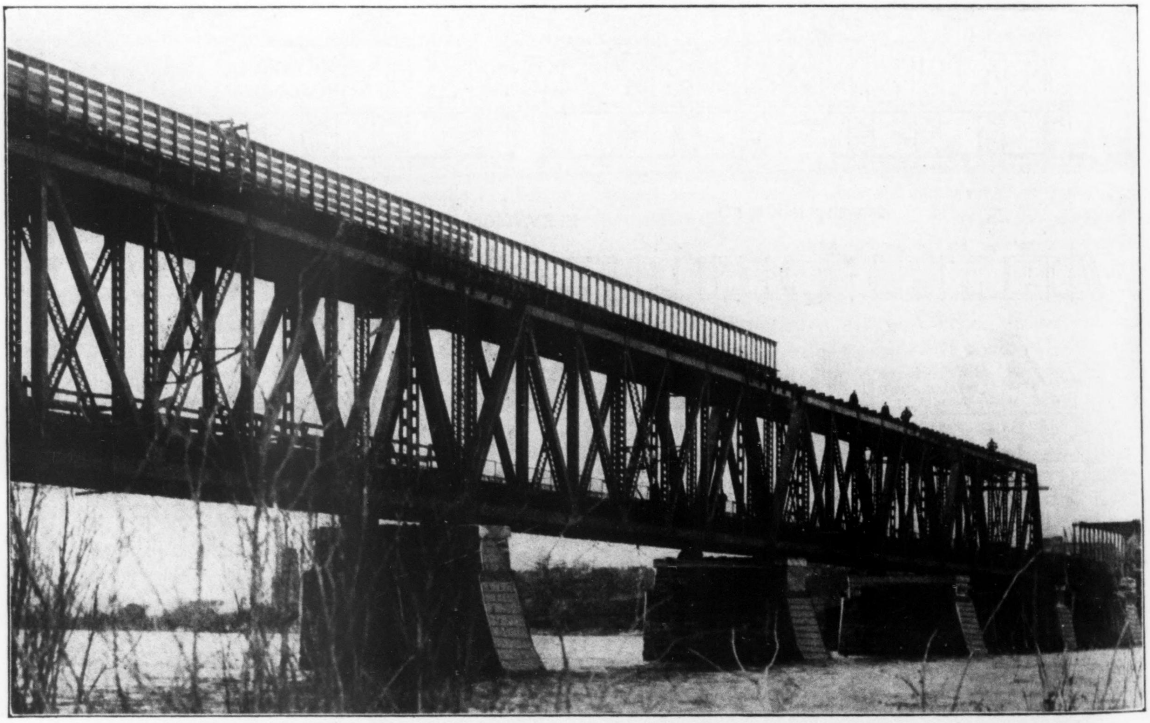

FIG. 6. NEW DOUBLE-DECK SPANS OF THE KEOKUK BRIDGE

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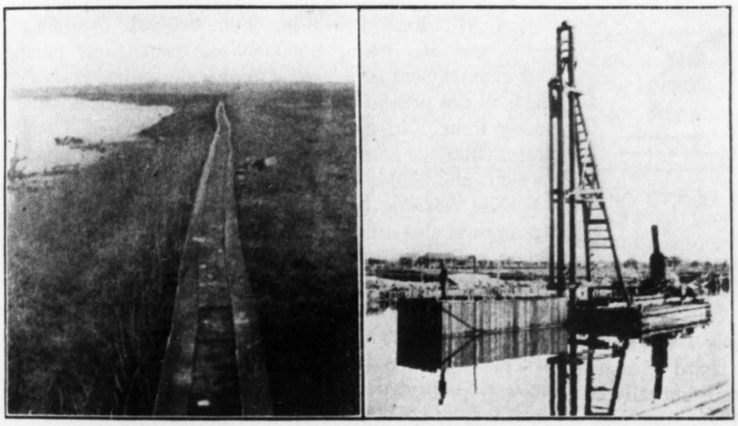

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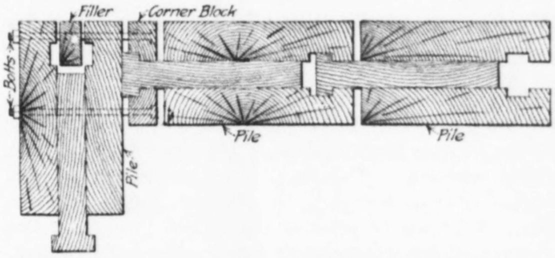

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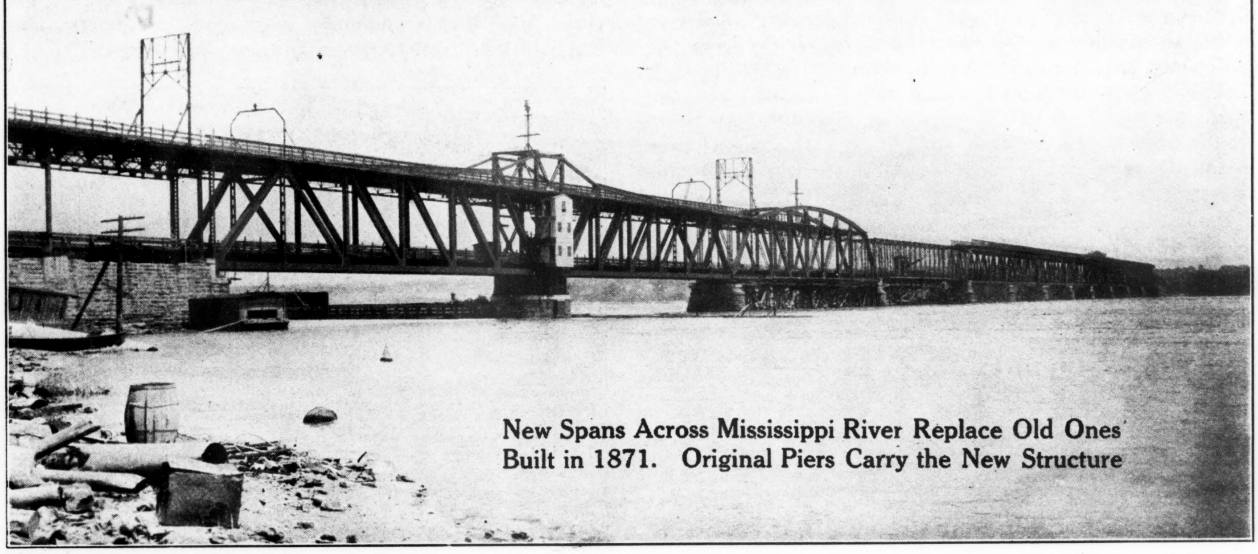
The Reconstruction of the Keokuk Bridge



New Spans Across Mississippi River Replace Old Ones Built in 1871. Original Piers Carry the New Structure

The Bridge with One Old Span Remaining

THE erection of a new superstructure for the Keokuk and Hamilton bridge over the Mississippi River at Keokuk, Iowa, has just been completed, thereby replacing 11 old spans of cast and wrought iron which had carried rail and highway traffic across the river for more than 45 years. Considerable interest is attached to the details of the old structure and the excellent condition of the material after its long period of service. The bridge carries a miscellaneous traffic consisting of trains of the Keokuk branch of the Wabash, of the Toledo, Peoria & Western, and of an interurban line, as well as highway traffic. The steam road traffic consists of six trains each way daily and the interurban business of a car each way every hour.

The bridge is located about one-half mile south of the dam and power plant of the Mississippi River Power Company, and the Government lock. The bridge, exclusive of approaches, is 2,194 ft. long and consists of 10 fixed spans and a draw span. Commencing at the east abutment there are eight spans varying from 148 to 162 ft. in length, followed by two spans of 254½ ft. with a draw span adjacent to the west abutment, having a total length of 380 ft. The piers and abutments are all founded on rock at a maximum depth of 50 ft. below the base of rail. All of the piers are on a slight skew to the northeast.

Interesting Old Spans

The old structure, built in 1869 and 1870, and placed in service early in 1871, presented many features of interest. The old spans were all Whipple trusses, having parallel chords with the exception of the draw span, the top chords of which were slightly bowed. The end and intermediate posts were made up of Carnegie octagonal columns, the top chords of two I-beams, two channels and a cover plate, the bottom chords of eye-bars, the diagonals and all laterals of loop bars, and the top lateral struts of tubular sections of cast iron. Cast iron joints were provided at the panel points to facilitate the connection of the members. There was almost a total absence of splice plates or other means of affording a positive connection of the compression members, the dead load stresses being relied upon to hold the structure together.

The bridge was a through structure carrying all traffic on one deck, the trusses being placed 21 ft. 6 in. center to center to afford an adequate driveway, with a single railroad track in the center; a sidewalk was carried outside the trusses on either side. The track and driveway floor was carried on timber cross ties, supported on two wooden stringers under each rail, with a jack stringer next to each truss. The floor beams, of unusual design for this day, consisted of two 10-in. channels, trussed by means of eye-bars and cast iron posts. The old structure was built and owned by the Keokuk & Hamilton Bridge Company and was a toll bridge, an arbitrary being imposed on the steam road and interurban traffic. The new bridge is being financed by the same interests and the existing traffic arrangements will continue.

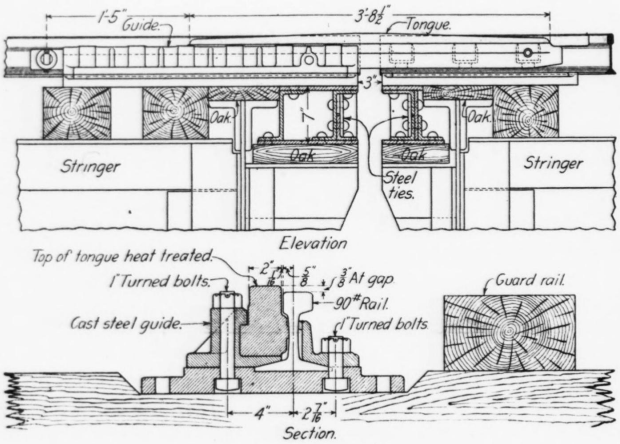
The New Bridge

The new superstructure for the eight shorter spans at the east end of the bridge consists of parallel chord riveted Pratt trusses. The two 254½-ft. spans are curved chord Pratt trusses with riveted top chords and eye-bar bottom chords. The swing span consists of two riveted spans, made partially continuous by eye-bar connections to the tower over the pivot pier.

As most of the old substructure was in good condition, the new superstructure has been placed on the old piers, with the exception of one which was partially rebuilt. On account of a difference in the floor depth the old piers have had to be cut down and capped with concrete. The old center pier is hollow, consisting of a circular wall under the drum with a central column under the center casting. In preparing this for the new superstructure the circular wall and central column were covered with a reinforced concrete slab.

An improvement has been obtained in the new structure through the separation of the highway traffic from the rail traffic by placing the former on an upper deck. This has necessitated a viaduct 600 ft. long on the west side of the river and one of 360 ft. on the east side. Owing to the fact that the business district of Keokuk is at a considerable elevation above the railroad tracks, the approach viaduct on the city side is a convenience rather than a detriment. On the east side of the river an incline on a 6 per cent. grade is necessary. The removal of the highway traffic from the lower deck has permitted a reduction of the distance between trusses to 16 ft. 7 in. for the eight short spans and 20 ft. 6 in. for the others and the use of the ordinary floor beam and stringer floor system, with an open timber deck.

The upper deck has a creosoted wood block roadway for the team traffic and a sidewalk 4 ft. 6 in. wide, cantilevered out on the south side. The floor is carried on wooden stringers having from 7 to 10 ft. spans, supported on 15-in. 42-lb. I-beams, spanning from truss to truss. On the eight short spans the highway deck is carried on top of the top chords of the trusses. In the draw span and the two curved chord spans the deck is carried between the trusses, longitudinal



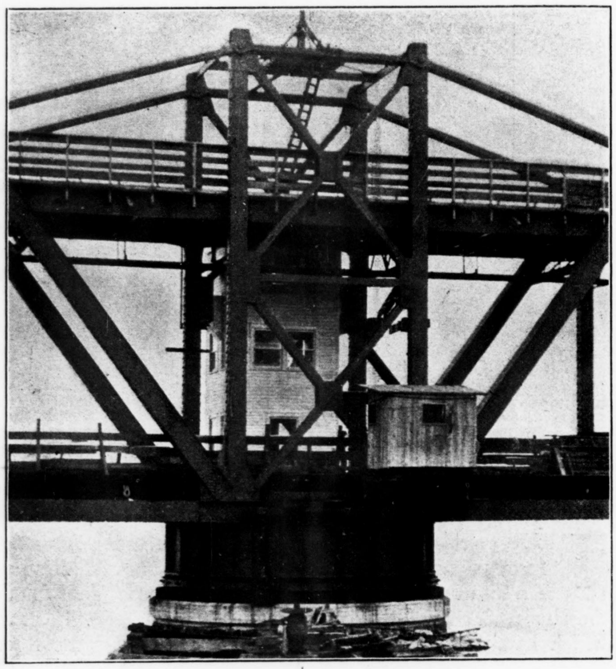
The Rail Lock

girders being provided just inside of each truss to carry the floor system, these girders being supported at each post by connections to the cross frames.

The Swing Span

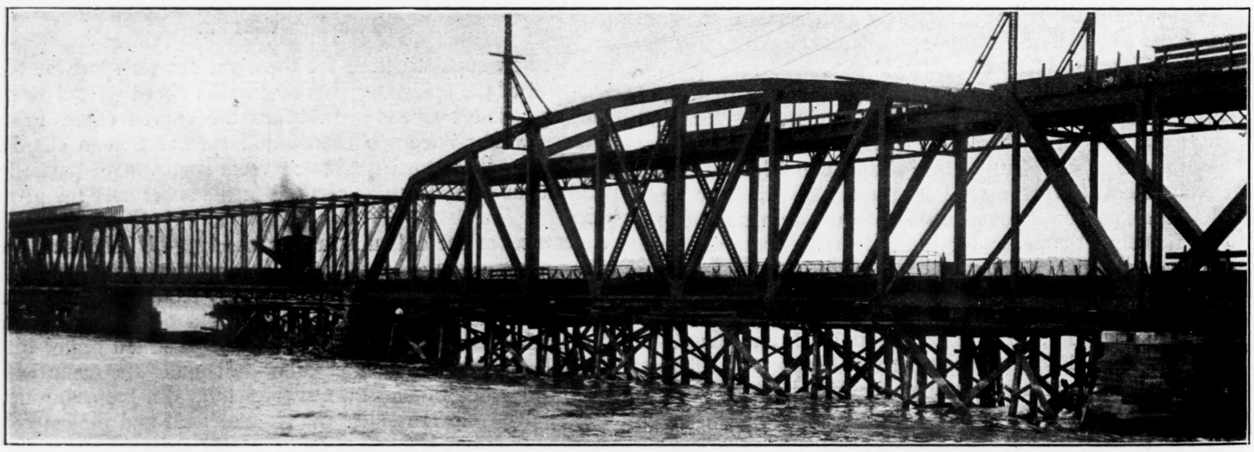
The center of the swing span is of the rim bearing type and has a four-support loading arrangement. The bottom chords of the trusses pass directly over the drum and the concentrations of the end posts and the tower posts are transmitted directly through the bottom chords to the drum, there being no intermediate loading girders. The rollers are secured between two concentric rings; a stiff structural ring on the inside and a lighter flexible ring on the outside, the inside ring being rigidly connected to the center by a system of stiff radial struts. With this arrangement the roller shafts are simply short axles connecting the rollers to the two rings.

Two sources of power are provided for operating the bridge machinery, a 37-hp. motor operating on a 25-cycle, 440-volt circuit, and a 14-hp. 2-cycle Fairbanks-Morse marine gas engine, operating at 800 r. p. m. The machinery is arranged so that it may be operated by either, the single unit performing all functions in either case. The motor will be used ordinarily, the gas engine serving merely as an alternative source of power in case of a failure of the current. The motor is connected to the machinery by a hand-operated clutch which may be thrown into gear either with the swing machinery or the longitudinal shafting connecting to the machinery at each end of the span.



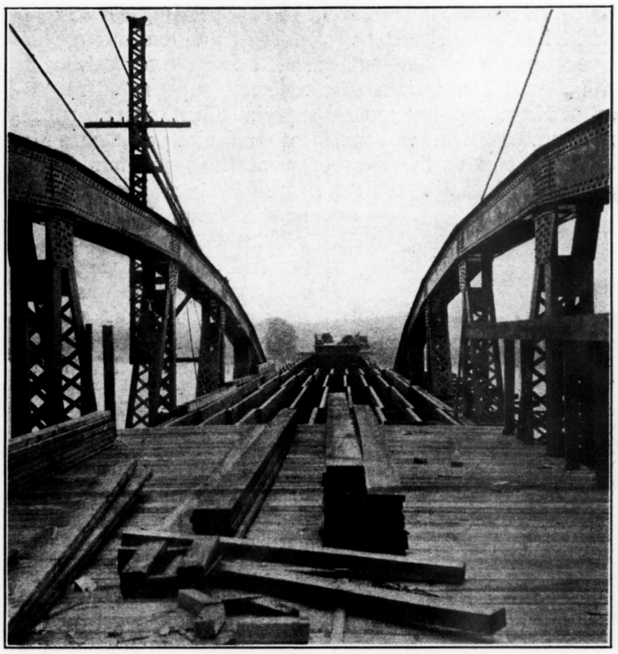
The Pivot Pier and Tower

These longitudinal shafts are connected by two clutches to the end lifts and the rail locks, but through a peculiar trip arrangement these clutches are alternately operative and inoperative, thereby automatically effecting the alternate operation of the end lift and the rail lock in the proper sequence. Thus in opening the bridge the end machinery first withdraws the rail lock and with the completion of this function, the clutches are shifted automatically, putting the end lift machinery in motion to lower the end of the bridge. The



Locomotive Crane Placing False Work Under the Last Old Span operator, observing the completion of this operation on a mechanical indicator, shifts his hand clutch and the bridge commences to swing. When the bridge is being closed all of the operations are reversed.

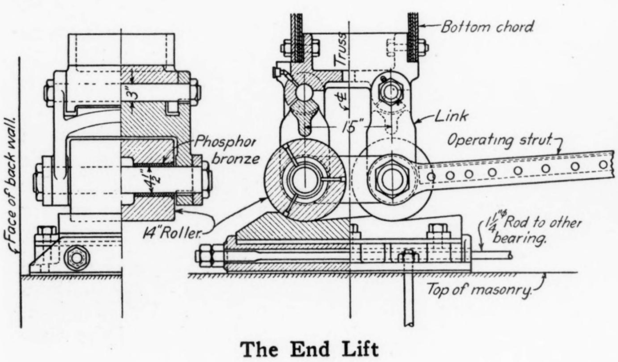
As shown in one of the accompanying drawings the end lifts are of a type which serves to center the bridge automatically and will readily overcome the warping effect resulting from the unequal expansion of the two sides of the structure. The ends of the spans are raised by forcing the



Highway Deck of One of the Two 154½ ft. Spans

toggles from an inclined to a vertical position, the rollers at the lower ends of the toggles being in contact with the inclined bearing surfaces. As the toggles are raised, the rollers roll down the inclines to the lowest position, after which any further movement of the toggles serves to center the ends of the span.

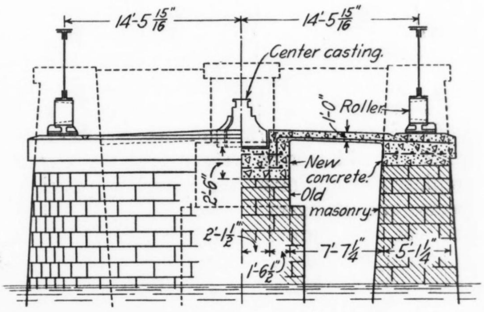
The rail locks are of the sliding tongue type as shown. A



The End Lift

new development in this case is the use of steel ties under the ends of the rails, a measure adopted because of the rapid crushing of wooden ties as a consequence of the impact obtaining when the wheels pass over the gap in the rails. The tongues of the rail locks are of uniform section throughout except for the bevels on the top surface. Instead of being provided with a removable head which may be replaced when worn out, they are cast in a single piece and the top surface is treated by the "Stroh" hardening process. The rail traffic being relatively light and with moderate loading, it is not expected that the wear of the rail locks will be severe.

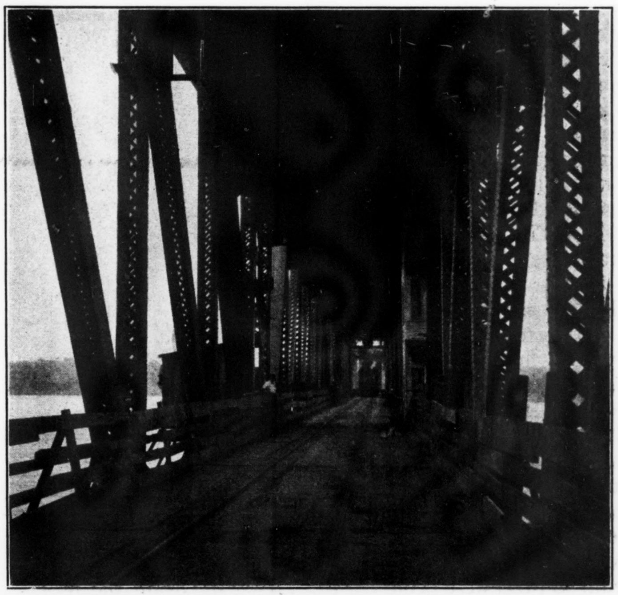
The operator's house is a three-story frame structure carried outside the truss on the south side of the bridge. The room on the top floor is for the accommodation of a watchman who must close the gates on the highway deck before the bridge is turned. The room on the second floor contains the controllers, switchboard, clutch levers and mechanical indicators for the end lifts and will be used for operating the



Reconstruction of the Top of the Pivot Pier

bridge with electrical power. The first floor contains the gas tank, the water tank, a hot water heating plant and the gas engine. No interlocking plant is provided.

Because the channel of the river is bare rock it was considered unsafe to transmit the electrical power by means of a marine cable. The current is carried by wire to a pole mounted over the top of the tower and which carries the cross-



The New Draw Span with the Old Highway Floor Still in Place

arm which supports telephone and telegraph wires carried across the bridge. This pole consists of two pipes, an 8-in. extra heavy pipe on the outside which is held in a fixed position by the cross-arm and the wires and a 2½-in. pipe on the inside which turns with the bridge. A drum at the top of the pole contains collector rings for transferring the current to the swing span.

Falsework and Erection

Owing to the fact that the river has a rock bottom, piles could not be driven and the falsework consisted of frame bents of six posts each, arranged in pairs to form towers, the longitudinal and transverse bracings being carried as low as the water level permitted. For falsework stringers, temporary use was made of floor beams from the old spans and stringers from the new spans, the stringers for the 254½-ft. spans being used in the erection of the 8 shorter spans.

Because the new highway deck could not be placed in service until all the new spans were erected, it was necessary to maintain the highway on the lower deck until the new bridge was entirely completed. The plans for the erection were therefore perfected with this in mind. The old trusses were dismantled, leaving the old floor system in place, the oxy-acetylene torch being used extensively in removing the old material. Because of the loose-jointed nature of the old trusses it was necessary to guy them thoroughly as soon as they were placed on falsework and any members were removed. After the old trusses were out of the way, the old floor was replaced by the new floor, panel by panel, and the old floor beams and stringers were taken out, depending upon the continuity of the old track rails to carry the highway deck until the panel of the new floor system was put in place. Owing to a difference in length in the old and new panels, the old stringers were cut off each time and blocked as required to fit up against the last new floor beam set.

The erection was started in July, 1915, beginning with enough falsework to carry the two spans at the east end of the bridge the falsework was used over and over as the work progressed, about 75 per cent. of additional falsework material being provided later. The short spans were completed by January 7, 1916. The erection of the draw span was started on November 22, 1915, and completed about March 1, 1916.

Owing to a delay in the delivery of the drum the trusses were erected except for the towers before the drum arrived. The bottom chords were jacked ½-in. above the final position and the threads, rollers and the drum in four sections were slipped under the trusses. The four tower posts were not erected until after the drum was in place to provide room for swinging out the boom of the derrick car while the drum sections were being erected. After the drum and its radial braces were completely assembled, the drum was rotated on the rollers until the holes in the top flanges of the drum registered with those in the bottom chord of the trusses, thus permitting the connection of the drum to the trusses.

The erection of the westerly 254½-ft. span, followed that of the draw span, but when the falsework for the easterly 254½-ft. span was to be placed high water made it necessary to stop the work on January 25. The stage of the river continued high and work could not be resumed until May 31.

The new bridge was designed by Ralph Modjeski, consulting engineer, Chicago, who was represented at the bridge by G. C. Hinckley, resident engineer. The Strobel Steel Construction Company, Chicago, had the contract for the entire new bridge including alterations to the substructure.

JOHN J. BERNET

John J. Bernet, vice-president in charge of operation of the Michigan Central, and resident vice-president at Chicago of the New York Central, has been elected president of the New York, Chicago & St. Louis, with office at Cleveland, succeeding W. H. Canniff, resigned. Mr. Bernet has been connected with the lines now included in the New York Central continuously since 1889, when he started with the Lake Shore & Michigan Southern as a telegraph operator. His entire career has been spent in the operating department, and he has made steady and consistent progress through the various grades in that department, serving consecutively as train despatcher, trainmaster, assistant superintendent, superintendent, assistant general superintendent, general superintendent, assistant vice-president and vice-president. Mr. Bernet belongs to the class of men whose progress is not spectacular, but who achieve success by great thoroughness and efficiency in every task which they are called upon to perform. Before engaging in railroad service he was for a time a blacksmith, and as one of his associates remarks, he learned early the importance of "striking while the iron is hot."

John J. Bernet

He is a rather quiet man of a retiring disposition, who by steady and painstaking application has come to be regarded as an unusually efficient operating officer. One of his striking characteristics is his ability to get to the heart of each problem that is presented to him, and to reach a prompt decision as to the necessary action. In this way he always has been able to keep up with his office work and spend a great deal of time on the road. He has never been a man to spare himself as far as hard work is concerned, and his subordinates have appreciated his willingness to consider the important details of various propositions submitted to him.

Mr. Bernet was born on February 9, 1868, at Brant, Erie county, New York. He was educated in the public schools at Buffalo, N. Y. He entered railway service in 1889 as a telegraph operator for the Lake Shore & Michigan Southern, and on March 12, 1895, was appointed train despatcher, which position he held until April 2, 1901. From April 2, 1901, to March 6, 1903, he was trainmaster of the Eastern division. On March 6, 1903, he was appointed assistant superintendent of the same division; on February 1, 1905, superintendent of the same division. On November 22 of the same year he was appointed assistant general superintendent of the same road at Cleveland, Ohio, which position he held until October 1, 1906, when he was appointed general superintendent. He was general superintendent until June 1, 1911, when he was appointed assistant to vice-president of the New York Central Lines West of Buffalo, with headquarters at Chicago. On April 15, 1912, his title was changed to assistant vice-president. On April 1, 1913, he was appointed vice-president in charge of operation, and on January 1, 1915, at the time