Double-Deck Bascule Bridge Over Chicago River

By Hugh E. Young*

SYNOPSIS—The new Lake St. bridge over the Chicago River will be a double-leaf bascule of 245 ft. span, carrying an elevated railway on the upper deck and a roadway (with car tracks) and sidewalks on the lower deck. The bridge itself is of interest, and its construction involved specially interesting and difficult problems, since the elevated railway had to be kept in operation over the old swing bridge during the construction of the new bascule bridge.

The Lake St. bridge, on one of the main thoroughfares entering the business district of Chicago, crosses the south branch of the Chicago River just south of the turning basin at the junction of the north and south branches with the main stem of the river. The present bridge has a three-truss swing span, which was built as a single-deck structure in 1888 and strengthened in 1893 to carry an upper deck for the Chicago & Oak Park Elevated R.R.

The river channel is 235 ft. wide at Lake St., but the swing bridge interferes seriously with navigation, giving a clear channel width of only 65 ft. on each side of the center pier. The United States War Department ordered the removal of the bridge several years ago, as an obstruction to navigation, but owing to the desirability of avoiding interruption to elevated-railway traffic and the difficulty of arranging for a temporary means of crossing the river, the city authorities procured an extension of time. Before this was done, however, studies were made for an incline from the elevated structure to the street level just west of the river, the trains crossing the river on the Washington St. bridge (two blocks south) and then rising again to the elevated structure in North Market St. This scheme was abandoned, as it would be too dangerous to run five-car trains on the streets in the busy district.

It was decided therefore to construct the new bridge in such a manner that the elevated traffic could be continued over the old swing bridge, except occasionally for a few hours at a time and when the inconvenience to passengers would be at a minimum. Plans for this new bridge were well-advanced by the end of 1912 and provided for three railway tracks, but later the elevated railway company decided to have only two tracks. The changed plans and specifications were finished in June, and bids were opened on Sept. 18, 1913, but the lowest bid exceeded the estimate for the bridge.

Owners of patents for movable bridges then claimed that a more economical bridge could be built on their plans, and a commission of three engineers was selected in accordance with a resolution passed by the Finance

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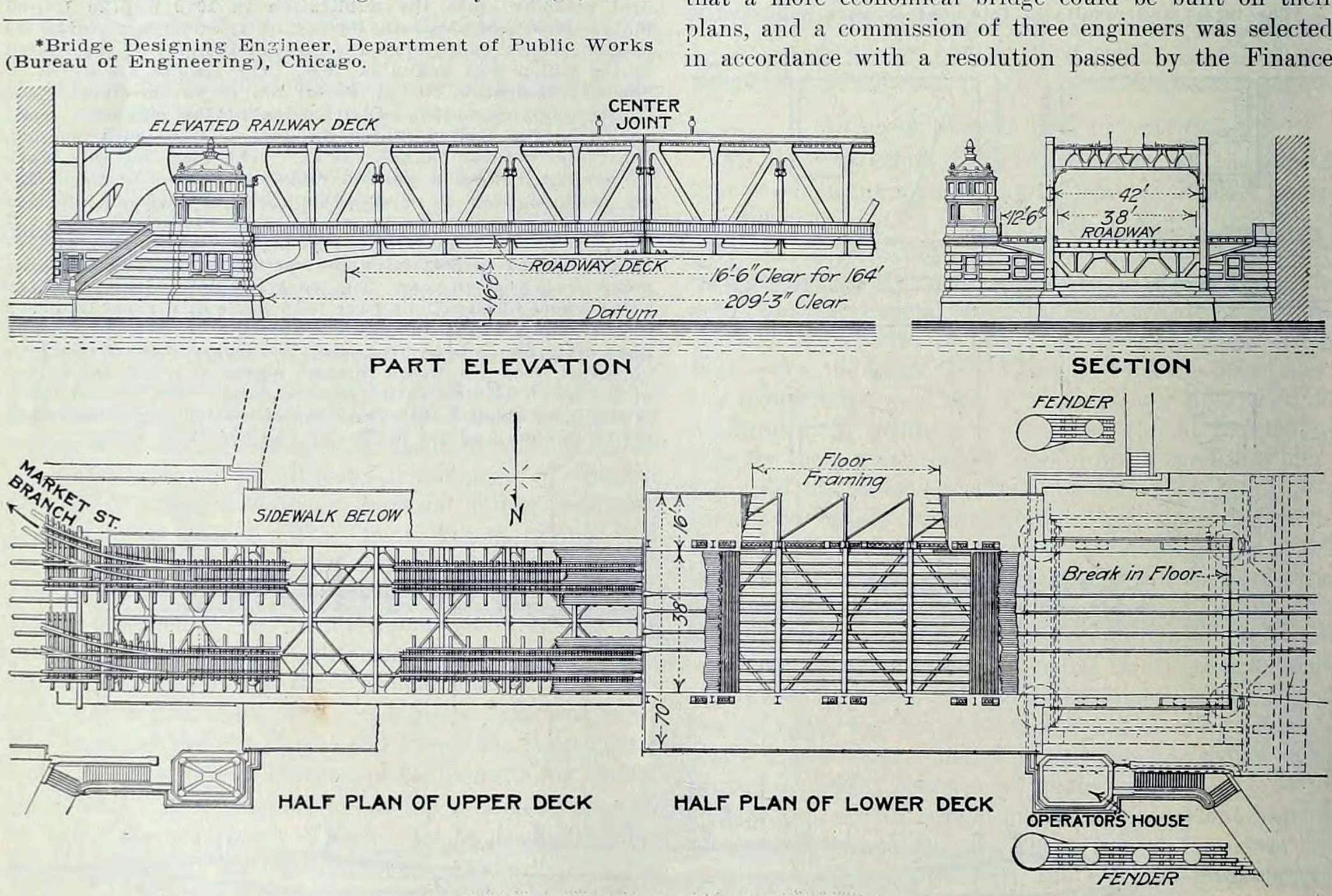

FIG. 1. ELEVATION AND PLANS OF THE DOUBLE-DECK DOUBLE-LEAF TRUNNION BASCULE BRIDGE ACROSS THE CHICAGO RIVER AT LAKE ST., CHICAGO, ILL.

This bridge will carry a roadway, sidewalks and street-car tracks on the lower deck, and a double-track elevated railway on the upper deck

Committee of the City Council on Oct. 24, 1913. This commission consisted of John Ericson, City Engineer; J. E. Greiner, Consulting Engineer, of Baltimore, Md., representing the elevated railway, and W. H. Finley, Chief Engineer of the Chicago & Northwestern Ry. Mr. Finley was selected by the other two members. Competitive plans and estimates were received by this commission for various types of bridges which could be erected without materially interfering with the operation of the existing bridge. These included a double-deck lift bridge and double-deck single-and-double-leaf trunnion bascule bridges.

The lift-bridge design placed the towers straddling the elevated structure on the approaches. The lift span could be erected in place in the open position or erected at the north side of the turning basin and floated into place on scows. The bascule bridges could be erected in the open position without interfering with the swing bridge, by omitting part of the floor system, thus allowing the trains to pass between the trusses. When the bridge was ready to be lowered, traffic would be interrupted long enough to complete the floor system and remove the swing bridge.

The commission recommended a vertical-lift design submitted by the city. On considerations of public policy, however, the City Council recommended the double-leaf bascule bridge (according to the city's plans somewhat revised). Accordingly, the various bids were rejected and the plans and specifications were revised.

Description of the New Bridge

The new bridge (Fig. 1) will have the following main dimensions: 245 ft. c. to c. of trunnions, 217 ft. c. to c. of bearings; clear width of channel, 195 ft.; clear distance between masonry piers, 209 ft. 3 in.; length of counterweight arms, 39 ft.; truss spacing, 42 ft. c. to c.; width over sidewalks, 70 ft.; depth of trusses at center, 30 ft.; clear headway over the water, 16 ft. 6 in. for a width of 164 ft. The lower deck, 70 ft. wide, has two 16-ft. walks and a clear roadway of 38 ft. with two lines of street-car tracks. The upper deck carries the double-track elevated railway.

This type of bridge was chosen mainly because it could be treated architecturally better than any other type, being symmetrical and having the counterweight under the roadway. The counterweight lowers into a tailpit between the river pier and anchor pier. The operating machinery will be placed under the sidewalks at each corner of the bridge and will be inclosed with concrete walls treated with suitable ornamentation. The new bridge is located symmetrically about the center of the present swing bridge and is being erected in the open position. During the construction, traffic on the lower (street) deck of the present bridge is discontinued, street cars being diverted to the Randolph St. bridge, one block south.

The new substructure consists of a tailpit and an abutment on each side of the river. This will be described in a separate article.

Temporary Supports for Elevated Approaches

After the street-railway company had removed trolley wires, rails, etc., from the swing span and approaches, the sidewalk brackets of the swing span were cut off with the acetylene torch, in order to obtain a wider channel with the bridge opened. The operator's house, situated over the sidewalks, had to be removed and a new one erected on the roadway of the lower deck. This involved no great amount of work as the bridge is operated electrically. The old protection (which was almost all broken away) was removed, and a new protection constructed to suit the new channel lines on each side of the center pier.

The approach spans on the street level were removed, the steel being cut with the acetylene torch and removed from the site by scows. Excavation was then started on both

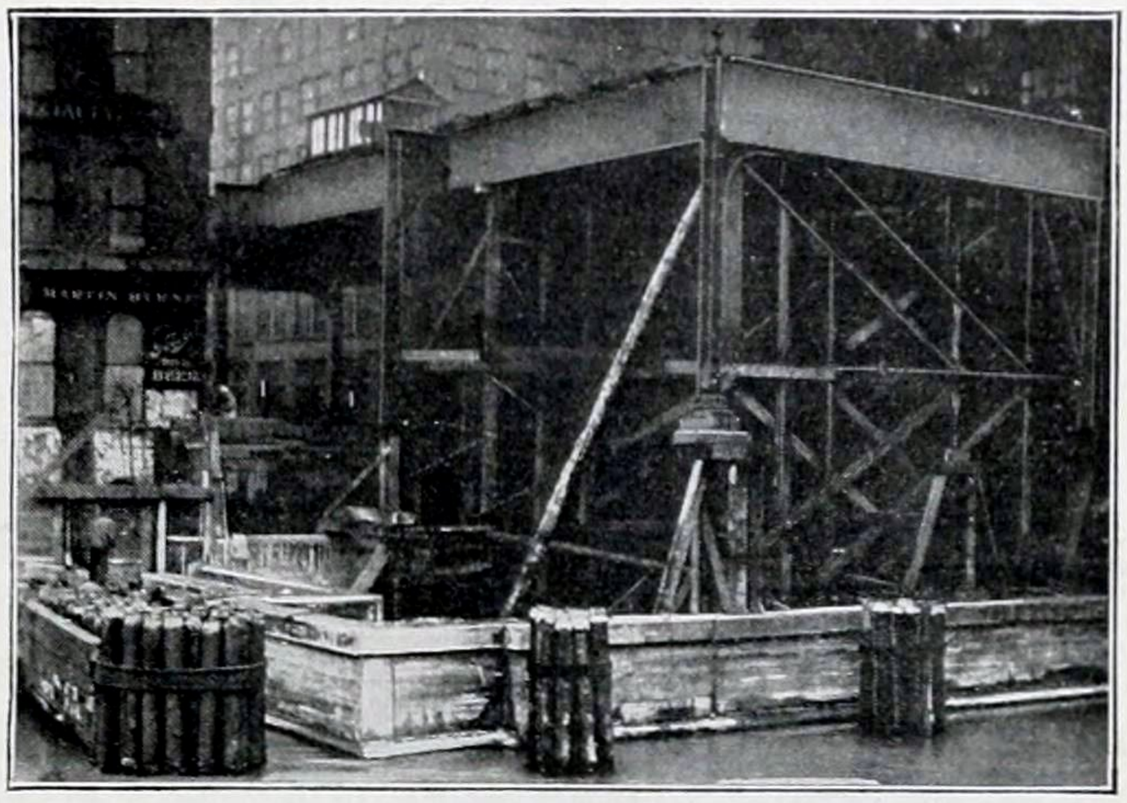

FIG. 2. TEMPORARY SUPPORTS FOR END OF THE EAST APPROACH OF ELEVATED RAILWAY

approaches back of the old abutment. The center part of the old east abutment was removed first. The ends of the abutment were left in place temporarily, as the columns of the elevated structure rested on them.

Timber bents were then erected under the elevated structure, as shown in Fig. 2, which illustrates the east approach. Bents were erected just back of the river pier and in front and back of the abutment. These bents consisted of 12x12-in. posts directly under each girder of the elevated structure, which rested on piles capped just above the water-level surface. Old foundation piles uncovered during the excavation were used for supporting the bents, if suitably located. These were first tested by placing jacks between the bottom of the 12x12-in. posts and the piles. The piles were observed for settlement under this load, and if none occurred during an interval of about a day they were considered suitable for use.

The number of these old piles was due to the fact that, previous to the construction of the present bridge (1888), there had been at least two bridges, both supported on pile foundations. These piles were of a kind not common today, ranging from 18 to 24 in. in diameter at the butt. They were in a remarkable state of preservation, being practically as good as when driven, which must have been nearly 50 years ago. The bents were capped with 12x12-in. timbers, braced with 2x12-in. sway bracing. A batter pile was used in the bent at the river pier.

The columns of the elevated structure were supported on girders spanning the space for the tailpit. These girders rested on groups of piles driven in line with the first and second bents of the elevated structure east of the swing span, as shown in Fig. 3. Each girder consisted of two separate plate girders connected by cross-bracing. Each girder had a 96x$\frac{1}{4}$-in. web plate and four angles 6x6x$\frac{7}{16}$ in.; it was stiffened at points of local load and about every 4$\frac{1}{2}$ ft. at other parts, by 5x3x$\frac{3}{8}$-in. stiffener

angles. Webs were spliced for moment. The overall length of these girders was 78 ft. The double girder for the rear bent was placed first, the abutments having been entirely removed. The girders supporting the front bent and the end of the swing were placed when it was convenient to close elevated traffic for a few hours, as the masonry of the old river pier had to be removed when the swing bridge was open and the bridge could not be closed again for traffic until a new end bearing could be provided.

This work was done July 3, 1914, traffic being closed on the elevated structure from 9 a.m. to 4 p.m. Passengers used the Canal St. station, two blocks west of the river. As soon as the girders were in place, the temporary timber supports under the elevated structure (Fig. 2) were removed.

After the construction of the tailpit, temporary timber bents were erected to support the elevated structure on the east side (Fig. 2). These rested on timbers laid on the pit floor. When these were ready for the elevated structure the box girders were transferred to similar positions on the west side. The girder under the first bent was transferred Dec. 29, when traffic was shut off on the elevated for 7½ hr. The temporary timber bents were removed as soon as the girders were in place.

The contractor for the superstructure started on Jan. 13, 1915, to erect falsework for the erection derrick on the east side and had this practically finished on Jan. 30. This falsework, or tower, required careful study, as the position of supports was not only limited by vertical headroom over the elevated structure, but by lateral clearances of a car swinging around the curve into the North Market St. branch (Fig. 1). This derrick is shown in Fig. 4.

The structural steel began to arrive at the site on Feb. 8. It was delivered on flat cars and unloaded at the railway yard on the north side of the turning basin (just north of the bridge site) where it was stored until needed. Thence it was delivered on scows.

The contractor started as soon as possible to erect the steel of the fixed parts upon which the movable structure rests. These parts consist of two carrying trusses, 48 ft. c. to c., parallel with and just outside the movable trusses.

The machinery girders are 7 ft. back from and parallel with the carrying trusses. The carrying trusses and machinery girders span from river pier to anchor pier, a distance of 53 ft.

The carrying trusses are the supports for the cross-girders (Fig. 5). They also carry the gear trains which are located opposite the racks in the rear arm truss members. The cross-girders are located 14 ft. back of the river pier; they carry the entire dead-load of the bridge, and have a span of 48 ft. c. to c. of carrying trusses, spanning the entire distance across the tailpits.

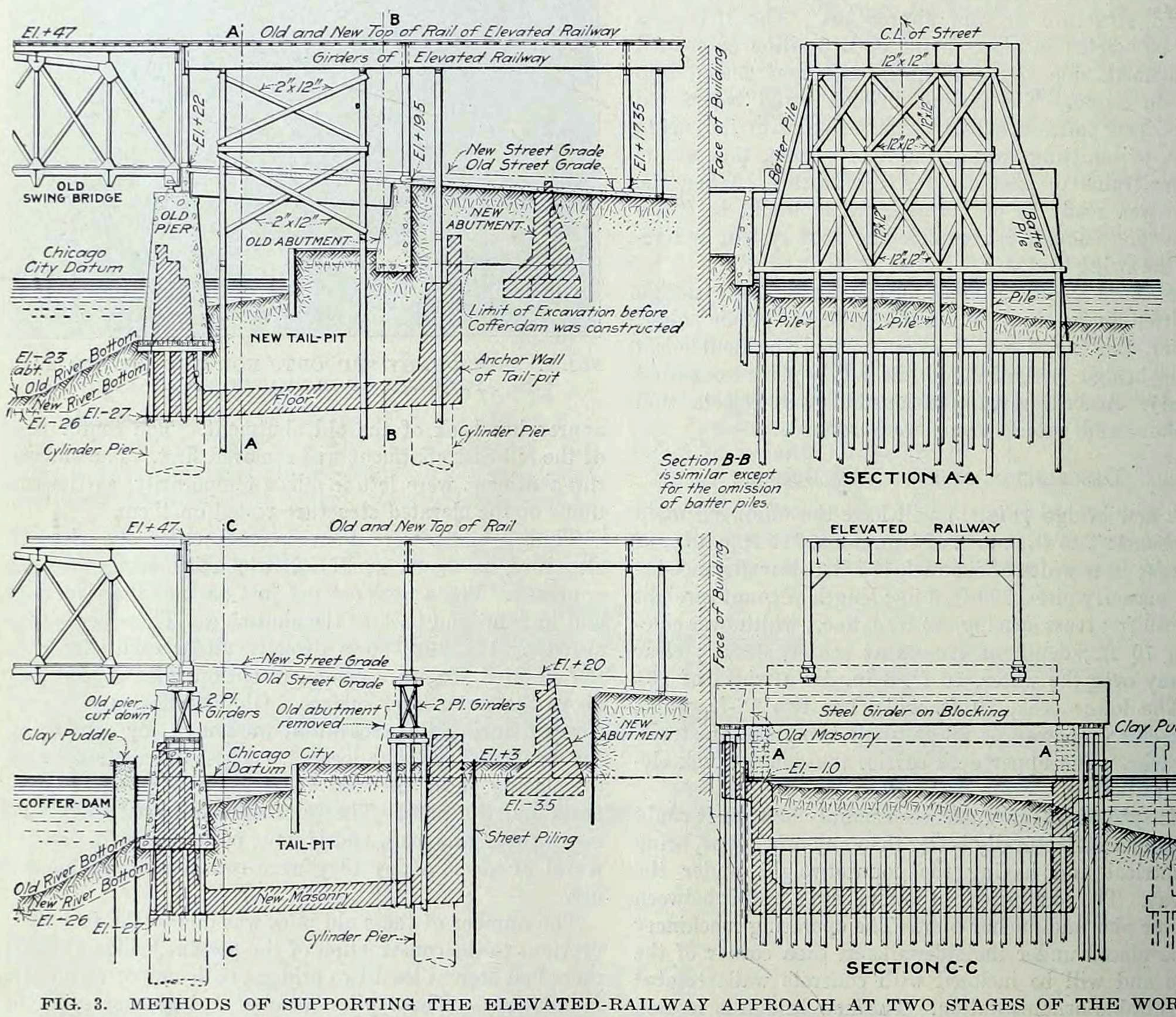

FIG. 3. METHODS OF SUPPORTING THE ELEVATED-RAILWAY APPROACH AT TWO STAGES OF THE WORK

At the time the superstructure contractor began work on the east side the elevated structure was supported on timber bents resting on the floor of the pit (as shown in Fig. 2). These bents were so placed that the contractor could erect the carrying trusses and machinery girders without difficulty. These trusses and girders, being outside of the elevated structure, could be handled by the derrick. The erection of the cross-girder, on account of its weight and its position under the elevated structure, was more difficult.

Additional falsework was built to place the cross-girder. This consisted of A-frames resting on the floor of the tailpit. On the frames were placed two 15-in. channels, forming a runway for sliding the girder across the pit. The girder was lowered from the A-frame to its final position on the carrying trusses by means of jacks.

The fixed portion of the new elevated structure over the tailpits will be supported on new columns, which rest on the carrying trusses about 7 ft. from the center line of the anchor pier (Fig. 1). These columns are in the same place as the old floor-beams, but are located a greater distance out from center line of structure. The old floor-beam was therefore lengthened in order to provide a connection for the new columns.

The steel columns in the bent at the river pier were also moved out, lengthened by splicing on portions of the

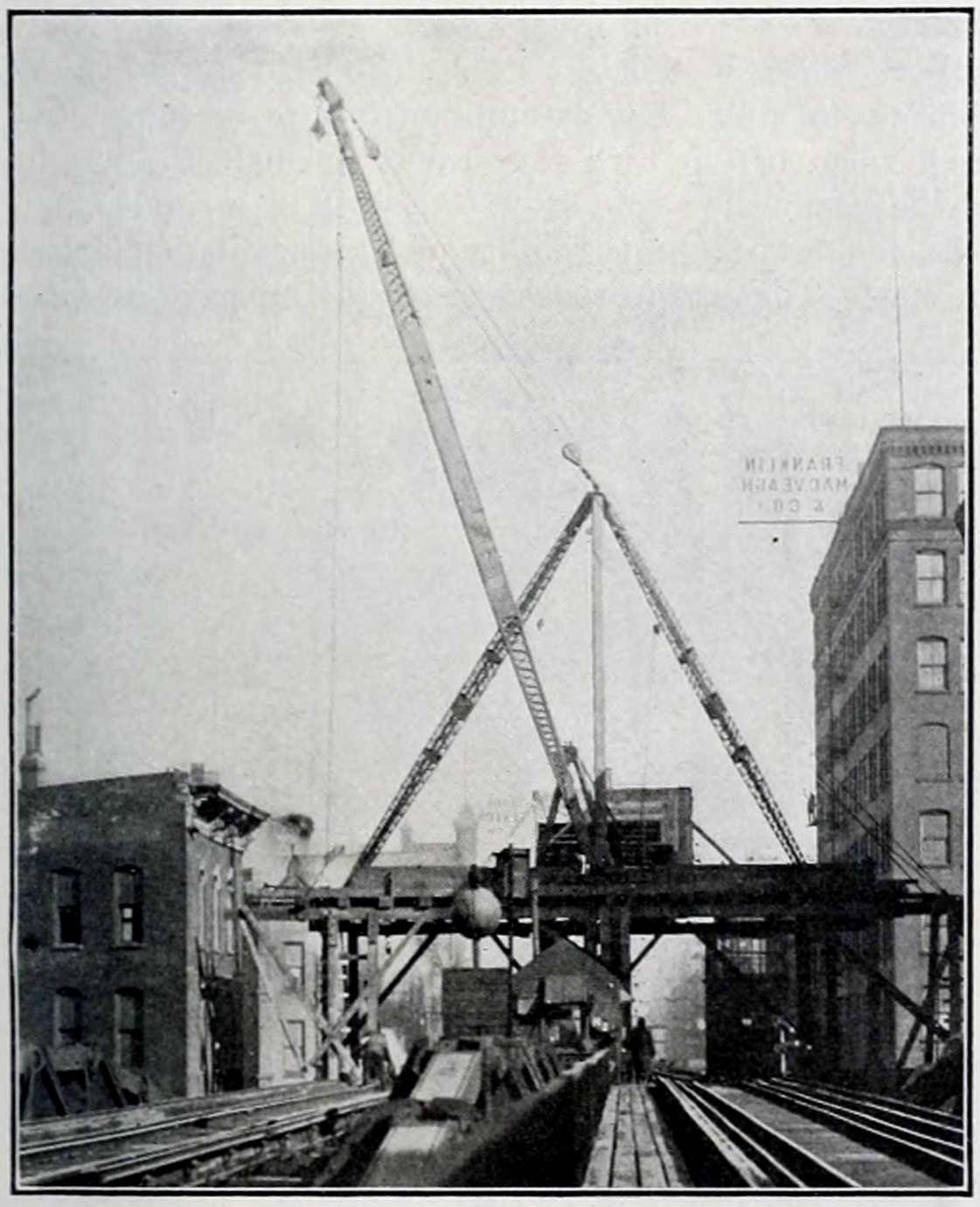

FIG. 4. STIFF-LEG DERRICK OVER THE ELEVATED RAILWAY APPROACH

old columns, removed from the bent near the anchor pier and carried down to a bearing on the carrying truss, the floor-beam of the elevated structure being lengthened as before.

The temporary timber bents under the elevated structure were then removed and the elevated structure carried on the new steel. The erection of the tail end of the bridge was then started, and part of the trusses had been assembled at the time a strike of the structural iron workers was called at the end of April.

During the week ending Apr. 17, 1915, the contractor began erecting his derrick on the west side. This was not placed over the elevated structure but in the tailpit, the mast resting on the floor and the stiff-legs being anchored to the sidewalls of the pit. A strike stopped the work in April and from that time until work was resumed on July 8, 1915, the elevated structure on the west side

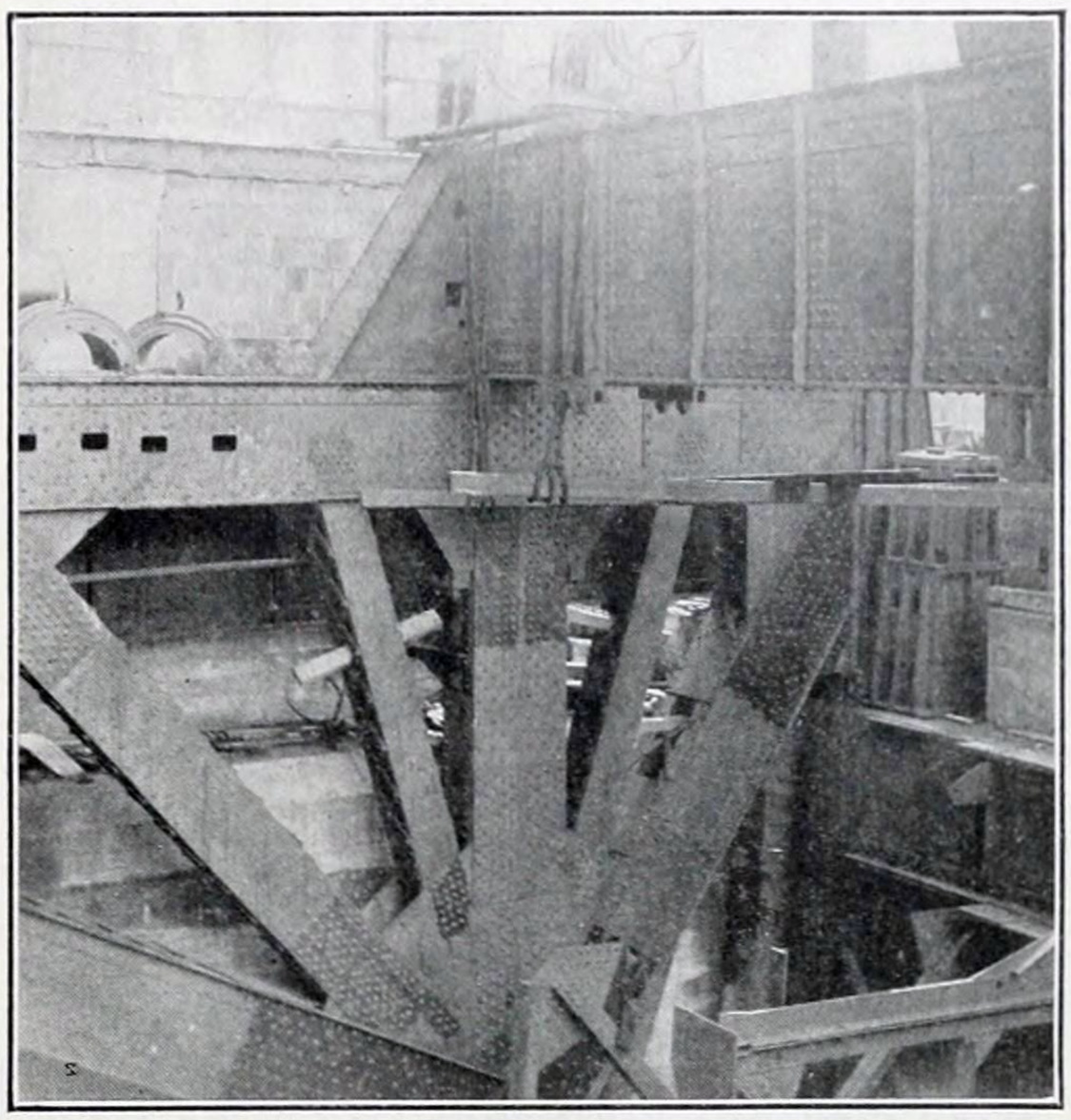

FIG. 5. ONE OF THE TRUSSES OVER THE TAILPIT

rested on two temporary cross-girders, and on the east side on the new carrying trusses with the permanent columns in place for the bent near the anchor pier and temporary bent in place near the river pier.

The leaves will be erected in the open position, a portion of the floor system being omitted to permit of passage of trains. When the leaves are lowered the two spans of the elevated structure over the pits will be removed and the floor system on the upper deck completed.

Engineers and Contractors

The work is under the Department of Public Works, the head of which is W. R. Moorhouse, Commissioner of Public Works. The City Engineer, John Ericson, is head of the Bureau of Engineering, and Thomas G. Pihlfeldt is Engineer of Bridges and Harbor. The final plans were prepared in the Designing Section, under the immediate direction of A. von Babo, Engineer of Bridge Design, and the writer. The construction is supervised by the Construction-by-Contract Section, under Clarence S. Rowe, Assistant Engineer, and the resident engineer on the work is William A. Mulcahy, Assistant Engineer.

The contract for the substructure was awarded to the FitzSimons & Connell Dredge and Dock Co., of Chicago, on Mar. 14, 1914. The contract for the erection of the superstructure was let Mar. 18, 1914, to the Ketler-Elliott Erection Co., of Chicago. The contract for the steel was let to the American Bridge Co.

Substructure of the Lake St. Bascule Bridge at Chicago

By Hugh E. Young*

SYNOPSIS—Foundation work on one of the heaviest drawbridges ever built, a double-deck double-leaf bascule. Anchor piers in open wells. Steel sheetpile coffer-dam for main piers.

The double-deck double-leaf bascule bridge now being built across the river at Lake St., Chicago, was described by the writer in *Engineering News,* Nov. 4, 1915. The substructure consists of a tailpit and an abutment at each side of the river. The tailpit is a concrete box resting in four cylinder piers carried down to solid rock, the walls of the pit acting as beams. The piers are spaced 34 ft. laterally so as to provide for a possible future double-track subway on Lake St. North of the tailpit are foundation walls for the operators' houses. These rest on pile foundations. The abutments are supported on groups of piles driven on each side of the street, and act as beams, spanning the space that would be occupied by a future subway.

The depth of excavation for the tailpit necessitated special care to protect adjacent buildings and the elevated railway structure. Work did not proceed simultaneously on both sides of the river due to the fact that the scows for delivering material and removing excavated material effectually blocked the channel adjacent to the pier under construction, and it was necessary that one draw be left clear for the passage of the river traffic. Work was started Mar. 30, 1914, by the Fitzsimons & Connell Co., contractors for the subway.

General Method of Working

The general method of conducting the work on the east side was as follows: Excavation was carried down to a general elevation of about 3 ft. above datum, giving about 38 to 40 ft. clear headroom under the elevated structure. A land piledriver was rigged up to clear the elevated structure, and all piles were driven. It was occasionally necessary to dig a hole for the point of the pile, in order to get the butt in under the hammer. By doing this piles about 25 ft. long could be driven.

As the four-story brick building on the north side apparently rested on floating foundation, steel sheeting was driven to protect it. The contractor braced the structure by tying the outside walls together by means of rods connected to timbers on the outside faces. During the excavation a reinforced-concrete wall inclosing the subsidewalk basement of the building on the south side of the street had to be removed. This was broken up by light charges of dynamite without any accident. The foundation piles under the operator's house on the north side of the street were also driven.

The coffer-dam was next constructed. This consisted of a double row of Lackawanna steel sheet-piling for the portion in the river and a single row of steel or wood piling for the portion on land. Where channel clearances permitted, two rows of sheeting were driven about 7 ft. apart; but the rows for the front wall of the coffer-dam were 3 to 5 ft. apart. The two rows were tied together with rods and the space between filled and puddled with clay dredged from the river. The sewer on the north side was diverted through a trough outside of the coffer-dam.

A derrick was then erected on the north side to handle the excavation from the coffer-dam. Its mast was carried by a group of piles near the north support of the rear girders supporting the elevated structure, and the stiff-legs were anchored to the coffer-dam. The derrick hoist was erected on a pile foundation outside the coffer-dam.

As the excavation for the tailpit proceeded the coffer-dam was braced by four horizontal tiers of 12x12-in.

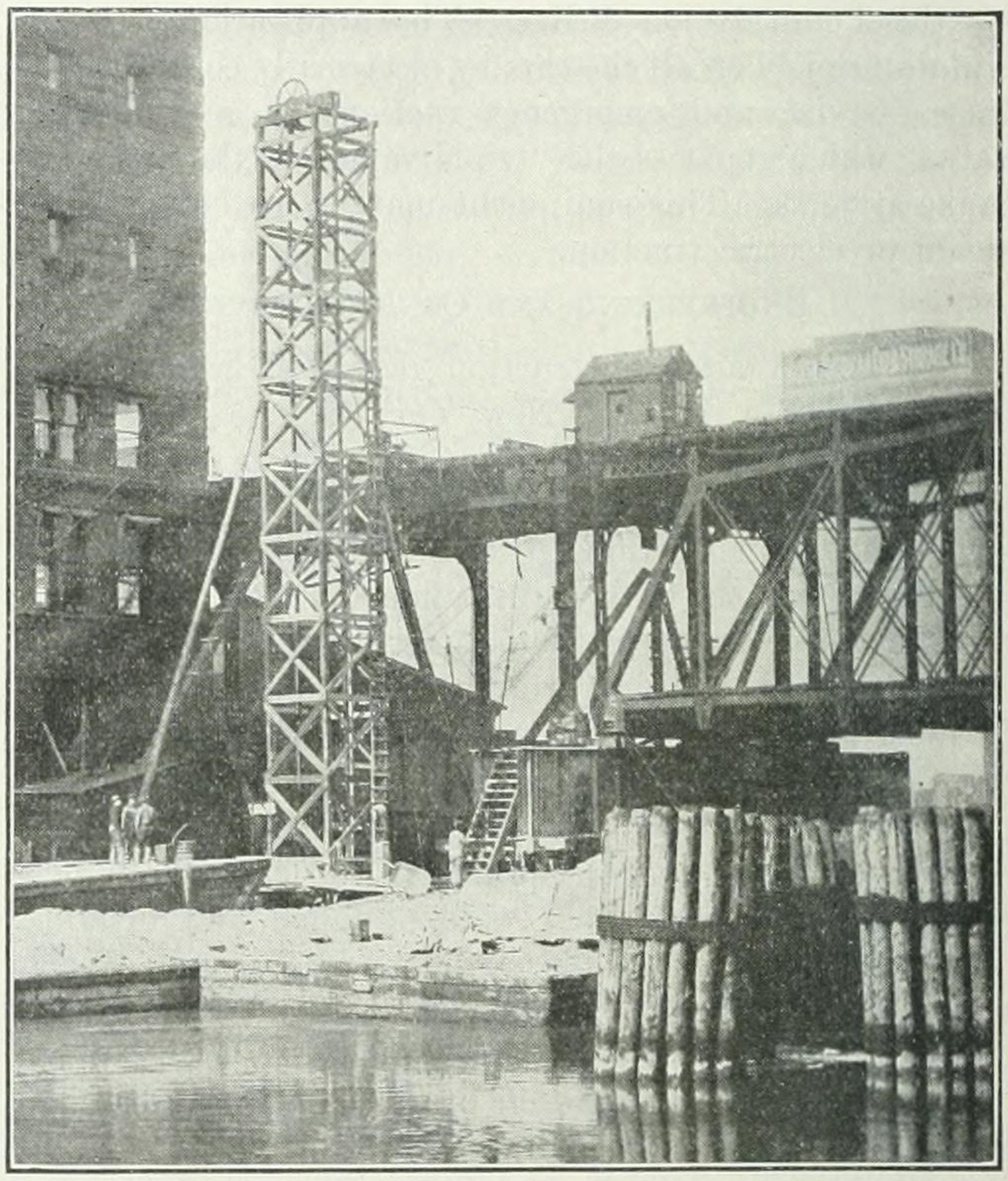

FIG. 1. CONCRETING PLANT AND TOWER

The materials are delivered on scows. The view shows the west end of the old swingbridge, with the columns of the elevated railway approach carried temporarily on a box girder spanning the tail-pit of the new bridge

cross-bracing. One tier of bracing was placed about 18 in. above datum; the others were 6, 13 and 19 ft. below datum. The bracing was supported by means of old piles and partly by suspension rods from the temporary box girders carrying the columns of the elevated approach. The material was loaded into buckets, which were lifted out by the derrick and dumped into a scow alongside the coffer-dam. The excavation was rushed day and night, with men working in three shifts.

When the excavation for the tailpit was practically completed, that for the subpier wells was started. The 8-ft. anchor-pier wells were started first and were dug as open wells, being excavated about 5 ft. at a time and then lined with 3x6-in. tongued-and-grooved maple lagging in

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lengths of 4 ft. 8 in., each length being held in place with two or three rings of 1x4-in. steel. These rings were made in two sections, with a lug bent on the end of each for bolting together. The wells were excavated in this manner to solid limestone rock, the bottom of the well extending 1 ft. into the rock to insure a good bearing.

The material encountered in these wells was blue clay from 20 ft. (where the well started) to about 60 ft. below datum. This ranged from soft clay at the top to very stiff clay at the bottom. From 60 to 75 ft. below datum the material was a mixture of tough blue clay with gravel and boulders; from 75 to 90 ft., a mixture of soft clay and sand; from 95 to 105 ft., gravel and sand. At 105 ft. a water-bearing stratum of sand was encountered, extending to rock at 107 ft. below datum. The quantity of the water was not enough to necessitate an air-lock, the water being removed by a centrifugal pump; but progress was much retarded. It took from Aug. 14 to 28 to excavate these two wells.

Concreting Plant Erected

While these wells were being put down the concreting plant was erected. The mixer plant was placed alongside the dock of the building at the south side of the street, on a pile foundation. In front of the mixer was erected a tower, similar to that shown in Fig. 1 (which is the tower at south side of west coffer-dam), for elevating the concrete to metal chutes that distributed the concrete to the forms. Handling concrete in barrows was unnecessary except for minor parts of the work beyond the reach of the chutes. These chutes were supported from the elevated structure by means of tackle and blocks, and were easily adjusted. Material was delivered to the river plant on scows, being wheeled from the scows in barrows to the mixer hopper.

When the excavation of the wells was completed the concrete filling was started. The concrete was mixed wet and dropped through pipes into the well. The work was inspected at regular intervals during the pouring of the concrete to see that it was being properly filled around the reinforcement and that too much water was not accumulating on top. As the concreting proceeded, the lagging and rings were removed, except for the bottom 15 to 20 ft. of the well. The concreting of the anchor-pier wells was completed on Aug. 31.

Excavation Started

The excavation for the 12-ft. wells for the river pier was started Aug. 31, as soon as the anchor-pier wells were concreted, and proceeded uninterruptedly until Sept. 10, the wells having been carried down to 95.5 ft. below datum. Work was then suspended temporarily, as the contractor encountered some difficulty in getting proper sand for concrete, and decided not to finish the well to rock until the proper materials were available. After a short delay excavation was again started, and rock was reached Sept. 15. Fig. 2 shows the rings and lagging in place, the line of electric lights in the well to illuminate it, and the pump for keeping the well dry.

Concreting was started immediately after the excavation was completed and concrete brought up to 93 ft. below datum, when work was again suspended due to the rejection of the sand by the inspector. This was lake sand from the eastern shore of Lake Michigan, and was finer than that called for in the specifications. After a delay of about a day suitable sand was procured and delivered in cars to a dock a short distance from the bridge, from which place it was brought to the site on scows. The work was then started again, the wells being concreted to the top. The lagging in these wells was left in place from the bottom up to 90.4 and 91.6 ft. below datum for the north and south wells respectively. The wells were completed on Sept. 21.

A bad leak in the south wall of the coffer-dam was noticed on Sept. 14; and it required considerable pumping to keep the water low enough to continue to work. The water entered at the connection of the double row of steel sheeting with the dock, and then through the wood sheeting which forms the part of the coffer-dam on the land. Considerable material was dumped in the river along the

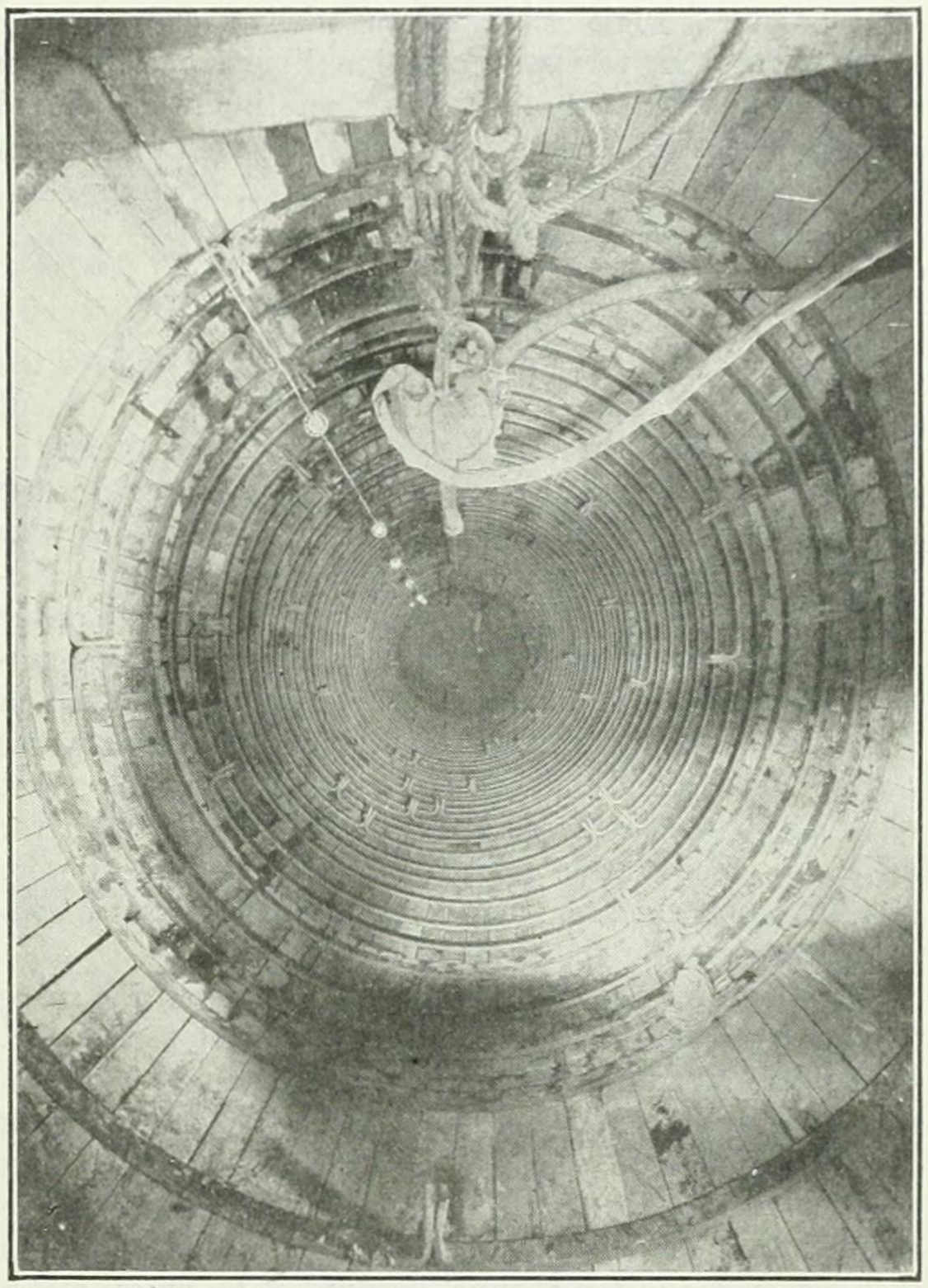

FIG. 2. INTERIOR OF SHAFT FOR ONE OF THE FOUNDATION PIERS

The shaft is 12 ft. in diameter and 107 ft. deep, extending 1 ft. into solid rock. The pump and the electric lights are shown. The shaft is ready to be filled with concrete

dock where the leak started, and finally stopped the leak, on Sept. 24.

Forms for the tailpit proper were prepared at the time the piers were being constructed, and as soon as these piers were finished (Sept. 29) the concreting of the tailpit was started. The floor of the pit, a 5-ft. slab, 62x64 ft., was finished Oct. 3. The construction of the floor requires all piles and other supports for the bracing of the coffer-dam to be cut off above the top of floors, in order to avoid holes in the slab. The bracing is made to hold itself by trussing. The side walls and the river and anchor piers (forming the end walls) of the pit were then brought up to an elevation 1 ft. below datum, and were completed on Oct. 22. The overhanging parts of the side walls were temporarily omitted, so as to clear the piles

under the girders supporting the elevated structure. The outside walls for the operator's house were also brought up to the bottom of the cross walls joining them to the tailpit.

In order to make the pits watertight, a 6-in. layer of cement mortar, made of 1 part portland cement and 2 parts fine aggregate, was placed in the floors and on the outside faces of the walls, up to above datum. The mortar facing on the walls was applied by means of a mortar board, used as a form, which was placed inside the wall forms at the proper distance to give the required thickness of facing, the board being raised as the facing course was carried up with the concrete. The mortar was made in a mechanical mixer, and was delivered in chutes to a box, from which it was carried to the forms in coal scuttles or pails. The concrete was delivered by chutes directly into the forms. From the time the coffer-dam was first pumped out until the concreting was finished the work was carried on continuously, the men working in three shifts, except on Sunday (midnight to midnight), when no work was done.

East and West Abutments

At this stage of the work excavation was started for the west abutment, and the excavation for the east abutment was finished and the forms were constructed. After the concrete in the tailpit had set the girders supporting the elevated structure were shored up on the masonry, as described in the previous article (and shown at *A* in section *CC* of Fig. 3). The piles were cut off so that the overhanging walls and top of the walls under the operator's house could be finished. This work was finished on Nov. 12. The concreting of the east abutment was started Nov. 13 and finished Nov. 25. The concrete plant was then moved to the dock on the west side of the river (Fig. 1). Foundation piles for the west abutment were then driven in the same manner and under the same conditions as those for the east abutment.

The forms for the east tailpit being removed, the space between the coffer-dam and tailpit was filled with water. Under full head of water the pit showed a small leak in the north wall at an elevation of about 1 ft. below datum at the junction of the side wall and overhang. This stopped as soon as silt filtered into the crack, and the pit was then accepted by the city. The coffer-dam was then removed and the channel dredged of all excess material, such as puddling and excavation.

At this same time the west coffer-dam was being constructed and foundation piles for the operator's house were being driven. Excavation was also made for the new portion of the 5-ft. sewer on the west side, and the sewer constructed up to the abutment, where a temporary bulkhead was placed and an outfall constructed under a freight house into the river.

Work on the West Pier

Pumping out of the west coffer-dam started Jan. 11, and as the excavation proceeded the dam was braced as described for the east dam. Excavation for the foundation wells under the west anchor pier was started Jan. 23 and for the river wells Jan. 25. On Jan. 31, due to a rise in the river, the water overflowed the puddle wall of the coffer-dam and partly filled the wells, which were then pumped out. Excavation in the anchor-pier wells was done after the river-pier wells were finished. Water was encountered in the wells at 101 ft. The excavation for the river-pier wells was completed Feb. 7, having been carried to a depth of 109 ft. below datum and 1 ft. into solid rock. Concreting was finished in these wells on Feb. 12, the lagging below 94 ft. and 87.25 ft. below datum being left in place.

The excavation for the north anchor-pier well was completed on Feb. 10 and the south well Feb. 11. They were immediately concreted, work being finished Feb. 15. The lagging was left in place below 82 ft. and 80 ft. below datum for these walls. The tailpit forms were then constructed and concreting commenced Feb. 16. The floor was finished Feb. 20, and by Mar. 6 the walls were brought up to about 1 ft. below datum.

On Mar. 5 a leak developed in the south wall of the coffer-dam adjacent to the building, and this flooded the coffer-dam to river level. This break was repaired and the dam pumped out again.

During the time that excavation for the operator's houses was proceeding the forms for the west abutment were erected and the wall was concreted. This work was started Mar. 12 and finished Mar. 19. The box-girder supports of the elevated structure were then blocked up on the masonry and the overhanging walls and operator's house walls concreted, finishing Mar. 29. As a precaution against freezing the finished work was covered with tarpaulins.

The test of the west pit was made Mar. 31, and the coffer-dam was removed Apr. 2. The plant was then removed, docks were repaired where they had been cut for the coffer-dam, backfilling was placed, the permanent pier protection constructed, and the site cleaned up. The substructure contract was completed Apr. 28, or about 13 months after starting work. The girders supporting the elevated structure on the west side were left in place.

Activities at a War Port

Engineers on this side of the ocean who are concerned in the development of port works in an orderly, and sometimes in a dilatory, fashion will be interested in the feverish activity forced upon the port authorities of Archangel, Russia, in order to make that port equal to the greatly increased trade of the war. United States Commercial Attaché H. D. Baker reports upon this activity as follows:

> Information has been received of continued improvement in conditions at Archangel since the time of my visit there early in August. Notwithstanding increasing arrivals of steamers, the goods are shipped out now within a reasonable time after they arrive, and considerable cotton and other merchandise that had accumulated there early this year have now found their way to interior destinations.
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> It is reported that very good progress has been made during the last month in railway improvements between Vologda and Archangel. It is possible now to run broad-gage cars from any part of Russia direct to Archangel, and for half the distance from Vologda to Archangel the line is double-tracked. The narrow-gage line will be retained, so that it will still be possible to make use of the narrow-gage equipment. Rapid progress is also being made on the line through Lapland between Kandalaksha and Kola. It is expected that it will be possible to run cars over this line after Jan. 1, 1916, so that Kola during the winter season can be substituted for Archangel as a port, there being no heavy ice there as there is at Archangel.
>
> Three cargo ice breakers, one of 2,500-ton capacity and two of 500-ton capacity, will be put on the run for the winter season between Kandalaksha and Sorotskoe, the voyage probably taking about 24 hr. each way. Owing to their limited capacity, the ice breakers will probably be reserved for freight urgently required by the government service.

way to the job, where it was dumped on the subgrade. The requirements of the traprock were that it should have a French coefficient of wear of at least 17, and should be the run of the crusher that would pass a 1½-in. ring and be retained on a ¼-in. screen. The sand used was dredged sand of exceptionally good grading, with the larger particles nearly ¼ in. in size. By using this sand with the graded stone the theoretical grading of the aggregates of the concrete was nearly perfect, and a very dense concrete resulted. A representative of the Bureau of Standards, who made a number of tests to determine the movement of the pavement, declared that the density of this concrete was greater than any he had previously drilled.

In view of the well-known diversity of opinion as regards the spacing of expansion joints, it was decided to place them on this road only when the mixer was shut down for 15 min. or longer. This resulted in some long slabs—in some cases reaching as great a length as 460 ft.

The specifications permitted the use of "any machine devised to finish pavement." On Section 1 a power screed, manufactured by the R. D. Baker Co., was employed successfully. On the other sections hand screeds made by bending 4x4x½-in. angle iron are used.

As soon as the concrete is finished, it is protected from the sun and wind by canvas-covered frames. As soon as possible after the concrete becomes hardened it is covered with 2 in. of earth and kept wet for 14 days. No traffic is allowed on the concrete pavement for at least 30 days.

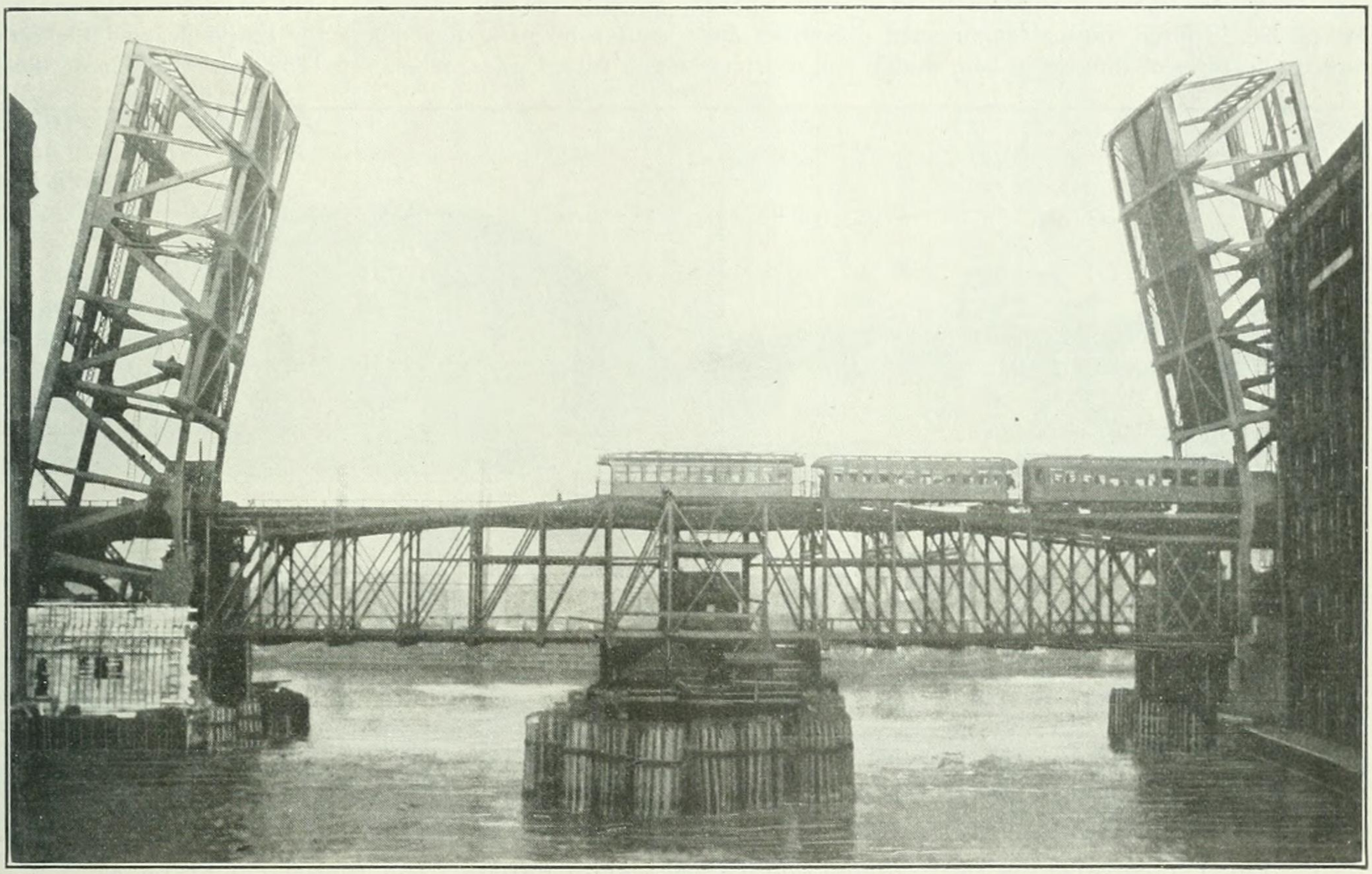
Each of the four contract sections is inspected by a resident engineer, who reports to the Chief Engineer, Charles Upham. Associated with Mr. Upham is C. D. Buck, Superintendent of Construction.

Renewing a Drawbridge Across the Chicago River

The new double-deck bascule bridge and the old center-pier double-deck swingbridge over the Chicago River at Lake St. are shown in the accompanying view, which represents the condition of work a month ago.

The old swingbridge is kept in service to carry the elevated-railway trains, but the roadway is closed to traffic. The bascule bridge was erected with its leaves in the raised position, the deck and bracing of one panel in each leaf being omitted to allow trains to pass through until the bridge is ready for operation. Then traffic will be stopped for a short time while the old bridge is removed and the floor system of the new structure is completed.

The bridge is of the trunnion bascule type, with a span of 245 ft. c. to c. of trunnions, giving a width of 209 ft.



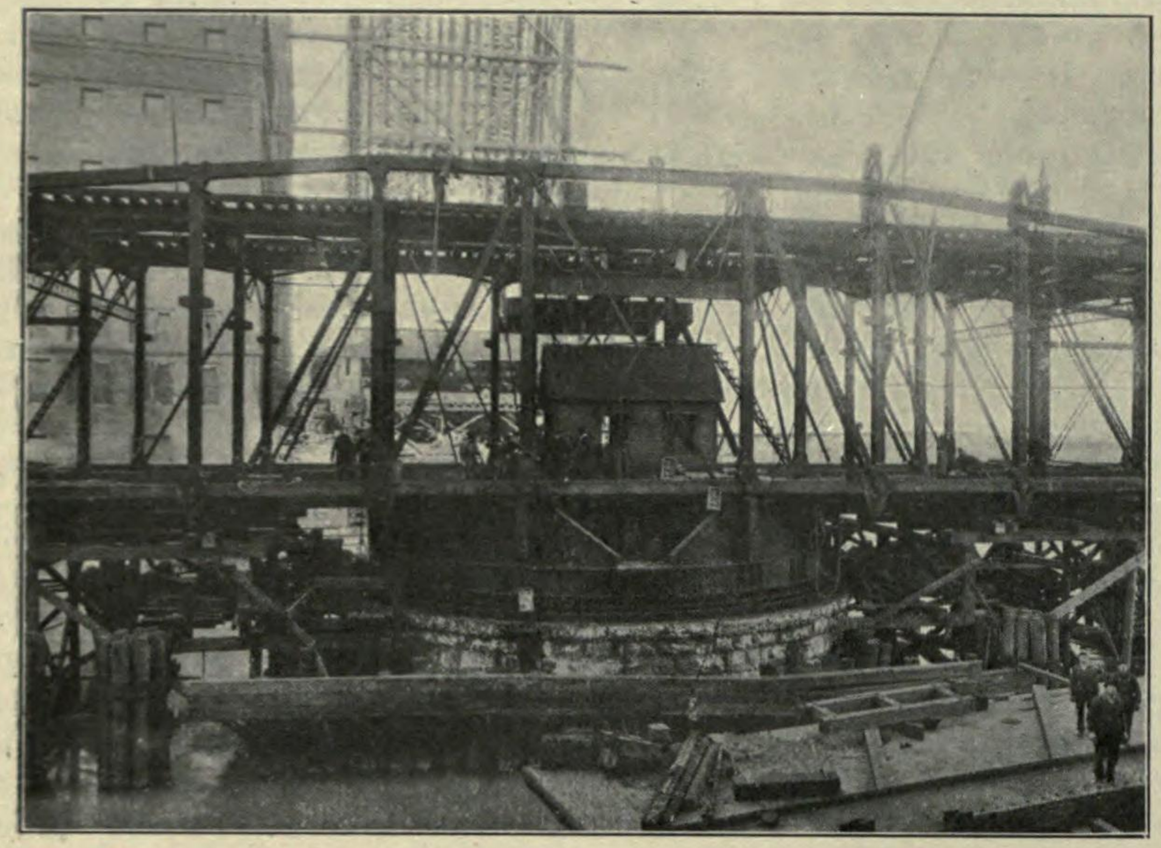
OLD AND NEW DRAWBRIDGES OVER THE CHICAGO RIVER AT LAKE ST.

between the piers for a channel 195 ft. wide in the clear. The old bridge gives two channels only 65 ft. wide. The trusses are spaced 42 ft. c. to c. and are 30 ft. deep at the center. On the lower deck are a 38-ft. roadway (with car tracks) and two outside 16-ft. walks; on the upper deck is a double-track railway between the trusses.

The bridge was designed and built under the direction of John Ericson, City Engineer, and Thomas G. Pihlfeldt, Engineer of Bridges and Harbor. The contractors were the Fitzsimons & Connell Dredge and Dock Co. for the substructure, the American Bridge Co. for the steelwork, and the Ketler-Elliott Erection Co. for the erection. The steel was stored on the dock shown beyond the center pier and was floated into place on lighters.

The bridge and its construction were described fully in *Engineering News,* Nov. 4 and 11, 1915.

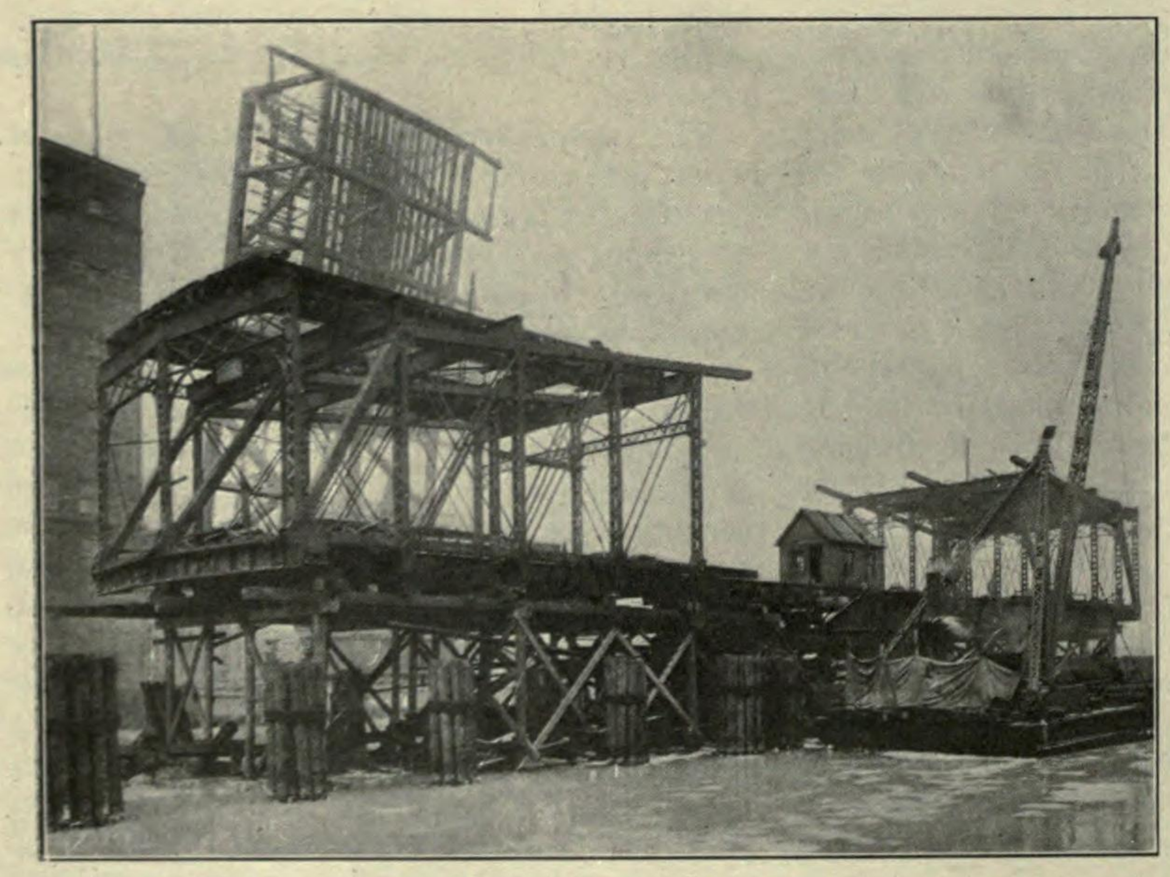
and moments along the rails for a given loading, (2) the division of vertical load among adjacent ties for a given loading, (3) the distribution of vertical pressures among the ties, through the ballast and over the roadbed, (4) the depression, compressibility or thickness of the track, (5) the effect of wheel spacing of some types of locomotives and also the effect of single and double concentrated loads, (6) the effect of speed from most of the foregoing items. Tests have been conducted at 65 miles per hour. Among the variables of the track were three weights of rail, two sizes of



STARTING TO CUT OUT CENTER OF OLD DRAW BRIDGE

ties and three depths of ballast. In addition to tests on standard track, minor tests have been made at spots where uneven tie spacing or worn or decayed ties might effect the stresses developed.

Considerable progress has been made in the development of instruments for determining the stresses. This has required con-



ENDS OF THE OLD SPAN WILL BE CUT UP AT LEISURE

siderable painstaking experimental work, and the calculation and compilation of the results of the test have also proved to require a great deal of time. The data are now being put into shape, and it is expected that the results will be ready soon for the consideration of the committee. Meanwhile the committee plans to continue the tests during the coming season, to complete the matters already partly covered and to extend the experiments to include other features, like action on curves and on tracks of different kinds. It proposes to report soon to the association the results of the tests already carried out. (Bulletin 182.)

Double-Deck Trunnion Bascule Bridge Put Into Use

Central Portion of Thirty-Year-Old Center-Pier Draw Span Cut Out with Oxyacetylene Torches in 1½ Days at Chicago

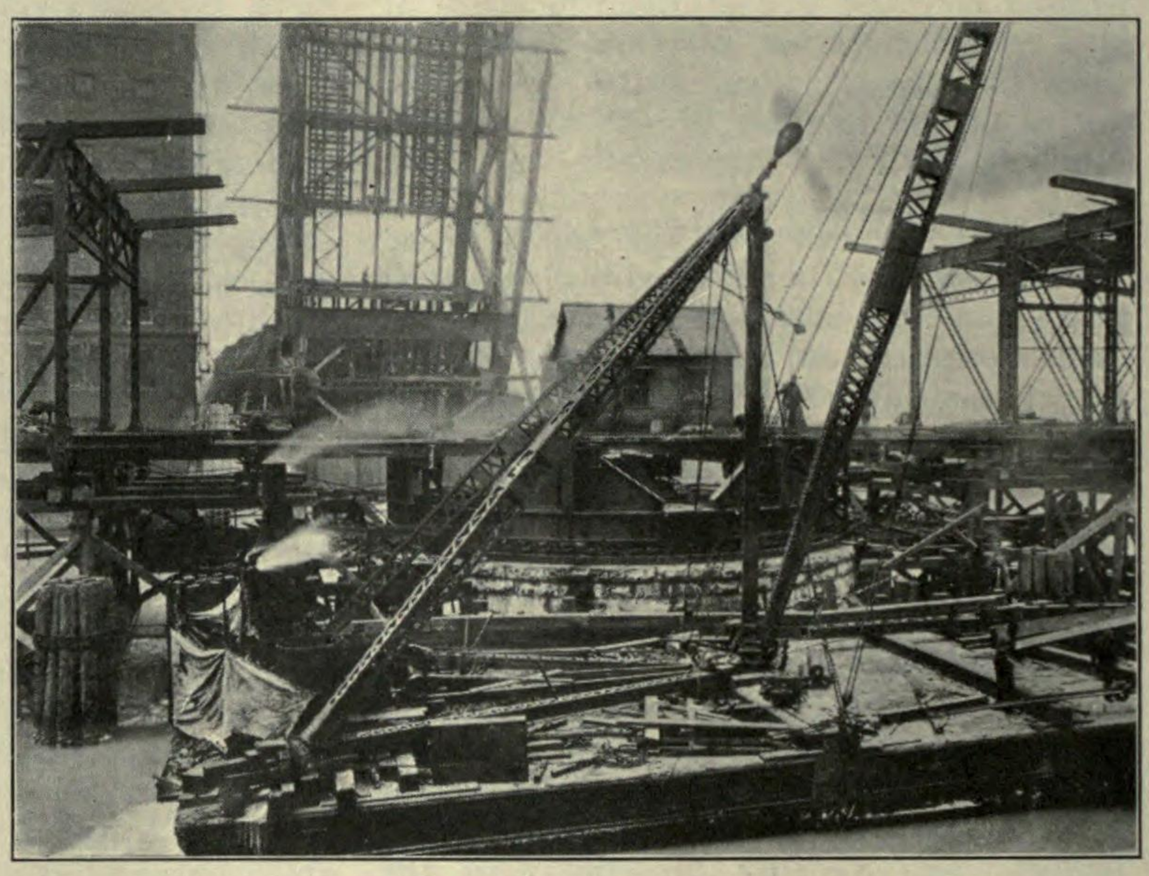
LESS than four days' time was required to replace the old double-deck, center-pier, iron draw span across the Chicago River at Lake Street with the new double-leaf, double-deck trunnion bascule bridge. The new bridge is 245 ft. 3 in. long between the centers of the trunnions and 70 ft. wide over all. It was erected around the old structure, while traffic on the Chicago & Oak Park Elevated line was maintained through the new leaves which were erected in a vertical position.

The program for the shift from the old bridge to the new was as follows: On Saturday, Feb. 26, at midnight, the elevated traffic was stopped over the old span and the elevated company immediately proceeded to remove the rails. The lower roadway deck had been closed during practically the whole period of erection.

On Sunday, Feb. 27, at 6 a. m., the draw span was swung into the river position and blocked up on falsework. The center portion of the old span interfering with the lowering of the leaves of the new bridge was then burned out utilizing several Oxweld acetylene torches. The sections were removed by a crane on a barge, and by noon the next day all that remained were the ends resting on the piling. The old panels of the elevated structure on each side of the river were removed and in the meantime floorbeams and stringers were placed in two panels of each leaf of the new bridge which had been omitted during construction to allow the passage of elevated trains.

While these operations were taking place the old viaduct just west of the bridge was moved south, transversely, about 4 ft. to allow the construction of the north leaf of the new viaduct in its final position. To permit uninterrupted elevated traffic during the construction of the new viaduct, an additional track will be placed on falsework south of the viaduct.

The whole of the center span panel had been removed by Monday noon and adjustments and alignments of the new leaves started. Various specified trial operations of the leaves were carried out Monday and Tuesday, until the center locks, rear locks,



BY THE NEXT NOON THE CENTER SPAN HAD BEEN REMOVED

anchorage bearings, supports on the river piers, brakes and other portions of the operating machinery worked satisfactorily.

Ties had already been placed on such portions of the new leaves as had been possible. Tuesday night the elevated company put down the rails and the new bridge was ready to care for traffic Wednesday.

The Fitzsimons & Connell Dredge & Dock Company with P. G. Connell, superintendent, was the contractor for the substructure, which was begun in March, 1914, and completed in April, 1915. The contractor for the superstructure was the Ketler-Elliott Erection Company, for which George Hoersch is superintendent.

The work was carried out under the general direction of John Ericson, city engineer. Thomas G. Pihlfeldt is bridge engineer, Alexander Von Babo, engineer of bridge design; Clarence S. Rowe, assistant engineer of bridge construction, and William A. Mulcahy, assistant engineer in local charge.

EXCAVATION FROM THE BASES of the Culebra slides of the Panama Canal during the week ending March 6 amounted to 246,011 cu. yd., according to a report in the *Canal Record.*