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ERECTION OF THE NEWPORT AND CINCINNATI BRIDGE.

[Builders' and Contractors' Engineering and Plant No. CCLIV.]

The Newport and Cincinnati Bridge across the Ohio River consists of masonry and plate girder approach viaducts at each end with a river portion between, 1,648.6 feet long, comprising four duplicate spans each of 198 feet 6 inches, one channel span of 505 feet 10 inches and one 133 feet span, all of through trusses, pin connected, with details as shown in the illustrations of one of the 198 foot spans, a description of which was published in "The Engineering Record" of April 23 last. This bridge transferred temporarily to it, the old bridge was pulled down and the railroad portion of the new structure erected. After this was completed the railroad traffic was transferred back to its permanent position, and roadway, electric tracks, etc., completed.

At ordinary stages of the Ohio River there is not sufficient water at this crossing for navigation except under the channel span, and as the government required a 200-foot opening to be maintained in the channel at all times during the reconstruction of the bridge, the required opening was spanned with steel trusses about 200 feet long, as shown by Figs. 1, 10 and 12. These trusses, designed primarily to pass under the bridge, and in order to prevent them from knocking the falsework down longitudinally by a glancing blow, fenders were built through the opening, in front of the bents E and F, and the falsework was strongly braced longitudinally at the pile caps by 12x12 inch timbers running back and abutting against the piers. A conventional diagram, showing the outline of the trusses and the positions of falsework spans and trestle bents, is given in Fig. 1. The longitudinal bracing is here omitted to avoid confusion.

The falsework bridge consisted of two parallel duplicate spans, set first in one position and afterward moved laterally to a second positon.

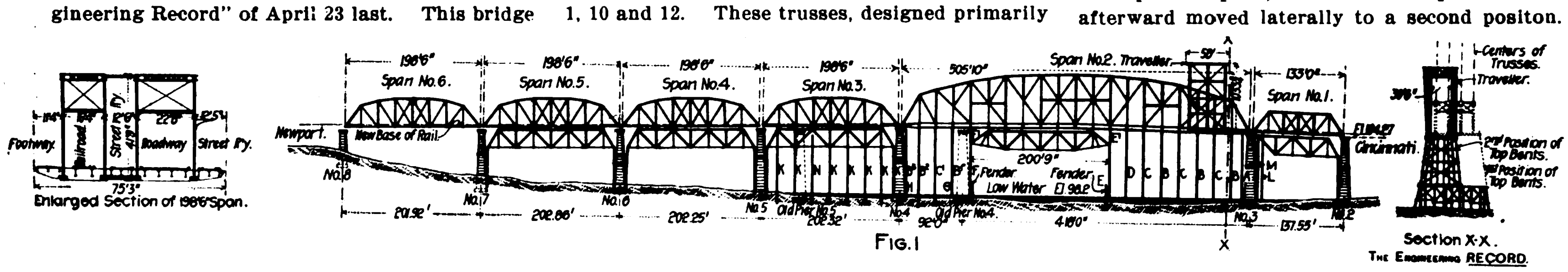


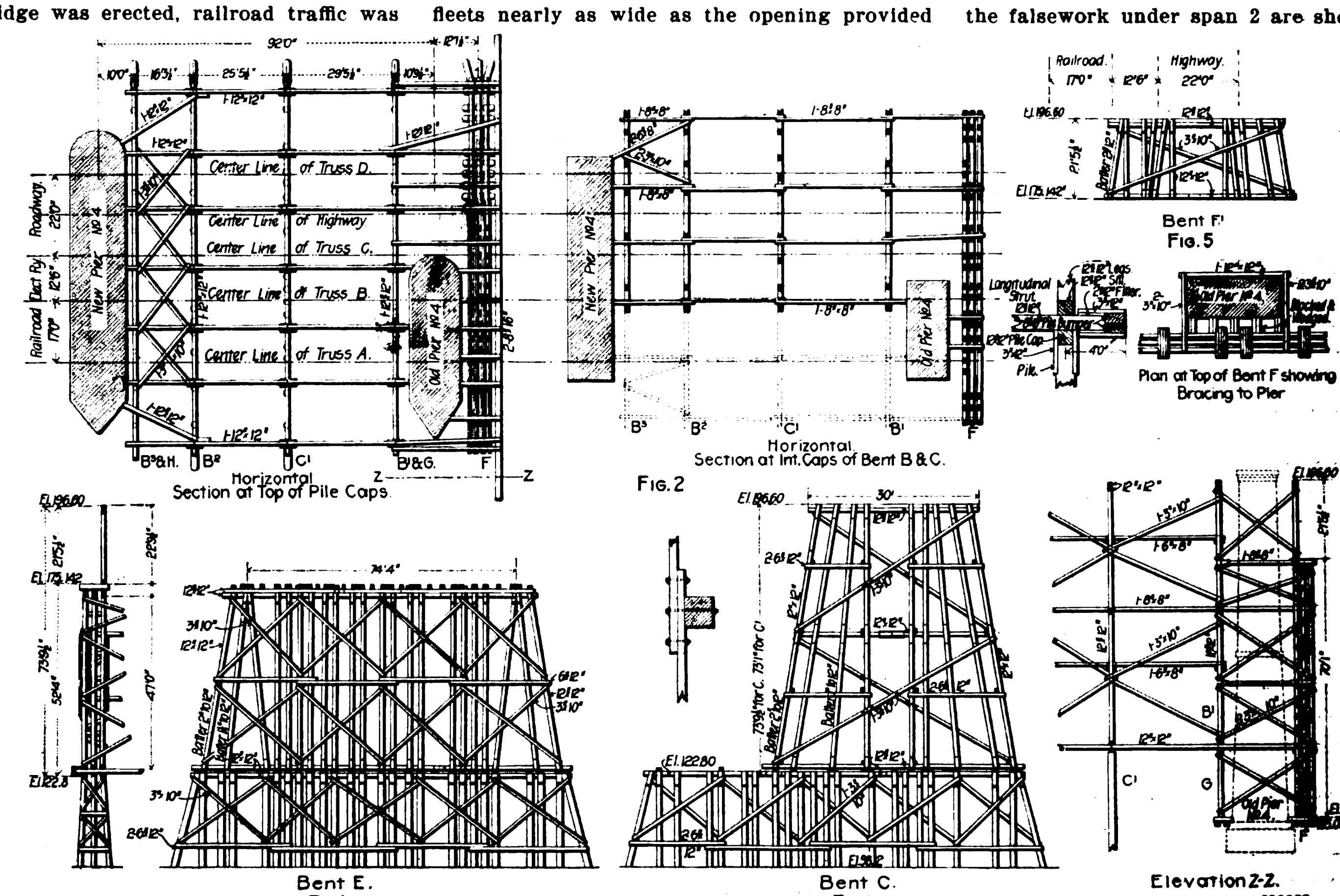
FIG. 1

carries one steam railroad track, two street railway tracks, a driveway and a footway, and replaced an old structure on the same site, but with different lengths for some of its spans. The old bridge carried one railroad track and two narrow roadways outside of the trusses on projecting floor beams. The old bridge trusses occupied the same position as the two trusses carrying the steam railroad track in the new structure, and where new piers were not built, the old piers were widened out down stream, so as to carry the two new trusses for the highway portion of the bridge. The channel span in the old bridge was 418 feet, while that in the new bridge is 510 feet. The length of the two spans just south of the channel span was also changed, which, with the change in length of channel span, required the building of new piers.

The general plan of erection was, first, to erect complete the trusses carrying the roadway, which could be done without interfering with the old bridge further than by the removal of the down stream overhanging brackets which carried a roadway. After the highway portion of the bridge was erected, railroad traffic was for the channel span, were so arranged that they could be used for the erection of all the other spans in the bridge, an expedient which, under the circumstances, was more economical than using falsework. In the case of the 200-foot spans, these erection trusses were carried on bents anchored to the piers and resting on the masonry footings, or coffer-dams, and in the channel the erection spans were carried on heavy timber bents. These spans were assembled in sections on boats, raised by tackle suspended from the old bridge, connected together and landed on the timber bents.

The Ohio River at this section is crowded with traffic, and in addition to the risk from high water there was constant danger while working at the channel span of being run into by steamboats, or tows of coal barges. To guard as far as possible against accidents of this sort, and at the same time be protected against drift in case of high water, cribs were built above the main bents E and F, carrying the ends of the erection span, and also at Pier 4 a V-shaped fender for the protection of the falsework. It is a common occurrence for coal fleets nearly as wide as the opening provided Its top chords supported the timber beams of a working platform about 40 feet wide, which was thus enabled to suffice for the erection of the new structure over 70 feet wide. In Fig. 1 the falsework span is shown in position under four of the permanent spans. These spans were each of them so supported during their construction, but there were never two of them simultaneously supported on falsework spans. The falsework span was first erected for span No. 5 and then for spans 4, 3, 1 and 2 successively. Span No. 6 being over dry land the new work was erected from a falsework of framed bents on bottom sills instead of using the falsework span. Falsework bents K, N, etc., had to be used under the railway trusses in span 3, as the old pier 5 prevented the use of the erection span in this position. For span No. 1 a portion of the members of the 200-foot falsework span were used to make the smaller temporary deck span there used; at spans 3, 4 and 5 the falsework spans were the same as in No. 2, except for variations in the end panels.

The construction, details and dimensions of the falsework under span 2 are shown in plan



ERECTION OF THE NEWPORT AND CINCINNATI BRIDGE.

THE LATE M. J. BECKER, CHIEF ENGINEER; THE EDGE MOOR BRIDGE WORKS, WILMINGTON, DEL., CONTRACTORS.

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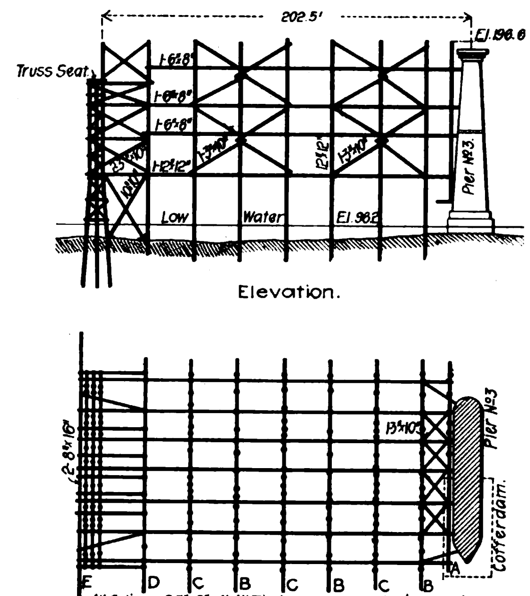
and elevation by Figs. 2 and 3. In plan the vertical pieces shown in section in Fig. 2 are solid black and those whose elevation are really concealed under some other piece are shown in outline by full lines, to make them more clear, although for accuracy they should be dotted. The details for splicing the posts and the transverse bracing of the trestle bents which served as abutments to support the temporary falsework trusses under span 2 are shown in elevation in Figs. 4 and 5. The framing of the bent C and C^1 are shown in Fig. 6; bents B, B^1, B^2 and B^3 are similar. The protection for the old piers 4 and 3 is shown in Fig. 7, and that for the pier bents E is shown in Fig. 8.

The pile bents under the channel span were put in wide enough to accommodate the erection of both the highway and railway trusses, while the framed bents on top of the piles were only made wide enough for the erection of one pair of trusses at a time, as shown in Figs. 5 and 6. The framed timber bents were first put up under the highway trusses and after they were erected these bents were shifted over bodily by means of rollers to their proper position for the erection of the railway trusses. The bents are not symmetrical, and have an uneven number of legs, on account of the highway trusses being 22 feet 8 inches center to center, while the railway trusses are only 16 feet 4 inches center to center, and the bents had to be designed to meet both cases. At new pier No. 4 the upper part of the falsework bents B^3 and K is the same as that shown for the upper part of bent C, but instead of being supported on a pile sub-bent as there shown it is supported on a framed timber bent H, that rests on the pier coffer-dam, except at one end, where it overhangs, and is carried by three piles. The bent B^1 south of old pier 4 and the triple bent F north of it are similarly carried. Bents E and F, at the ends of the channel opening, extended up only to the level of the falsework span they supported, and carried upon them secondary bents E^1 and F^1 for the support of the erecting platform extending beyond the ends of the truss.

Where not otherwise dimensioned or detailed, the timbering is in general as follows: The trestle bents are framed throughout with 12x12-inch vertical and batter posts, sills and caps, and square butt joints with double splice pieces, 3x12x3 feet or 4 feet with two ¾-inch bolts and 3-inch washer plates for each piece spliced. Diagonal braces are single 3x10-inch plank, bolted with two ¾ bolts at each end and one ¾ bolt at each intermediate intersection. Main longitudinals at pile caps and struts against piers are 12x12 inches throughout. The upper horizontal longitudinals between the old and new piers 4 and those that tie the panels adjacent to triple bents E and F are 8x8 inches. All others are 6x8 inches, overlapping side by side on the transverse caps and notched 1 inch and bolted with two ¾ bolts at each intersection. Sash pieces are generally two 6x12. The protection work shown in Figs. 7 and 8 is faced with vertical oak planks, 6 inches wide, spiked with two 8-inch spikes at each interesection to six rows of horizontals, and having 6-inch spaces between them. The triangular crib shown in Fig. 8 was built of round timber, log-house fashion, and filled with gravel.

The traveler used for assembling the new trusses on the falsework had a clearance of about 30x83½ feet, and was made of three bents of timber trussed with 3x8 and 6x12-inch plank bolted on. The three bents were trussed together in the outside longitudinal planes by upset screw ended steel rods, and the principal connections are made by 5x3½-inch angles, 5-16 and ⅜-inch steel gusset and pin plates and two 3-16-inch pins. The general elevation and details of the traveler are shown in Fig. 9.

The falsework span consisted of one pair of trusses R, 200 feet long, center to center, made as shown in the right hand of Fig. 10, and of another pair L, 182 feet long, center to center, made as shown in the left hand of Fig. 10, both being symmetrical about their common center line, and both being provided with 8x8-inch yellow pine transverse lateral struts at panel points, and single square sleeve nut diagonal rods for the lower lateral system. Span R was transformed to span L by modifying the end panels and by moving the trusses out from 15 feet 10 inches, center to center, to 24 feet in centers. Span R was first built for the erection of the railway track trusses and span L for the other trusses subsequently. The principal detail of construction of the falsework trusses is shown in inside elevations in Figs. 11 and 12, which show the special connections devised as the most efficient and economical for the assembling and disconnecting of the different members. All the diagonal posts throughout had bolted gusset plate connections, so that they could be more easily assembled, and to diminish the pin bearings. The lighter vertical posts were made of wood with concave bearings on the pins at both ends, and a flat iron strap bolted on outside, as shown in the detail. Both top and bottom lateral struts were made of 8x8-inch yellow pine, secured to U plates, which were riveted to the top chord webs, and engaged the ends of the lower chord pins. The top chord struts were through bolted to the U plates and the bottom chord struts were connected by vertical pins that received the diagonal rods. The top lateral diagonal rods were pin connected to horizontal connection plates, riveted to inside top flanges of top chords. The main vertical posts were made of iron and had pin connections on the inside faces for sway brace rods. At panels where there were no iron vertical posts, angles were riveted to the top chords and received through their vertical flanges pins for sway rod connections. At the second panel point of the top chord, at one end of the truss, a seat A was riveted to the connection plate, to furnish bearing when the span was shortened up for use in span 1. Double top lateral struts and sway bracing were used at the points where the trusses were disconnected in sections when being moved from one span to another, so that each section would be completely braced in itself. The inclined end posts of both spans were braced transversely by two panels of rods and struts corresponding to the top lateral system. The detail of top chord panel points and of the loose floor platform in span R is shown in Figs. 13 and 14, where the steel beams temporarily used were those provided for the permanent sidewalk floor. The corresponding details for span L are similar, except that the steel beams are replaced in the latter cases by a pair of 8x16-inch timbers. The channel spans, falsework trestles and trusses, protection work and fin-



Plan
FIG. 3

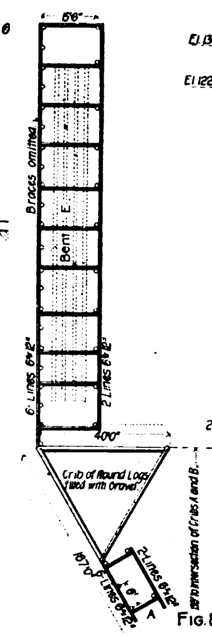


FIG. 8

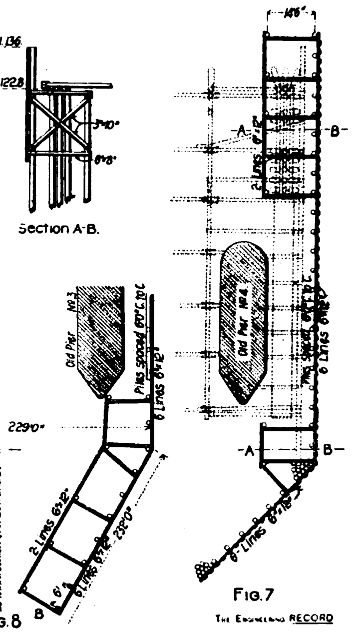


FIG. 7

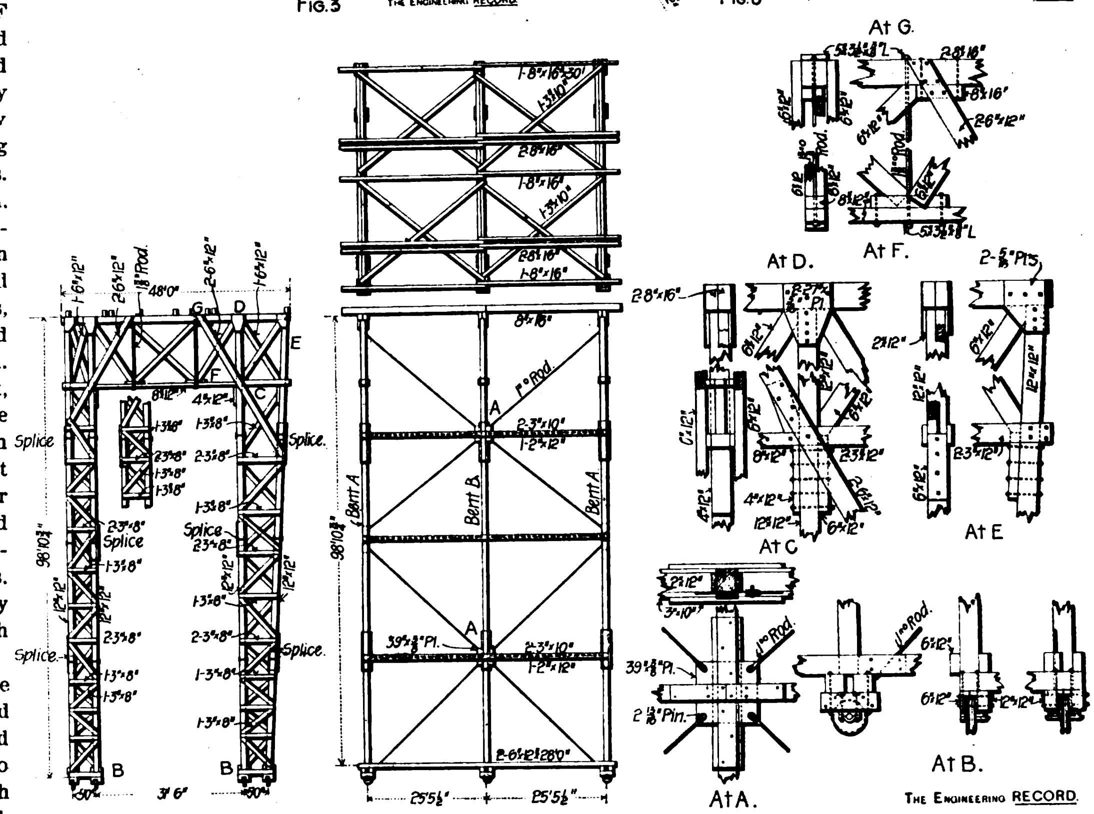


FIG. 9

ERECTION OF THE NEWPORT AND CINCINNATI BRIDGE

THE LATE M. J. BEEKER, CHIEF ENGINEER; THE EDGE MOOR BRIDGE WORKS, WILMINGTON, DEL., CONTRACTORS

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ished 510 feet permanent spans are shown in Fig. 15, while the falsework trusses are shown in the first position under one of the 198 feet spans in Fig. 16, which shows the two new trusses for the highway half erected and the old superstructure still in place.

There were two considerable floods which caused much anxiety and delay during the erection of the channel span, and one of these carried about one-half of the protection away, but the protection saved the falsework. After the completion of the channel span there were three other floods, which caused much delay in the removal and the re-erection of the remaining river spans on the railroad side. In fact on account of the very unfavorable season this work could hardly have been proceeded with at all if regular falsework had been depended on instead of using erection trusses. After many delays from high water the railroad side of the bridge was completed and trains turned back on to it in February, after which the balance of the work on the highway side of the structure was quickly finished up.

From the time the work was actually started in the middle of August, until the structure was completed, ready for trains, was less than six months, which was a short time, when it is considered that the work practically included the erection of two bridges over the Ohio River and the removal of one old one in one season, and that this season was unprecedented as far as records show for the number and extent of the floods. The highway side of the channel span was erected in 55 hours and the railroad side in 52 hours, counting from the time raising iron was begun until the spans were connected. The total weight of steel work in the bridge is over 7,000 tons.

The water in the river had fallen low enough to permit driving piles for the river portion of the work by June 20, 1896, but work had only been in progress a few days when the erectors were driven out of the river by a flood, and the water did not get low enough again to enable them to resume operations until about August 15. On August 2 the river reached a stage of 42 feet, which was the highest water known during the summer months for over 30 years. The work was practically not started until the middle of August, and the railroad side of the channel span was swung on November 10. In this time all the heavy falsework had been put in place, the entire river portion of the bridge on the highway side erected, and the channel span on the railroad side.

The plans were prepared, the contracts let and the work started under the direction of the late M. J. Becker, chief engineer of the Newport & Cincinnati Bridge Company, which is owned and controlled by the P., C., C. & St. L. Ry., of which he was also chief engineer, but unfortunately he did not live to see the work completed. The superstructure was built and erected by the Edge Moor Bridge Works, Wilmington, Del., William H. Connell, president; S. P. Mitchell, manager, and C. W. Bryan, chief engineer.

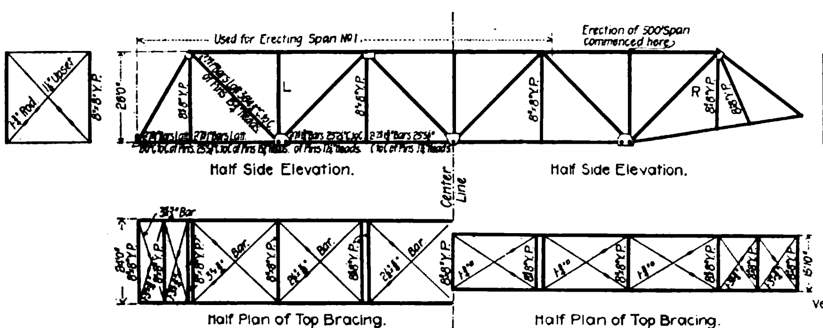

Fig.10

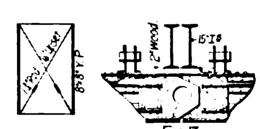
Fig.13

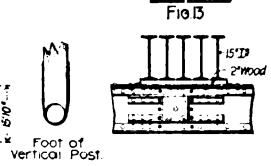

Fig.14

The Engineering Record

FATAL COLLAPSE OF A HIGHWAY BRIDGE.

On July 4 a street bridge at Shelby, O., fell under the weight of a large crowd of people, some of whom were killed and injured. The accompanying sketch of the truss was sent by the City Surveyor, who states: "A wedding took place on the bridge July 4, and the bridge was loaded with all the humanity that could stand on it; when so loaded it gave away slowly, the center going down first. * * * The bridge at its best was too light, and by appearances had been much weakened by corrosion."

From the memorandum accompanying the sketch it appears the bridge was 60 feet wide, transverse to the direction of the trusses, and had a 3-inch plank floor of about 3,000 square feet surface, which was supported on floor beams each composed of two 10 x 2½ ¼-inch channels, 17 feet long. There were three trusses and 1-inch and ¾-inch round "tension" rods. No idea is given of the details of the bridge, but judging from the dimensions and materials given, and the fact that the truss is shown without diagonal ties in the two center panels, it may be assumed that they endured until the bridge was fully loaded.

A live load of 100 pounds per square foot of the bridge platform, assumed as the weight of a crowd, would produce a maximum chord stress of over 216,000 pounds in each of the three trusses, and this alone would strain the given cross-sections fully up to the breaking value of good wrought iron. As this does not make any allowance for the important additional strains produced by the weight of the structure itself by impact, vibration, for deteriorating metal, poor manufacture, or imperfect details and connections, it is evident that the bridge was entirely inadequate and unsafe for ordinary and reasonable town service.

Since writing the above some further data have been received from Mr. J. C. Fish, Secretary of the Shelby Electric Company, who states:

"I am in receipt of your favor of July 14, and as you requested I inclose you a sketch, roughly made, of the Shelby bridge. I also mail you to-day, under separate cover, photograph taken about one hour after the accident occurred. The writer is not posted on bridge engineering, and you will have to draw your own conclusions from the following statements:

"Location.—The bridge which fell was located on the main street of the village, and spanned the Blackfork of the Mohican, a small stream which separates the two business portions of the village.

"Time.—The accident occurred at 4:30 p. m. on July 4. At this time there had just been completed, upon the bridge, a wedding ceremony, which was one of the features of the Fourth of July entertainment.

"Size.—By referring to the inclosed sheet you will see the span of the bridge between abutments was 51 feet 6 inches, and the width of the bridge from side to side was 72 feet.

"The bridge was of the eye-beam pattern, being supported from five trestles of 'U' shaped iron, by three supports to each beam.

"There is estimated to have been 2,400 people on the bridge, and the approximate weight is estimated at 125 tons. Immediately after the ceremony, which was performed on a platform erected in the center of the bridge, the crowd cheered, and the bridge began to sink in the middle. The 10-inch main of the water company crossed the bridge on the north side. The water main was independent of the bridge, being put in with flanged pipe and fastened together with iron rods connected in the center

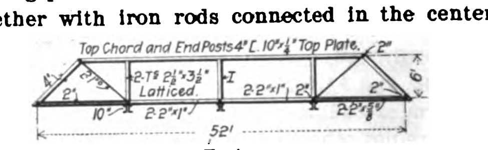

Fig.1

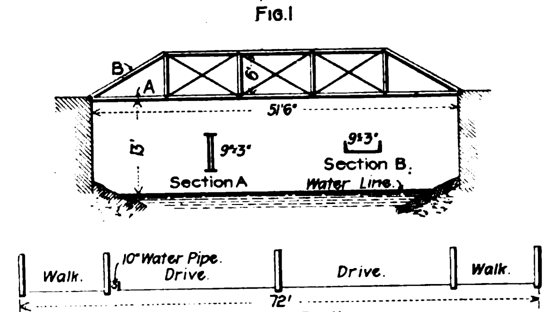

Fig.2

The Engineering Record

COLLAPSE OF A HIGHWAY BRIDGE, SHELBY, O.

with swivels. The water mains did not fall until about 30 seconds after the bridge. There were fully fifty people standing upon the mains, and the weight of the trusses, together with the weight of the people upon the pipe, finally broke the cast-iron bend on the west side, which permitted the pipe to drop down on the crowd, and caused two 10-inch streams of water

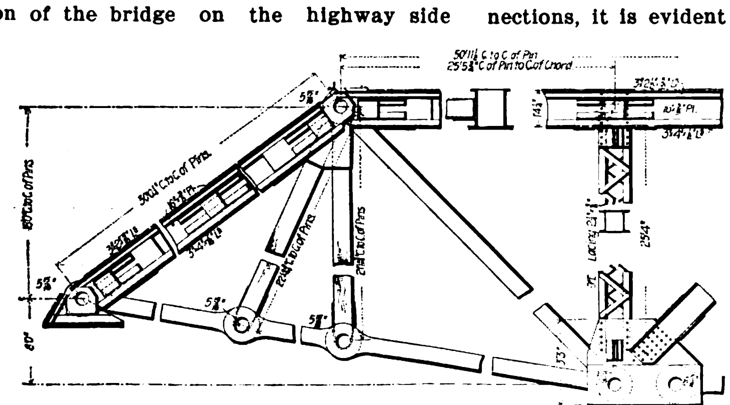
Fig.11

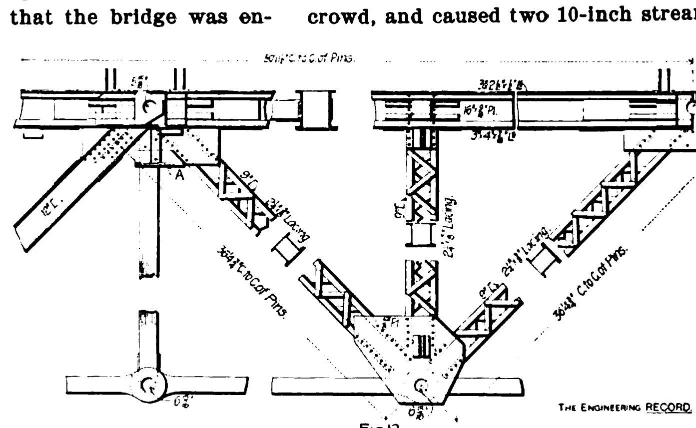
Fig.12

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ERECTION OF THE NEWPORT AND CINCINNATI BRIDGE.

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