Renewing Heavy Swing Span by Floating Into Place

Old North Western Bridge in Milwaukee Removed and New Span Weighing 800 Tons Placed in One Day

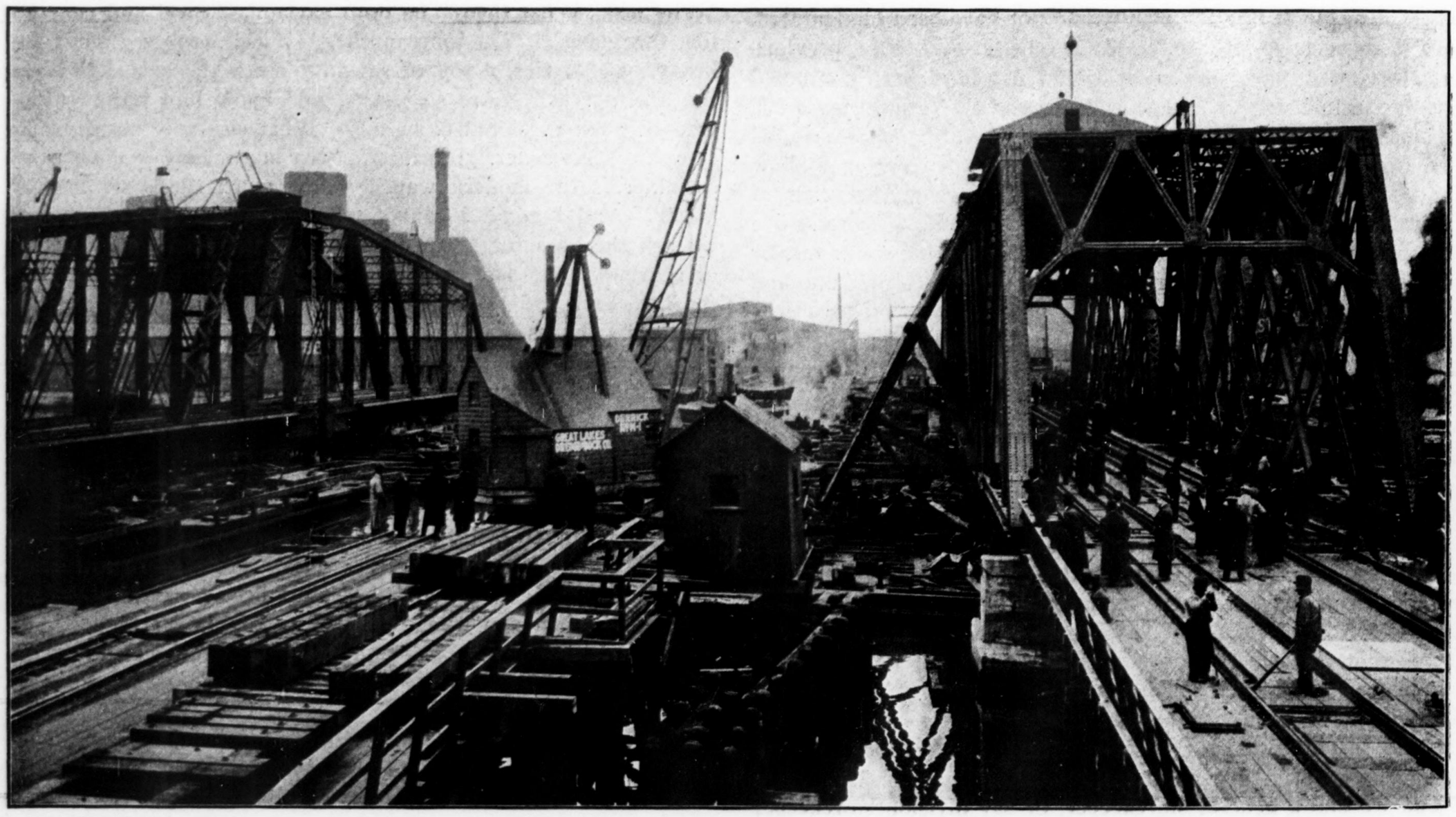
The placing in service of the new Chicago & North Western swing bridge over the Milwaukee river, in Milwaukee, Wis., on March 14, involved the simultaneous handling of two heavy spans on scows. The large amount of floating equipment necessary for such an undertaking and the care with which all details had to be worked out to safeguard the structures during the movement are noteworthy features.

This bridge is located about ¾ mile south of the Milwaukee passenger station on the main line to Chicago and about ¼ mile from the mouth of the river. It is a double-track structure, carrying all main line passenger trains and numerous freight and switching movements to and from the Milwaukee freight houses, the engine terminal just north of the river and the adjacent industries. Through freight trains use the belt line around the city.

The old bridge built in 1890 and operated by a gasolene engine was too light to carry the increasing wheel loads of modern equipment and the substructure also was in need of repair. Since another swing bridge could be built without the necessity for securing a new permit from the government, and the city and government officials were inclined to favor that type, it was decided to replace the old span by a new one of the same length, 240 ft., providing two clear channels of 90 ft. each.

It was essential on account of yard connections and the proximity of structures on the water front that the old alinement be retained on the new bridge, but in order to rebuild the center pier and the abutment it was necessary to remove the old bridge. It was, therefore, floated downstream about 60 ft. to a temporary location and traffic carried over it during the repair of the permanent substructure and the erection of the new bridge. The narrow right of way and the presence of elevators and docks close to the line limited the amount of this move so closely that the new bridge could not be erected in the open position on its permanent center pier. Falsework was therefore driven in line with the center protection pier upstream from the site to support the new bridge during erection.

The operation of placing this structure in position on the new substructure, without undue delay to traffic, required the movement of both bridges in one day. First the new span was blocked up on scows and floated out into the north channel, taken upstream to clear the falsework, then turned and brought down over the falsework to the permanent location. This movement could not be completed with the old span still in its temporary location on account of the difficulty that would then have been connected with the removal of the old bridge. So the new span was anchored about 100 ft. from the permanent location, while the old span was blocked up on scows and moved downstream a sufficient distance to clear the operations at the permanent location, after which the new bridge was brought down and centered on the permanent pier.



New Bridge in Final Location Before Scows Were Removed; Old Bridge Shown at Left Has Been Moved Downstream from Its Temporary Location

The moving of the old bridge to its temporary location on October 25, 1914, and of the new bridge to its permanent position, as mentioned above, were both carried out on Sunday, when river traffic could be stopped and the tracks cut between 10:15 a. m. and 4:00 p. m., during which time passenger trains were detoured around the belt line. In connection with the new work, a 56-lever General Railway Signal Company's all-electric interlocking plant was installed in a new tower, just north of the bridge, to govern movements across the river.

The first step in the renewal of the old bridge was the driving of piles for the temporary center piers, abutments and approaches on the downstream side of the bridge in its original location. At the same time, timber wedging and bracing was provided along the I-bar diagonal members in the two spans each side

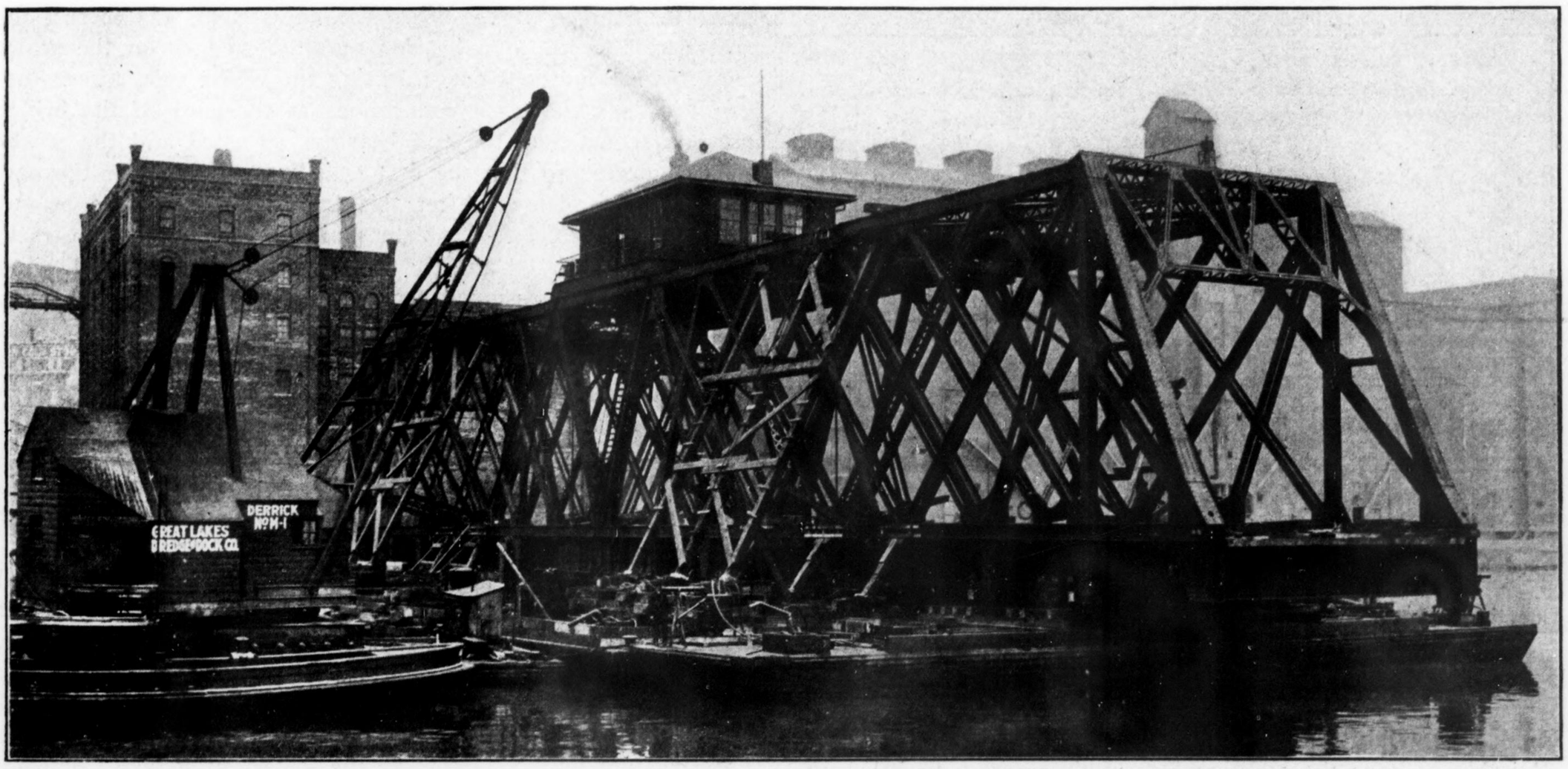
of the center in each truss, to allow them to take the compressive stresses, which would result in carrying the bridge on scows located in the two channels. The movement of this bridge was successfully made on a steel scow 100 ft. by 35 ft. by 8 ft., and a wooden scow 112 ft. by 33 ft. by 9 ft. The bridge weighed about 500 tons, making it necessary to place the blocking against the stringers in order to secure the 2 ft. greater height for distribution of the load on the scows and to reinforce the bottom chords of the trusses in the wooden scow.

The old substructure consisted of stone masonry on timber piles. In the reconstruction, new concrete bridge seats and backwalls were placed on the abutments and a new octagonal concrete top on the center pier, after removing the old masonry down to a level as near the water as possible. The new pier top has a diameter of 34 ft. and is reinforced by ¾-in. radial bars 6 ft. long and five ¾-in. bars 14 ft. long, placed parallel to four of the faces.

The new bridge is 237 ft. 6 in. long, center to center of bearings, 31 ft. wide between centers of trusses, and 32 ft. high between centers of chords. The trusses are of the quadruple intersection type, with a panel length of 14 ft. 9 in. The structure was designed for a live loading of Cooper's E-55, with the following impact allowances: With the bridge closed, $I = \frac{3}{4} L + \frac{L}{L+D}$ for the trusses and floor beams, and $I = L + \frac{L}{L+D}$ for the stringers; for the bridge swinging I = 0.25 D. The bridge is of the combination center and rim bearing type, the load being equally divided between the 2 ft. 6 in. phosphor bronze and steel center castings and the 64 rim bearing wheels. The estimated weight of the bridge, with the operating machinery, was about 800 tons.

The bridge will be operated normally by electricity. Two independent sets of machinery for turning have been installed, each driven by a 75-hp. motor, which can operate the bridge in the necessary time. In addition to this, an emergency plant is provided at the operating house, consisting of a 32-hp. Fairbanks-Morse gasolene engine, operating at 200 r. p. m., which can be connected to the operating shaft in case of failure of the electric power. This power is purchased from the local public service company and is brought to the operating house through a submarine cable and a drag cable on the center pier. A 15-hp. motor at each end of the bridge operates the end latch, end lift and rail lift at that end, both of these motors being operated through one controller in the machinery house on top of the bridge. Three sets of lights above the controllers indicate to the operator when the movements of the rail lift, the end latch and the end lift, respectively, have been completed. The machinery is interlocked from the signal tower and the separate circuits in the operating house are also interlocked.

The erection car was placed on the new falsework from the end of the old span in the open position by blocking up that span and extending the rails on blocking, and all steel was delivered to the site on scows without interruption to river traffic. Two girder spans were provided in the falsework to allow the placing of the barges on which the bridge was to be moved into position. The operating rack, tread rim bearing wheels and spider and the lower two center bearing castings were located on the new pier. To assist in centering the bridge on the bearings a 10-in. steel band made in three pieces bolted together was placed around the center on the pier. Two short sections of the operating rack at diametrically opposed points on the circle were omitted before the new bridge was put in place in order to allow the pinions on the bridge to be lowered into position without damage to either the rack or the pinion. The bridge was later turned by tugs to mesh the rack and pinion, after which the short sections were put in place to complete the circle. In order to provide for any difference in the deflection at the ends of the bridge from that computed in advance, the end bearings were set one inch below the calculated elevation and two ½-in. and several thinner shims were provided to adjust this height properly.

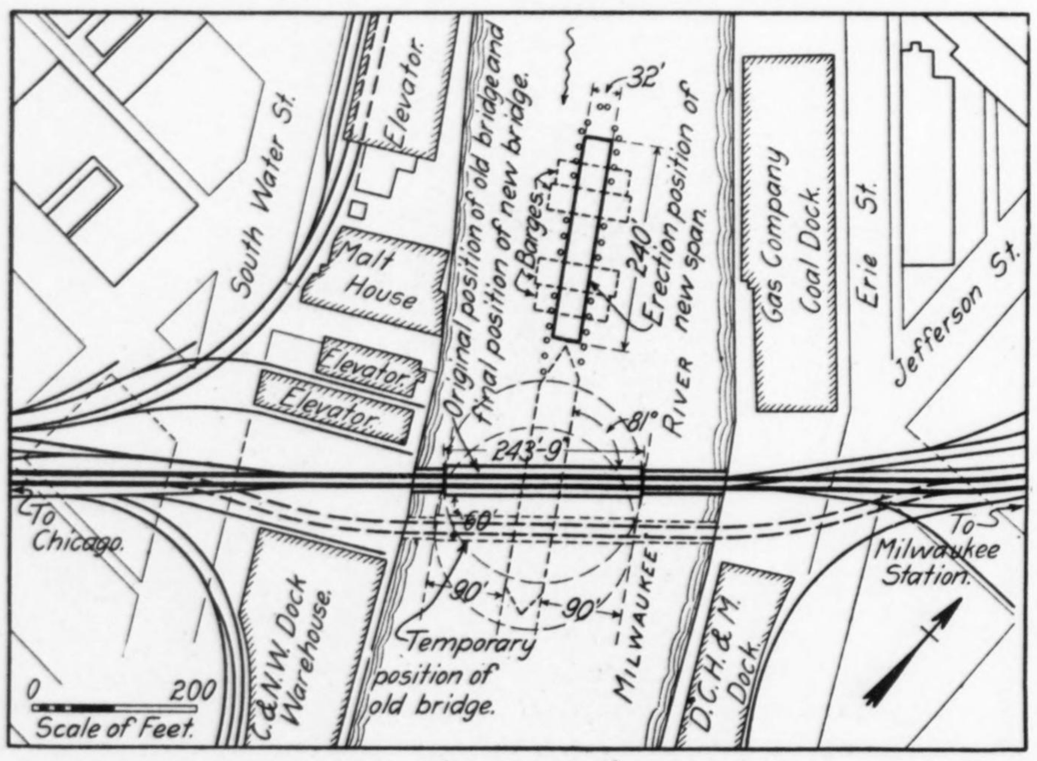


Floating the Milwaukee River Bridge on Four Scows Showing Diagonal Bracing for Distributing Loads on Two Main Scows

All preparations for the placing of the new bridge had been completed before February 21, and an unsuccessful attempt was made to carry out the work that day. The weather conditions and the surge in the river caused by winds from the lake prevented the movement of the span on the two succeeding Sundays, but on the next Sunday, March 14, the conditions were favorable and the movements were made with complete success. To make sure that enough time would be available on Sunday for the movements of both bridges, the water-filled scows were placed under the new bridge and the blocking wedged up by the Saturday night preceding the day of the movement. These scows were watched during the night by crews and tugs to protect the outfit from damage by passing boats and also to be ready to remove the wedges immediately

if any considerable change of river level occurred due to a shifting of the wind.

Four scows were used under this span instead of two, as originally planned, enough of the falsework being removed to provide clearance for the additional scows outside of the other two. The new bridge with all of the blocking on the scows made a total load of nearly 1,000 tons. The plan provided for carrying this load on a steel scow 35 ft. by 100 ft. by 8 ft., and a wooden scow 33 ft. by 110 ft. by 9 ft. These two scows had ample capacity to support this load but in order to distribute it more evenly over their length, and also to support the bridge more rigidly against tipping, diagonal bracing from the top and bottom chords to the scow decks was placed as shown in one of the illustrations. This bracing was designed to carry 60 per cent of the load of the bridge, the remaining 40 per cent being transmitted to the blocking from the floor beams directly over the scows. Two feet of combing was provided on the steel scow and one foot on the wooden scow as a precaution against filling with water on account of listing or washing. The two additional scows were used to give greater stability to the span during the movement and also to assist in supporting the load during the lowering of the bridge on its new center pier. When nearly submerged a steel scow



Location Plan of Milwaukee River Swing Bridge on the Chicago & North Western Showing Permanent and Temporary Locations and the Erection Position of the New Span

is not thoroughly reliable and for this reason it was considered advisable to have the additional scows in position to help support the load at this critical point. These two scows were 90 ft. by 24 ft. and 98 ft. by 24 ft., respectively. They were blocked up under the floor beams but carried no diagonal bracing.

As Saturday night passed without a change in weather conditions the pumping out of the scows to raise the bridge was started by 6:30 a. m., river traffic having been stopped at 6 a. m. Eight pumps were used in unwatering the scows, with leads of steam hose from tugs, etc. The new bridge had been erected 1.5 ft. above its permanent elevation and was lifted about 17 in. off the falsework by the scows. This lift was completed by 7:30, and during the following hour the bridge was shifted sideways into the north channel, taken upstream far enough to turn it across the channel and brought down over the falsework, the caps and blocking of which had been removed in the meantime to allow ample clearance for the operating pinions. These movements of the structure on the scows were accomplished by hand operated lines, the tugs and other floating equipment standing by in case of need. On the downstream movement the current was more than sufficient to move the scows, making it necessary to hold back continually on the lines. The floating outfit was tied up within 100 ft. of the permanent location of the bridge and men left to watch the scows while the movement of the old bridge was effected.

By 10:00 a. m. the old bridge had been wedged against the blocking on four water-filled scows, two in each draw. These scows were from 75 to 80 ft. long and 24 to 28 ft. wide, lashed together in pairs with continuous blocking over the two. The last train passed over the old bridge at 10:15, and immediately afterward the eight pumps were started pumping out the water. By 11:15 the old bridge, with the rack, tread, etc., had been lifted about 16 in. off its pier and removed downstream out of the way, where it was tied up during the remaining operations on the new span.

The final movement of the new span was begun about 11:25, the scows being kept parallel to the protection pier until the northeast corner of the span was about one foot from the west end of the north pier. It was then held stationary while the south end was swung downstream to bring the bridge parallel to its final position. Keeping this relative position, it was then floated over the center pier and held as nearly as possible in the true alinement. The centering ring on the center casting was adjusted so that its diameter was about 3 in. greater than the diameter of the casting on the bridge, and as soon as this casting had entered the ring three men were stationed at the joints to tighten up the bolts, thus accurately centering the bridge. This adjustment was made with the span about 6 in. above its final position. When the adjustment was correct the span was lowered to a bearing and the wedges on the scows were at once knocked out, releasing the scows soon after. Before 4 o'clock the track connections at the ends of the bridge had been completed, the end bearings adjusted and the power cable connected so that the first train was passed over the new bridge without delay. After this train had passed the bridge, the span was swung to mesh the pinions and the operating rack, the power was tested and the bridge operated at 5:20, allowing river traffic to be resumed according to schedule at 6:00 p. m.

During the centering of the new span the old bridge was floated downstream and was held on the scows for several days until a favorable opportunity offered for landing it endwise onto a dock. This landing was accomplished by sliding it on the floor beams on lines of rails placed on blocking at the proper height. The scows were removed one at a time and additional supports provided as necessary to carry the proportion of the weight of the bridge still over the water.

The design of the new bridge and the method of renewal were worked out under the direction of W. H. Finley, chief engineer, and W. C. Armstrong, formerly bridge engineer. H. M. Spahr was the resident engineer in charge of railway company's work in field. The substructure was built under contract by the Cleary-White Construction Company, Chicago, the superstructure was fabricated by the American Bridge Company and erected by the Bernhisel Construction Company, Chicago. The power equipment was installed by George P. Nichols & Brother, Chicago, and the Great Lakes Dredge & Dock Company handled the movements of the spans.

WAR TRAFFIC ON THE METROPOLITAN RAILWAY OF ENGLAND.—Since August the Metropolitan Railway, which connects with the Midland and Great Northern systems in the north of London and with the South-Eastern & Chatham, and London, Brighton & South Coast systems in the south, has been the means by reason of its lines under the "Circle," near Farringdon street, of conveying over these lines no fewer than 2,738 troop trains. During the despatch of the expeditionary force as many as 58 troop trains a day passed over the Metropolitan lines without any sensible interference with the ordinary passenger traffic. In addition to this burden during the first fortnight of February, 2,935 freight trains, equal to 210 a day, have passed over the Metropolitan lines, in addition to special trains with troops and government stores and the ordinary local passenger service throughout the day. This has been carried out without interference with normal traffic, except on one or two days of exceptional pressure, and without mishap of any kind.