Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

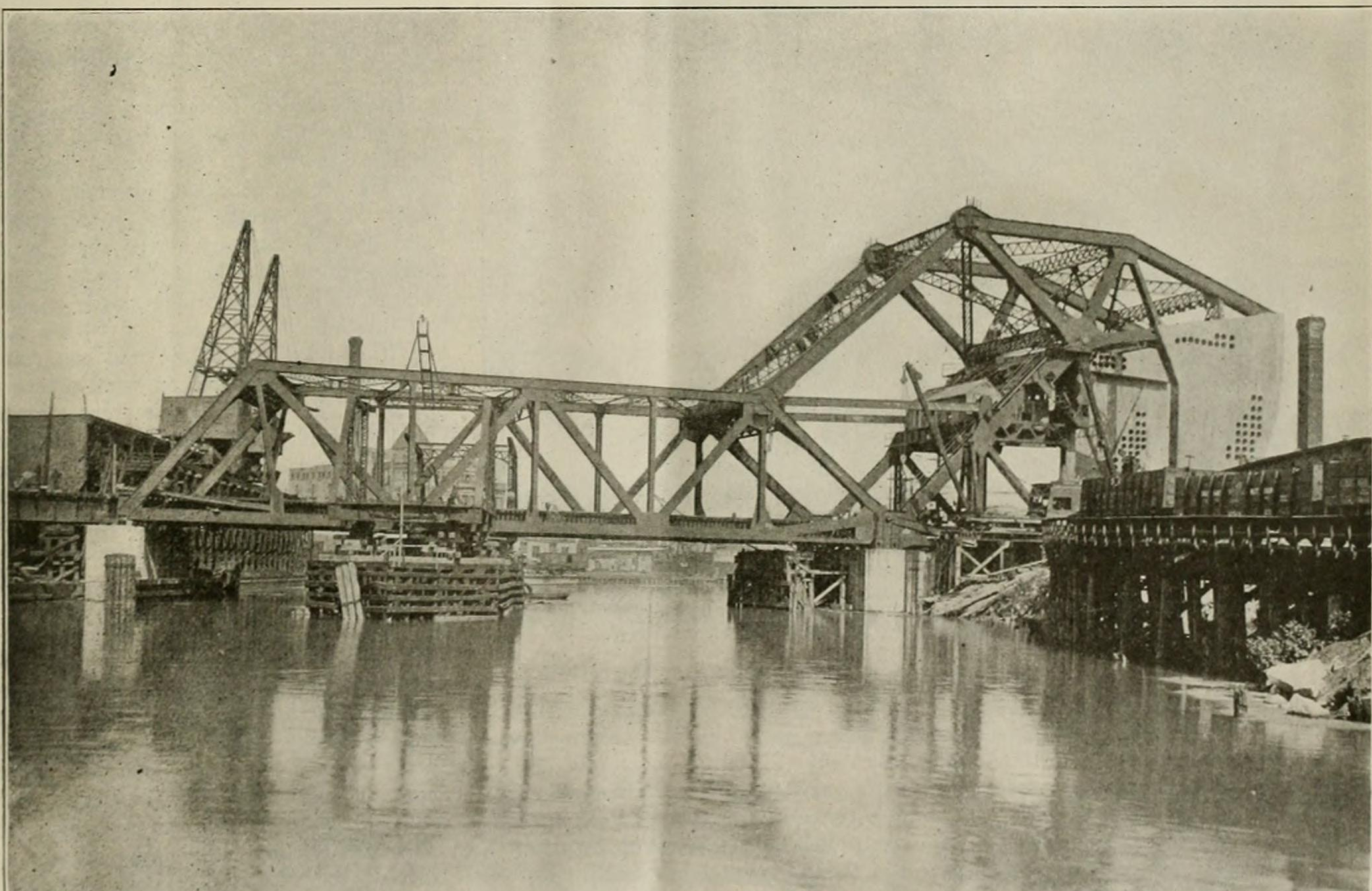
Vol. XXX. 114 Liberty Street, New York, January, 1917 No. 1

New Bascule Bridge at Deering Station, Chicago

Bridge Erected With Minimum Traffic Interruption—Old Bridge in Service Until the Last Moment—Signal Arrangement of the New Bridge

A few months ago the Chicago & North Western Railway put in operation a new bridge over the North Branch of the Chicago River, at Deering Station, Chicago. This bridge is a Strauss steel trunnion bascule bridge carrying three tracks. It double track, swing bridge of 176 ft. in length supported on a pier in the middle of the river. The old bridge, built in 1887, was worn out, and it had become necessary to replace it with a bridge of greater capacity and strength, on account of of which were passenger trains. The river traffic, while not heavy, was sufficient to require keeping one channel continuously available for navigation.

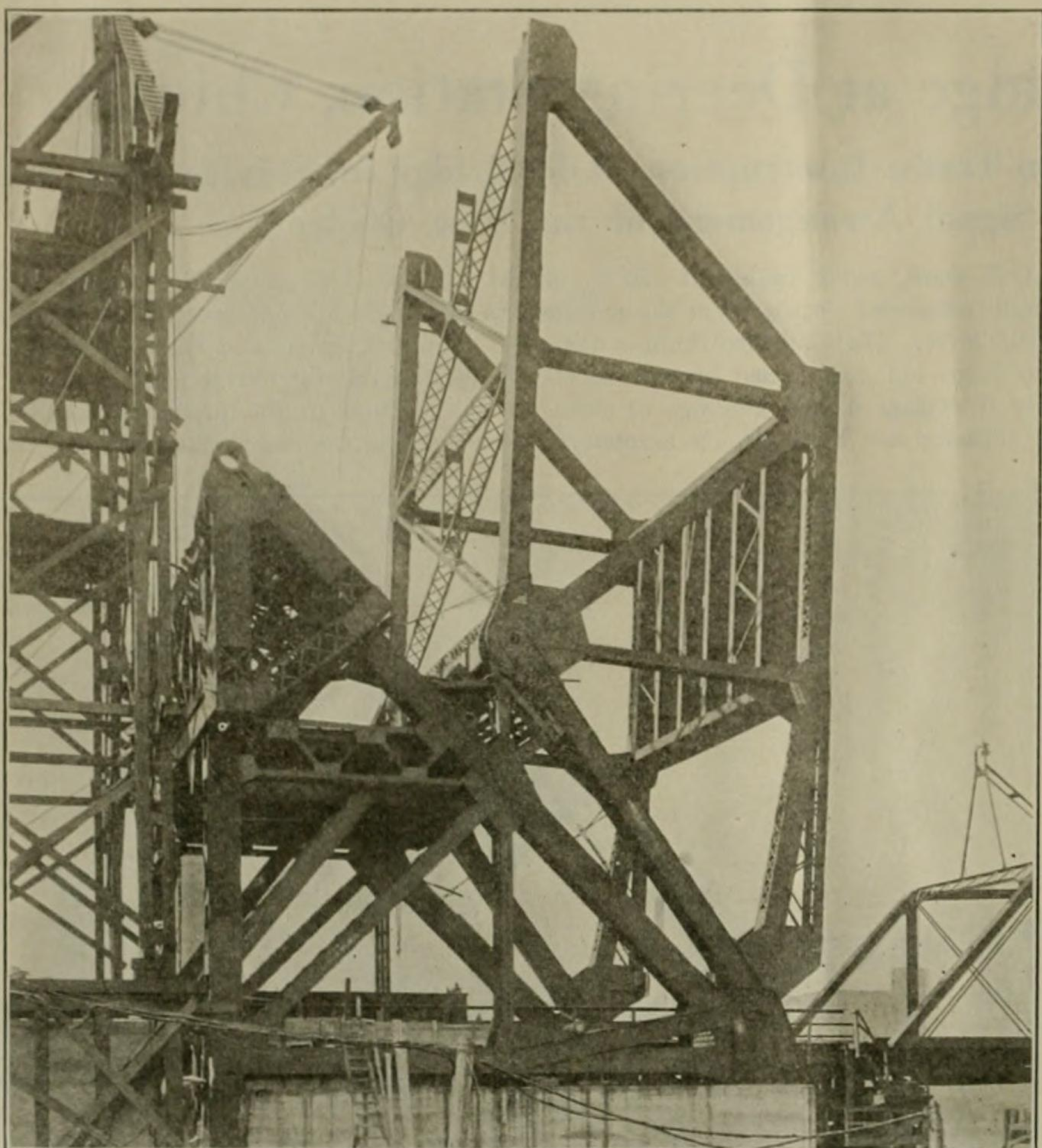
In addition to the increased facilities for handling the heavy railway traffic, the



CHICAGO & NORTH WESTERN RAILWAY BASCULE BRIDGE OVER THE CHICAGO RIVER NEAR DEERING, ILL. VIEW SHOWS BASCULE BRIDGE IN POSITION, READY FOR TRAFFIC.

spans a channel of 145 ft., clear width between fenders, crossing the stream at an angle of 16 degs. The rest pier and the front end of the movable span are skewed so as to be parallel with the channel.

The new structure replaces an old, the greater volume of traffic and the heavy power now on this line, which is the railway's main line between Chicago and Milwaukee. The railway traffic during construction consisted of about 200 trains every 24 hours, about 80 per cent. conditions for river navigation are greatly improved with the new bridge. A single channel, of 145 ft. clear width, replaces the narrow channel on each side of the old center pier, and this channel was deepened to 215 ft. below the water level. The vertical clearance under the span was increased from 16.5 ft. to 18.25 ft., which permits a large proportion of the boats navigating the channel to pass without opening of the bridge. The superstructure is here arranged under four heads for convenience in description. (1) Movable span and counterweight. This includes all moving parts except machinery. (2) Tower. (3) Operator's house. (4) Machinery, power and operating equipment. The movable span, being skewed at one end to fit the angle of the channel, has trusses of unequal length, the long truss being 186 ft. from the center of the main trunnion to the center of the bearing at the front end. Our illustration shows the general outline of the bridge in the closed position, and the general dimensions of the superstructure.



C. & N. W. RY. DEERING BRIDGE—FIRST STAGE OF ERECTION. THE COUNTER WEIGHT PIVOT AND BASCULE SPAN PLACED READY FOR PERMANENT SETTING.

The live load used in designing was Cooper's Class E-55, applied as follows: Stringers—Track fully loaded. Floor Beams—Full load on middle track and 5/8 of full load on two outside tracks. Trusses—Three-quarters of full load on all three tracks. The design, detail and material were in accordance with the C. & N. W. Ry. specifications for bridges, supplemented by special specifications prepared by the Strauss Bascule Bridge Co. to cover all features not covered by the C. & N. W. specifications.

The counterweight consists of two reinforced concrete wings, one on each side of the bridge and outside the clearance lines. They were cast around the framework of the counterweight trusses, which are mounted on trunnions set in heavy bearings at the top of the tower. The aggregate used in the counterweights was Fayalite, a very heavy and hard rock obtained in Northern Illinois. The concrete was mixed in different proportions for the two wings, in order to keep the volume and outline the same for each, but to give to each wing the weight necessary to counter-balance its corresponding side of the movable span. The concrete in the counterweight for the short truss weighed about 160 lbs. per cu. ft. at 20 days; that for the counterweight of the long truss about 168 lbs. per cu. ft.

The detail of the counterweights provided a number of horizontal, cylindrical pockets for adjusting blocks. These pockets are 1 ft. 11 ins. in diameter, and extend all the way through the counterweight, except where interrupted by the members of the counterweight trusses, where they extend only 1 ft. 11 ins. from the surface.

Cylindrical concrete adjusting blocks 1 ft. 10 ins. in diameter and 1 ft. 8 ins. to 1 ft. 10 ins. long were cast for these pockets. The volume of the pockets constitutes about 7 per cent. of the total volume of the counterweight, and it was estimated that the counterweights would balance the span when half of the pockets were filled with adjusting blocks. This gave a possible adjustment of 3½ per cent. of the total amount of the counterweight either way from the estimated requirement.

On account of the great weight of the moving parts, the trunnions are of unusual size. The trunnions at the top of the tower, carrying the counterweight trusses, are 24 ins. in diameter. The heel trunnions are 17 ins. in diameter, and those at the ends of the connecting links are correspondingly large. The four trunnions on each side of the bridge are so arranged that the four lines connecting their centers form a true parallelogram, a condition essential in applying the principle of counter-balance of this type of bridge. The counterweight, while revolving around a center different from that of the moving span, always moves through the same degree of angle as the span, but in the opposite quadrant of the circle.

The machinery is designed to open the bridge the full angle of 87 degs. in one minute, against an unbalanced load of 2½ lbs. per sq. ft., acting normally to the floor of the bridge. The specifications also provide that machinery shall be of such strength, and the power as to be sufficient, to open the bridge slowly against an unbalanced snow load of 10 lbs. per sq. ft. of floor area of moving span, combined with an unbalanced wind pressure of 10 lbs. per sq. ft. of this area; also, to hold the bridge stationary in any position against the snow load of 10 lbs. per sq. ft. combined with a wind pressure of 15 lbs. per sq. ft. The power installation consists of two 150 H. P. motors coupled in parallel. The power is alternating current, 3 phase, 60 cycle, 440 volts.

Auxiliary power is provided, consisting of a 50 H. P. gasoline engine connected through reduction gearing and reversible friction clutches with the spur gear driven by the motors. This arrangement makes the motors run idle when operating the bridge with the engine. The solenoid brakes on the motors, which are normally released only when current is driving the motors, are held in release position during the operation of the engine by special mechanism provided for this purpose. Auxiliary hand brake is provided for control of bridge when operating with engine. The emergency brakes to be described, are also available for this purpose.

To relieve the operating machinery

from the effect of applying brakes at the motor shaft, emergency brakes operated by compressed air are mounted on the operating shafts, enclosing the operating pinions. When set, these brakes seize the operating struts and transmit the action of the strut direct to the bearings of the operating shafts, without passing it through a single gear of the machinery. Compressed air for these brakes is furnished by a small electrically driven compressed air unit which is automatically controlled by the pressure of the air in the storage tank. The following is a table of quantities in the superstructure:

Moving parts	1,769,000
Tower	757,800 lbs.
Machinery and trunnions	255,800 lbs.
Total	2,782,600 lbs.
Concrete in counterweight	2,360,000 lbs.

When the bridge is in the fully open position, the counterweights extend about 14 ft. below the base of rail and their inner surfaces are 8 ft. 3 ins. from the centers of adjacent tracks. The operating struts are between the counterweights and the tracks, and when bridge is fully open extend about 12 ft. below the base of rail. This circumstance made it necessary to build retaining walls just beyond the pier to hold the embankment, placing the walls inside the limits of clearance required by counterweights and operating struts. To provide the necessary clearance for the operating struts, the face of the retaining wall was placed at 5 ft. 8 ins. from the center of track, for a distance of 15 ft. 6 ins. adjacent to the pier. This was so close to the track that hand railings could not be erected on top of this section of wall. To safeguard this section, a movable platform hinged at one end and carrying a hand rail, was built level with the top and just clear of the face of the wall. The other end was suspended by a rod from the framework of the counterweight truss bracing directly above. As the bridge opens, the platform, swinging round its hinged end, drops down out of the way of the operating strut, returning to normal position at the top of the wall as the bridge closes.

The pier at the front end of the span consists of two cylinders, 12 ft. in diameter, connected by a concrete girder 8 ft. thick and reinforced with two embedded trusses. The details are similar to those of corresponding parts of the substructure under the tower. All cylinders were carried down by open excavation, to rock about 50 ft. below water level. The lower section of each cylinder was provided with a horizontal diaphragm 8 ft. above the cutting edge, to make a working chamber. In the center of this diaphragm is a circular opening 3 ft. in diameter over which is built up the working shaft, consisting of a steel cylinder 3 ft. in diameter. The horizontal diaphragm is rigidly braced to the section of the cylinder below, with solid webbed radial braces extending from the diaphragm to the lower edge, which is heavily reinforced to make a cutting edge that would not be crushed by hard pan or boulders.

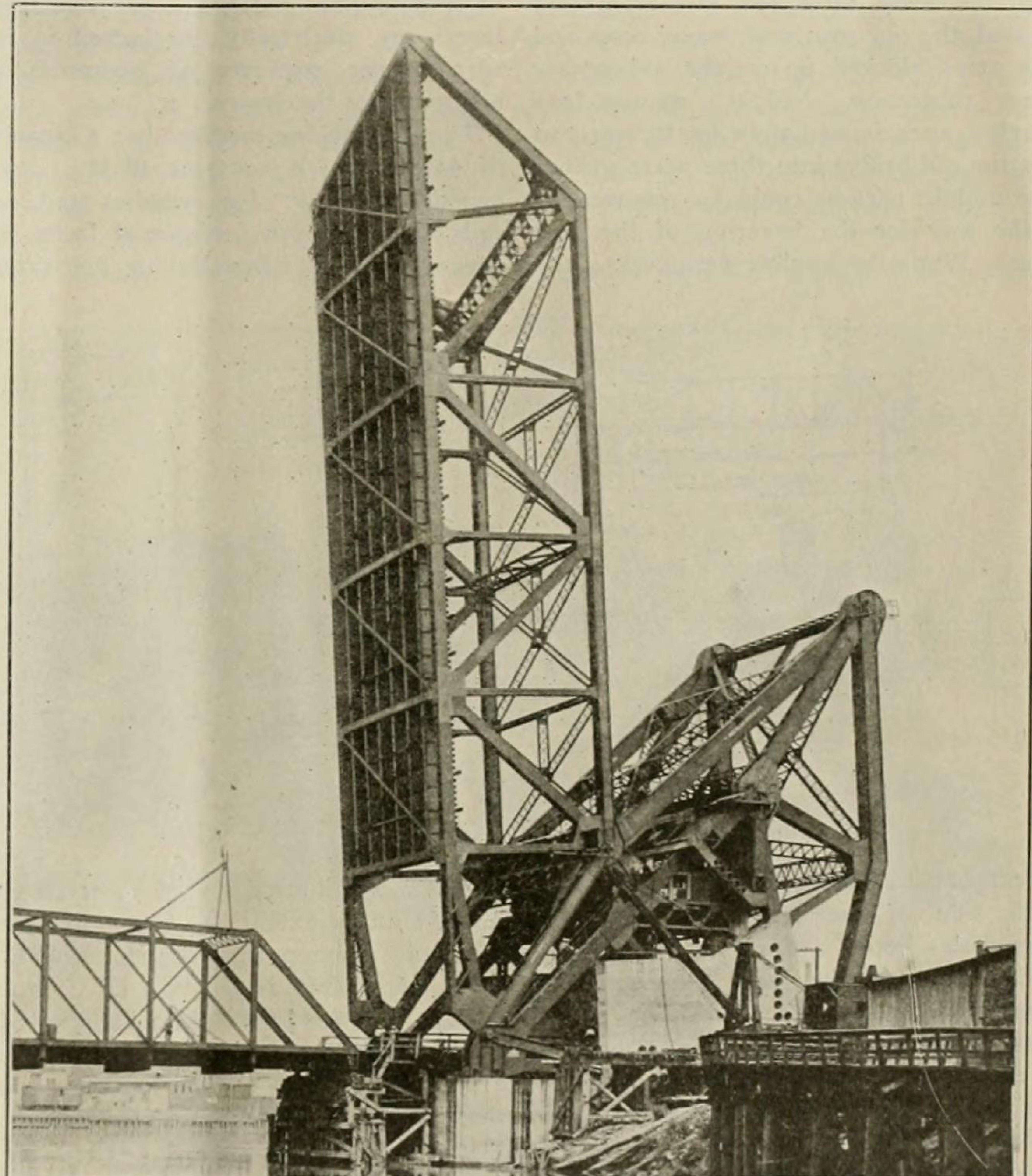
The cylinders were delivered at the bridge site riveted up in sections of about 8 ft. length. As the cylinder was carried down by the excavation in the working chamber, sections were riveted on above, carrying up the working shaft at same time as the large cylinders were handled. As fast as sections were riveted on they were filled with concrete; this gave the weight necessary to overcome the friction against the sides of the cylinder and carry it down, as excavation progressed. As the cylinders approached the final depth, it became necessary to add pig-iron on top of the concrete to overcome this friction and make them sink.

When the cylinders reached their final position on the rock, it was leveled off and cleaned, and the working chambers and shafts were filled with concrete. In the top of each of four of the cylinders 18 track rails 12 ft. long were set, embedded half their length in the cylinder, the other half projecting above the top to be built into the concrete girders, to strengthen the bond between cylinders and girders. These rails were omitted from the two rear cylinders, because the vertical posts of the towers were embedded in the tops of these cylinders and, in addition to doing duty as tower posts, they served the purpose for which rails were provided in the other cylinders.

As the concrete girders were to extend down to 2 ft. below water level it was necessary to enclose the piers in a coffer dam. A dam of sheeting and puddle was constructed on the river side of each pier and run shoreward well into the river bank. The bank formed the fourth side of the dam. The reinforced concrete girders were built in place, inside this dam, on top of the cylinders, first erecting the structural steel trusses, building the forms around them, assembling the reinforcing inside the forms, and proceeding in the usual way with the filling of the forms with concrete.

The bridge was erected in the open position, the usual method of erecting this type of bridge where traffic must be maintained during erection.

As the floor members of first panel (and some bracings between counter-



C. & N. W. RY. DEERING BRIDGE, PREPARATORY TO THE REMOVAL OF THE OLD SPAN. LOWER FLOOR SYSTEM OMITTED TO ALLOW TRAINS TO PASS WHILE ERECTING THE STRUCTURE IN THE VERTICAL POSITION SHOWN.

weight trusses and certain minor parts of the bridge) could not be erected while traffic was still being carried on the old bridge, the plan of erection was to suspend traffic on railway and river while the old bridge was taken out and the new bridge put into service. To make this interruption as short as possible, every member that could be erected was put in place and riveted up before traffic was suspended. Power transmission connections were completed and the operation of the machinery under power was tested. The bridge was also moved through a small angle and the counterbalance adjusted.

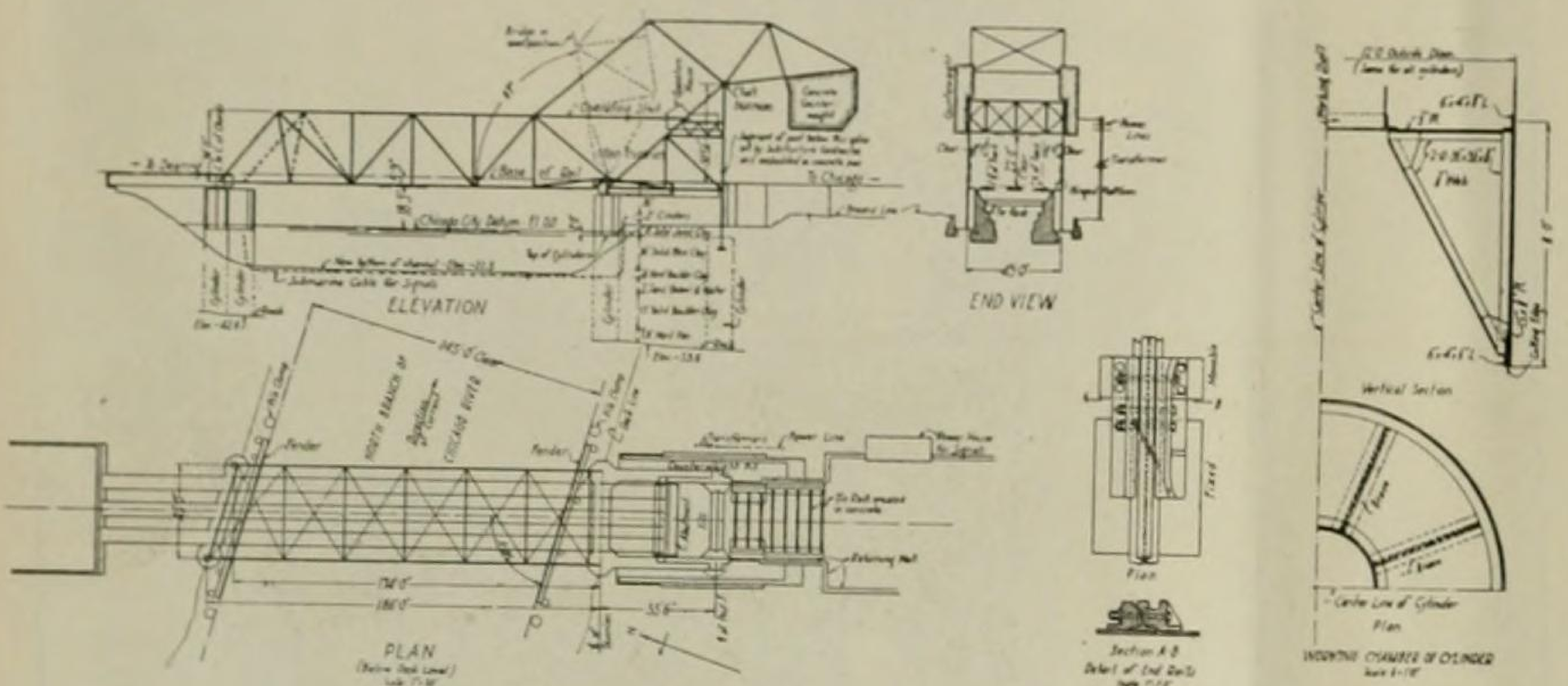
Immediately after the last train had passed, the old span was swung open and the arms blocked up on the old timber pier protection. Eight oxyacetylene torches were immediately set to work to cut the old bridge into three parts so that the middle portion could be removed to make way for the lowering of the new span. While the torches were cutting the span apart, a scow derrick was at work on each side of the span, removing the operator's house, operating machinery and deck. At the same time erectors were busy erecting the remaining members of the new bridge. By 8:00 o'clock in the morning the old span had been cut apart, the middle portion lifted out and taken away on scows, and at 8:15, the time fixed in the schedule, the new span was lowered to the horizontal position.

After lowering the bridge, the few remaining members were erected, the deck completed, and the end rails put on and adjusted. At the same time track gangs were at work re-aligning the tracks on the approaches and raising them to the established grade. By 6:00 P. M. the bridge and tracks were in shape for trains and traffic was resumed, after an interruption of less than 18 hours.

The signal operating mechanism of the bridge is interlocked with the switch and signal system controlling the traffic on all tracks adjacent to the bridge. The system of tracks controlled by the interlocking plant includes the switches about 200 ft. south of the bridge where the three-track system merges into a two-track system; also the switches to a number of industrial tracks on both sides of the river whose turnouts are close to the bridge.

The operating mechanism of the bridge is so interlocked with the signal system that it is impossible to unlock or open the bridge when a signal is given clear for a train, or while a train is within the limits of the interlocking plant. It is also impossible to clear a signal while the bridge is open or unlocked. The interlocking is effected by means of electrically operated locks applied to the controllers of the bridge-lock motor and the bridge operating motors, and to the operating shaft of the engine clutches. All operating levers are electrically interlocked to insure proper sequence of operation in manipulating the levers.

The interlocking machine has a capacity of 44 levers. It contains 18 levers for signals, 16 levers for switches and derails, and 3 levers for special locks between bridge and interlocking apparatus.



DETAILS OF THE DEERING LIFT BRIDGE ON THE C. & N. W.

This leaves 7 unused spaces, reserved for possible future extension of the interlocking plant. The power for operating the interlocking plant is 110 volt D. C. from storage batteries housed in a building adjacent to the tracks and about 100 feet from the bridge. The batteries are charged by motor-generator sets receiving power from the same source as the bridge motors.

The signals installed are of the three-position, upper-quadrant type, conforming to the latest established practice on the Chicago & North Western Railway. Detector bars are installed only at facing points. The usual channel lights are provided for navigation. These are electrically lighted by lamps set on the fenders on either side of channel; also bridge lights at front end of movable span, consisting of lamps with uncolored lenses, suspended in such manner that they hang vertically whatever the position of bridge may be. In front of each lamp is an arc of red and green glass, the red glass being in front of the lamp when bridge is closed. As the bridge opens, the lamp, swinging about its point of support, passes behind the green section of the arc. In addition to the lights required by the government, a special wigwag signal for boats was installed on each side of the span, just outside the lower chord and over the middle of the channel. This is a swinging lamp with a red lens, hooded so that the red light is distinctly visible against the dark background, even in bright day light. The purpose of this signal is to warn approaching boats, by the swinging of the lamps, that the bridge cannot be opened immediately, and that they must come to a stop. The lamps are operated by electric motors in the same manner as the swinging signals which are now much in use at dangerous highway crossings.

The general plan of construction, and the designs of substructure, approaches, interlocking system, and temporary structures, were made by the engineering department of the C. & N. W. Ry., under the direction of Mr. W. H. Finley, Chief Engineer. The superstructure was designed by the Strauss Bascule Bridge Company and built by the American Bridge Company. It was erected by the Kelly-Atkinson Construction Company, and the power and operating equipment installed by Mr. C. H. Norwood. The substructure was constructed by The Great Lakes Dredge and Dock Company. Mr. H. M. Spahr was Resident Engineer in charge of all field work for the railway company.

Oil Fuel for Locomotives.

Twenty-five locomotives have been changed from coal to oil burners on the Florida East Coast Railway. A Clarke burner is used. The fire pans are of the round bottom variety, and slope from back to front so that any surplus of oil accumulating in the pan is drained out at the forward end. A course of brick is set on edge along the sides of the fire pan to protect the lower portions of the side sheets from the intense heat, and also to add to the sealing of the pan at its attachment to the mud ring. Air is admitted at two points through a damper at the front wall of the fire pan, and also through a second damper controlling the supply through the flash hole located about two-thirds of the distance from the burner back to the rear of the pan. This second damper is manipulated by means of a notched lever set in the floor of the cab. Careful comparisons show a saving of 18 per cent. in the cost of fuel resulting from the use of oil.

Increased Demurrage Charges.

The Interstate Commerce Commission, with a view to relieving the freight car situation, has issued a circular announcing that the commission on car service had increased the rate for the use of freight cars to 75 cents a day, operative from December 15, 1916, until May 1, 1917.