High Viaduct 3 Miles Long Will Complete Gap in Holland Tunnel Road

Highway Crossing of Passaic and Hackensack Rivers and Meadows Calls for an Elevated Steel Structure Costing Nearly Twenty Million Dollars

A STEEL viaduct and high-level bridges across the Hackensack and Passaic rivers is the finally adopted plan for the trunk highway which is to take the Holland tunnel traffic across the present gap between the completed viaduct and subway section of this road in Jersey City and the completed section through Newark toward Elizabeth. A general description of the route and tentative plans for the road structure between Jersey City and Newark, and of the completed road structure in Jersey City, was published in *Engineering News-Record,* Jan. 3, 1928, p. 4. The Jersey City-Newark gap at that time was in process of consideration and negotiation with the U. S. Army Engineers and the state authorities over navigable waters in regard to type and design of the river crossings. The present plan described here is the culmination of these negotiations and of the continued engineering studies of the New Jersey Department of Highways.

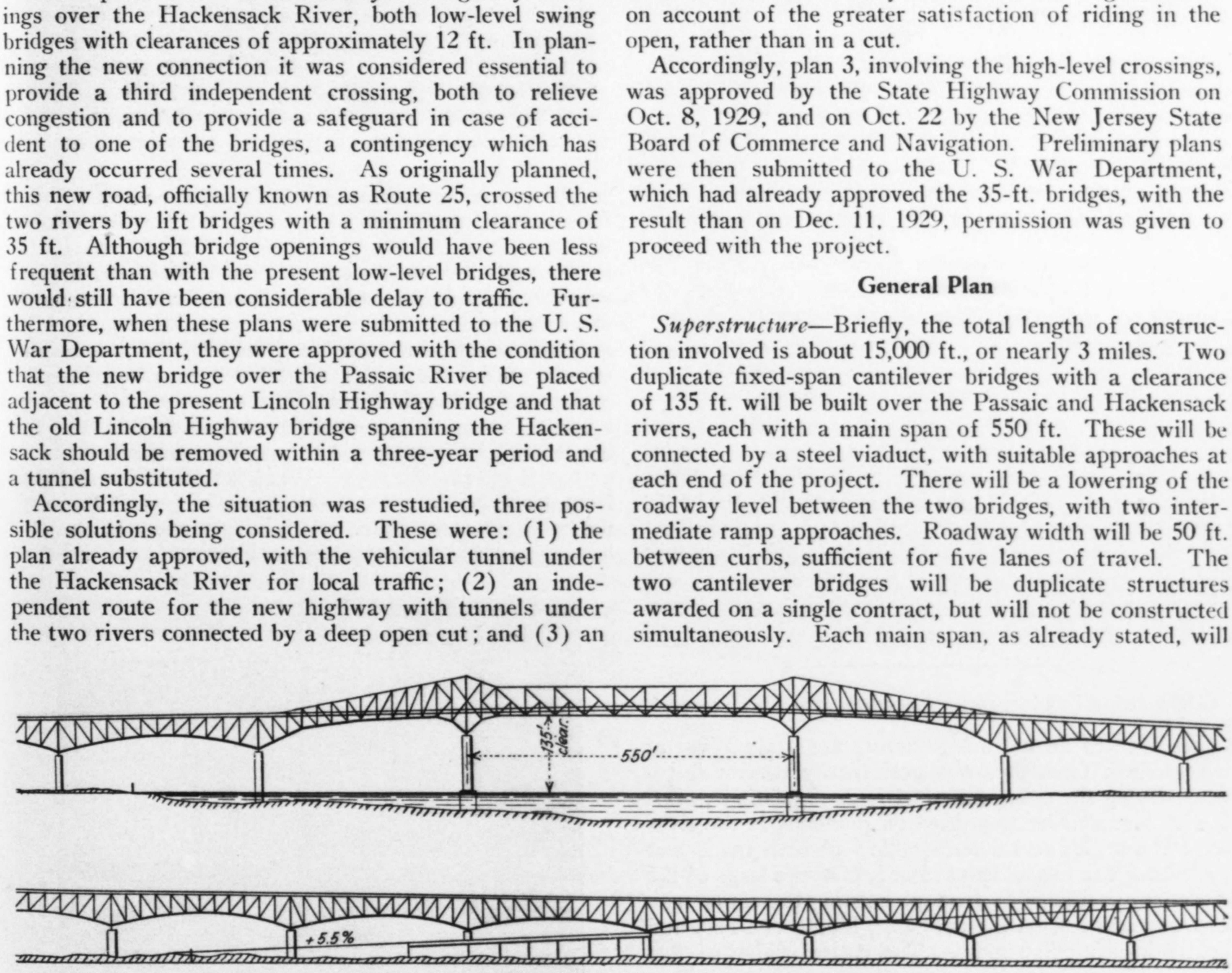
At the present time there are only two highway crossings over the Hackensack River, both low-level swing bridges with clearances of approximately 12 ft. In planning the new connection it was considered essential to provide a third independent crossing, both to relieve congestion and to provide a safeguard in case of accident to one of the bridges, a contingency which has already occurred several times. As originally planned, this new road, officially known as Route 25, crossed the two rivers by lift bridges with a minimum clearance of 35 ft. Although bridge openings would have been less frequent than with the present low-level bridges, there would still have been considerable delay to traffic. Furthermore, when these plans were submitted to the U. S. War Department, they were approved with the condition that the new bridge over the Passaic River be placed adjacent to the present Lincoln Highway bridge and that the old Lincoln Highway bridge spanning the Hackensack should be removed within a three-year period and a tunnel substituted.

Accordingly, the situation was restudied, three possible solutions being considered. These were: (1) the plan already approved, with the vehicular tunnel under the Hackensack River for local traffic; (2) an independent route for the new highway with tunnels under the two rivers connected by a deep open cut; and (3) an independent route with high-level fixed-span bridges having a clearance of 135 ft., connected by a viaduct. The two latter plans would leave the present bridge status unchanged. Preliminary plans and cost estimates were prepared for each of these proposals. Construction costs, including real estate expense, were estimated as follows: plan 1, $20,310,000; plan 2, $21,414,000; plan 3, $19,625,000. Estimates of comparative annual costs of operation, including maintenance of structures and machinery, operation of machinery, lighting and policing, and depreciation, were: plan 1, $356,800; plan 2, $468,300; plan 3, $398,300. Estimates of the annual costs of vehicular operation, comprising items of distance, rise and fall in grade, and delays due to bridge operation, also favored the high-level plan, the comparative figures being as follows: plan 1, $1,172,000; plan 2, $810,000; and plan 3, $760,000. In addition, it was considered that motorists would favor the high-level project because of the elimination of delay at the river crossings and also on account of the greater satisfaction of riding in the open, rather than in a cut.

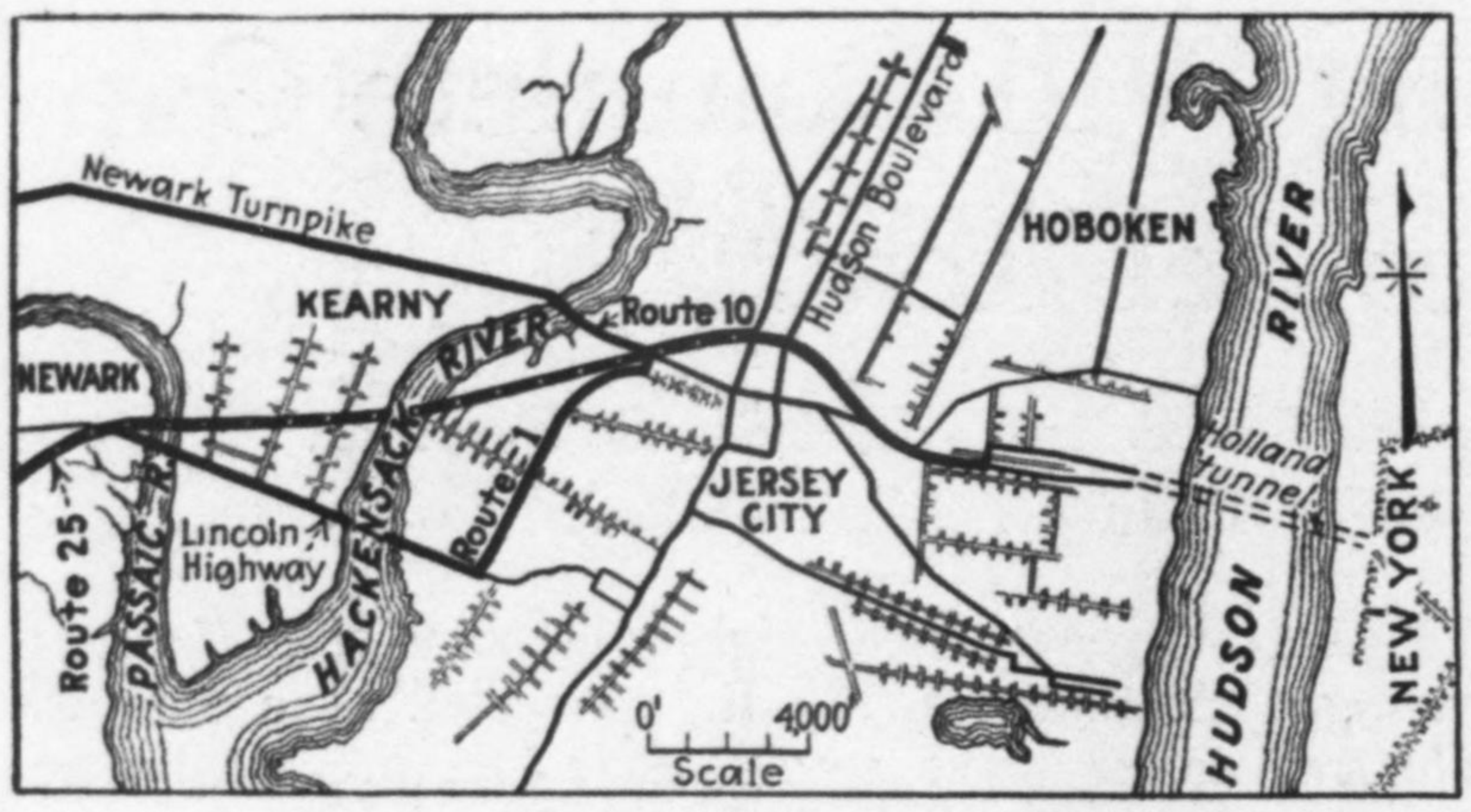
Accordingly, plan 3, involving the high-level crossings, was approved by the State Highway Commission on Oct. 8, 1929, and on Oct. 22 by the New Jersey State Board of Commerce and Navigation. Preliminary plans were then submitted to the U. S. War Department, which had already approved the 35-ft. bridges, with the result than on Dec. 11, 1929, permission was given to proceed with the project.

General Plan

Superstructure—Briefly, the total length of construction involved is about 15,000 ft., or nearly 3 miles. Two duplicate fixed-span cantilever bridges with a clearance of 135 ft. will be built over the Passaic and Hackensack rivers, each with a main span of 550 ft. These will be connected by a steel viaduct, with suitable approaches at each end of the project. There will be a lowering of the roadway level between the two bridges, with two intermediate ramp approaches. Roadway width will be 50 ft. between curbs, sufficient for five lanes of travel. The two cantilever bridges will be duplicate structures awarded on a single contract, but will not be constructed simultaneously. Each main span, as already stated, will



TYPICAL SECTIONS OF PROPOSED ELEVATED VIADUCT
Top—One of two duplicate cantilever bridges. Bottom—Viaduct section showing intermediate ramp.



NEW JERSEY CONNECTIONS WITH THE HOLLAND TUNNEL
Existing roads shown by full lines; proposed routes by heavy broken line indicated as Route 25.

be 550 ft., with suspended spans of 350 ft. Cantilever bridges are favored to avoid the necessity of erecting falsework in the rivers. The viaduct will consist, for the most part, of 300-ft. spans, except where variation is necessary on account of local conditions. Alternate spans of the viaduct will be of the fixed and cantilever types.

Foundations—Throughout the length of the project the soil structure consists of layers of muck over clay, sand and mixed sand and gravel, with bedrock at depths varying from 25 ft. at the Hackensack River to a maximum of 130 ft. at one point in the Kearny Peninsula, between the two rivers, decreasing to 70 ft. at the Passaic River. Present plans call for the use of concrete piles for the shallower foundations, with pneumatic caissons for depths varying from 90 to 130 ft.

Erection Schedule—The project will be divided into a number of contracts comprising three sections, of which the first, from the intermediate ramp in Kearny to that in Jersey City, will be completed and put into operation as soon as possible in order to provide a third independent crossing over the Hackensack River. The second section will complete the Jersey City end; the third, the Newark end, including the Passaic River cantilever bridge. Exploratory borings have been completed along the entire length of the project and contracts for foundation construction on the first two sections have been awarded. Details of these will be found in the unit price section of this issue.

Detailed plans for the steelwork are now being prepared; it is expected that bids for the first steel contracts will be called for about July 1, 1930. The project is being built by the New Jersey State Highway Department, of which J. L. Bauer is chief engineer. H. W. Hudson, assistant construction engineer, is in direct charge of the work.

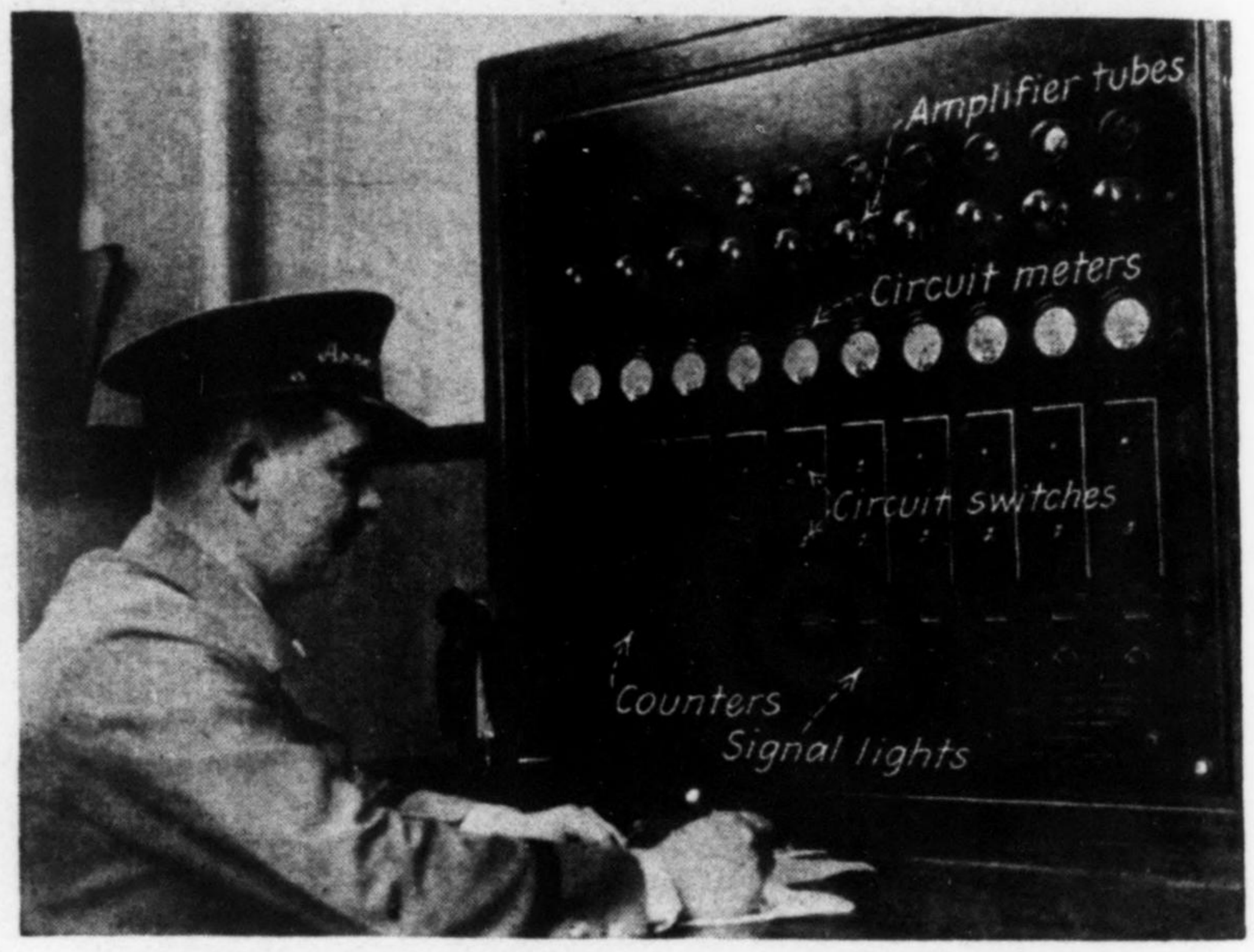
Old Bridge in Germany Accidentally Destroyed

One span of an old bridge across the Main River at Klingenburg, Germany, was accidentally destroyed recently during the construction of river-regulating works. A piledriver was being erected on pontoons in the river below the bridge and a steel cable had been made fast to the bridge railing to be used in raising the leads of the driver into position. During the hoisting the entire span gave way and fell on the pontoons, killing one man and slightly injuring five more. The entire bridge of five spans will be replaced by a new structure, as it had been considered inadequate for some time.

Bridge Traffic Controlled by Photo-Electric Cells

Ambassador Bridge Has Automatic Detectors and Counters on Each of Ten Entering Traffic Lanes

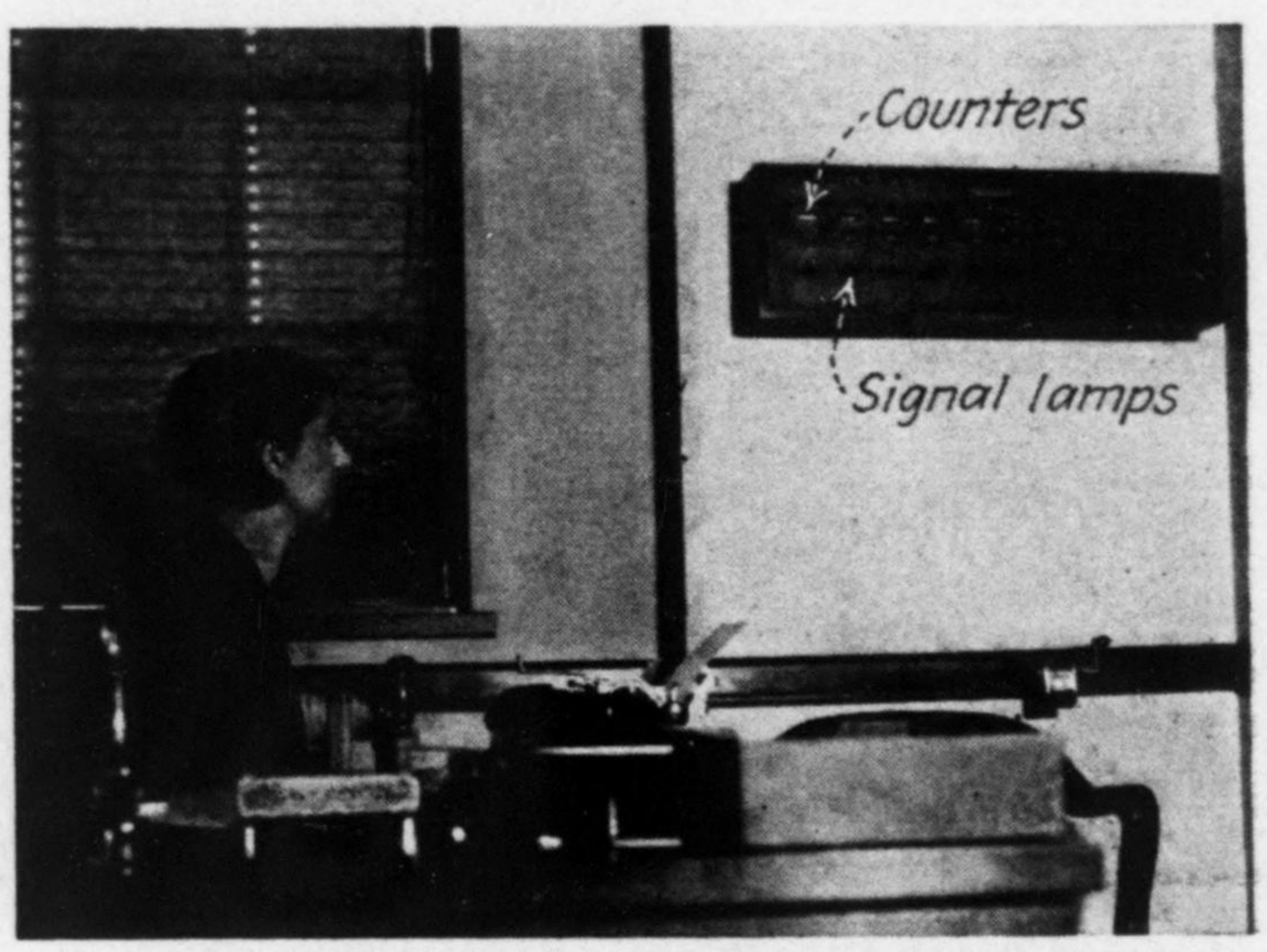
PHOTO-ELECTRIC detectors in the toll lanes at the entrance plazas of the Ambassador bridge, connecting Detroit and Windsor, give rapid and complete check on toll collection with twenty fewer attendants than would otherwise be necessary, according to an article in the June issue of *Electronics*. Benjamin Cooper, of New York, who designed and installed the equipment, reports the installation to be fully successful in speeding up traffic



CONTROL AND REGISTER BOARD IN TOLL HOUSE

handling, giving a complete supervisory control of the movement of traffic and reducing the labor of toll collection.

The wide approach plaza at either end of the bridge contains about fifteen traffic lanes, ten of which, arranged in pairs between the toll houses, are entrance lanes. It is in these lanes that tolls are collected. An automobile entering upon the bridge must come to a stop in the passage between toll houses. In this position it intercepts a vertical beam of light passing from an electric lamp in the ceiling of the passage to a photo-electric cell set in a protected cage in the floor. When it thus shuts off light from the photo-electric cell, the change of current through the latter actuates a relay, which in turn operates a counter register and extinguishes an indicator lamp on the



COUNTER IN SUPERINTENDENT'S OFFICE

Engineering News-Record

Vol. 110 | New York, January 12, 1933 | No. 2

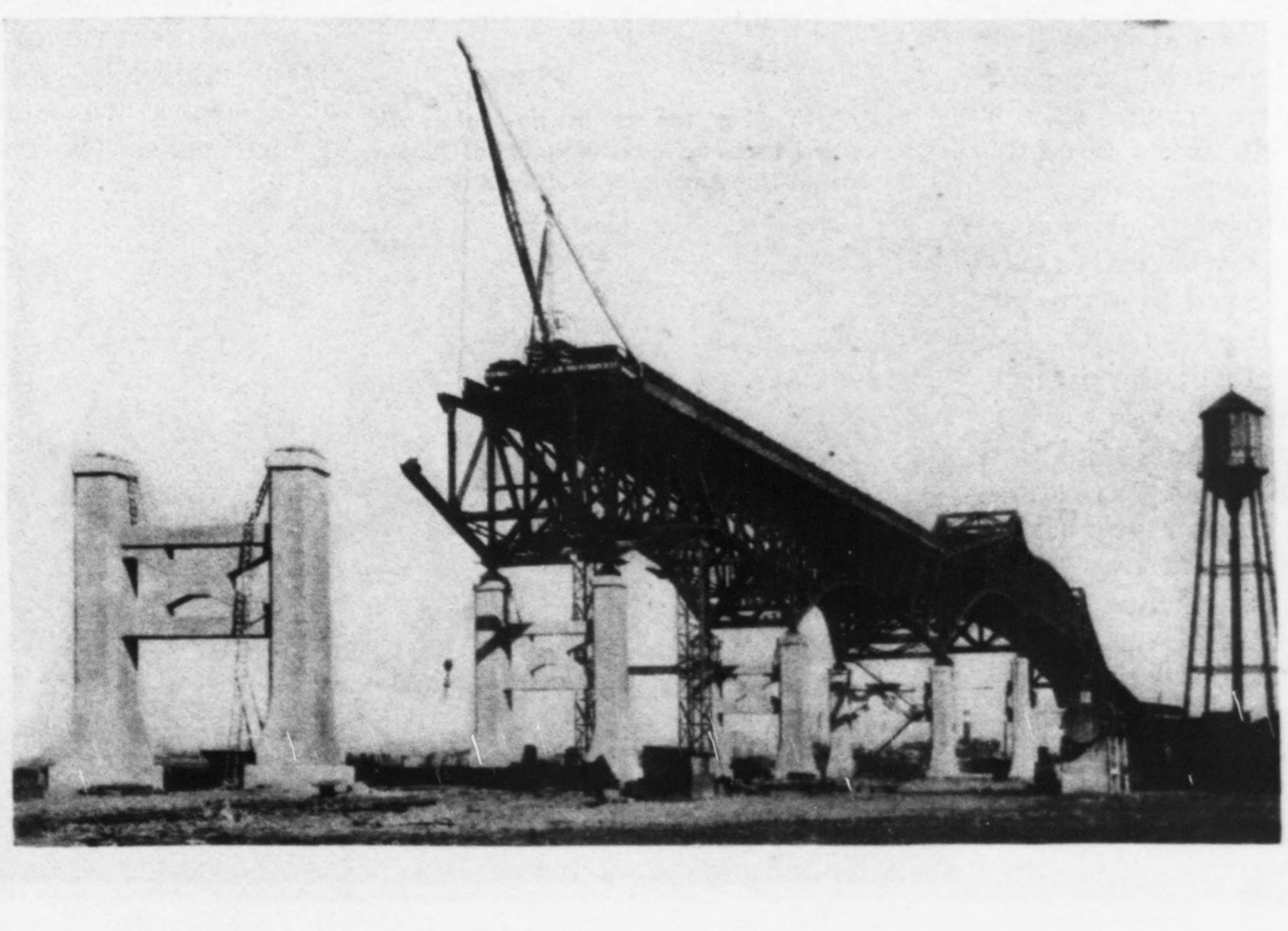
Varied Steel-Erection Practice on New Jersey Viaduct

Three miles of truss spans on high-level structure on Holland Tunnel approach highway in New Jersey erected by four contractors, using different equipment and procedure—Two 550-ft.-span cantilever river crossings in one of the contracts

As VARIED a picture of steel-bridge truss erection as one is likely to encounter on a single project was presented during the construction of the long High-Level Viaduct over the New Jersey Meadows on the approach highway to the Holland Tunnel, which was opened to traffic on Nov. 24, 1932. This structure, stretching for nearly 3 miles at such a height as to provide 135-ft. vertical clearances over the Hackensack and Passaic Rivers, is made up, with the exception of the river crossings, of deck-truss spans varying in length from about 175 to about 350 ft. Bearings on the piers are alternately fixed and free, and alternate spans carry suspended portions. Curved lower chords are used for all of the spans of the viaduct.

Four steel contractors were engaged on the work, constructing the sections indicated in Fig. 4. In general, each contractor was confronted with the same task, but no two chose the same method of attack. Equipment and procedure varied on each section. For example, on the section immediately east of the Hackensack River, locomotive cranes set most of the steel from the ground. Timber tower falsework was used, four bents in each anchor arm span, and one, two or none were used in the suspended spans. On the eight-span section extending west from the Hackensack River, mobile towers, 120 ft. high, running on tracks either side of the viaduct and carrying stiff-leg derricks on top, erected the steel. Five steel bents, with H-section legs, were used as falsework under each anchor arm span and three under each suspended span. For the nine spans immediately west of

Fig. 1—Section west of Passaic River span was erected by Taylor-Fichter Co. with deck travelers assisted by crawler cranes on the ground.



this section a deck traveler picked steel from cars brought in on a temporary track laid on the center line under the bridge. Two steel bents with K-braced panels and H-section legs were used for falsework in each span. The fourth contractor, in erecting the eleven arch spans at the west end of the viaduct, also used deck travelers, but he supplemented them with crawler cranes on the ground and adopted a straight cantilever method of erection, using only one falsework bent in a span. Each leg of these bents was a square tower.

On all of the sections the falsework was adjustable in height, inasmuch as most of the viaduct is on a grade. For camber adjustments, and for aid in swinging the trusses free from the falsework, wedges, hydraulic jacks and sand jacks were variously used. The deck-truss spans in the viaduct involved a total of 68,000 tons of structural steel. In addition, each of the cantilever river crossings required 8,650 tons.

The viaduct closes a gap in the through highway (route 25), leading from the Holland Tunnel west and south to Elizabeth and bypassing Newark. At the east end, in Jersey City, it connects at Tonnelle Circle with a viaduct and subway section completed some years ago (*ENR*, Jan. 5, 1928, p. 4); and on the west end, with an elevated highway, with no grade crossings, leading south past the Newark airport. The total length of the construction is, as stated, about 15,000 ft. Two ramps, one east of the Hackensack River and the other between the Hackensack and Passaic Rivers, provide access to and from surface streets in the industrial areas of the Meadows. Another ramp, at the west end, connects with streets in Newark. In general, two trusses are used, 36 ft. on centers, although at points where the structure is widened to accommodate ramps three and four trusses are necessary.

Throughout the length of the project the soil structure consists of layers of mud over clay and sand, mixed sand and gravel, with bed rock at depths varying from 25 ft. at the Hackensack River to a maximum of 141 ft. at one point between the two rivers, thence rising to 70 ft. at the Passaic River. This condition, which made foundation construction for the piers a major task, also added to the steel erection difficulties, particularly with reference to steel transportation and falsework supports.

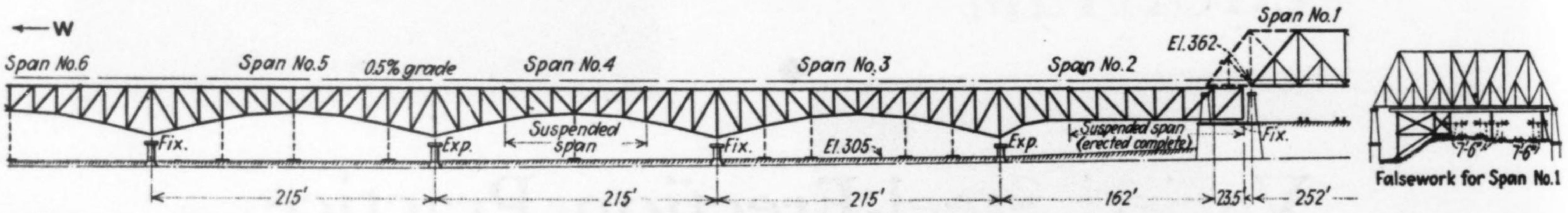


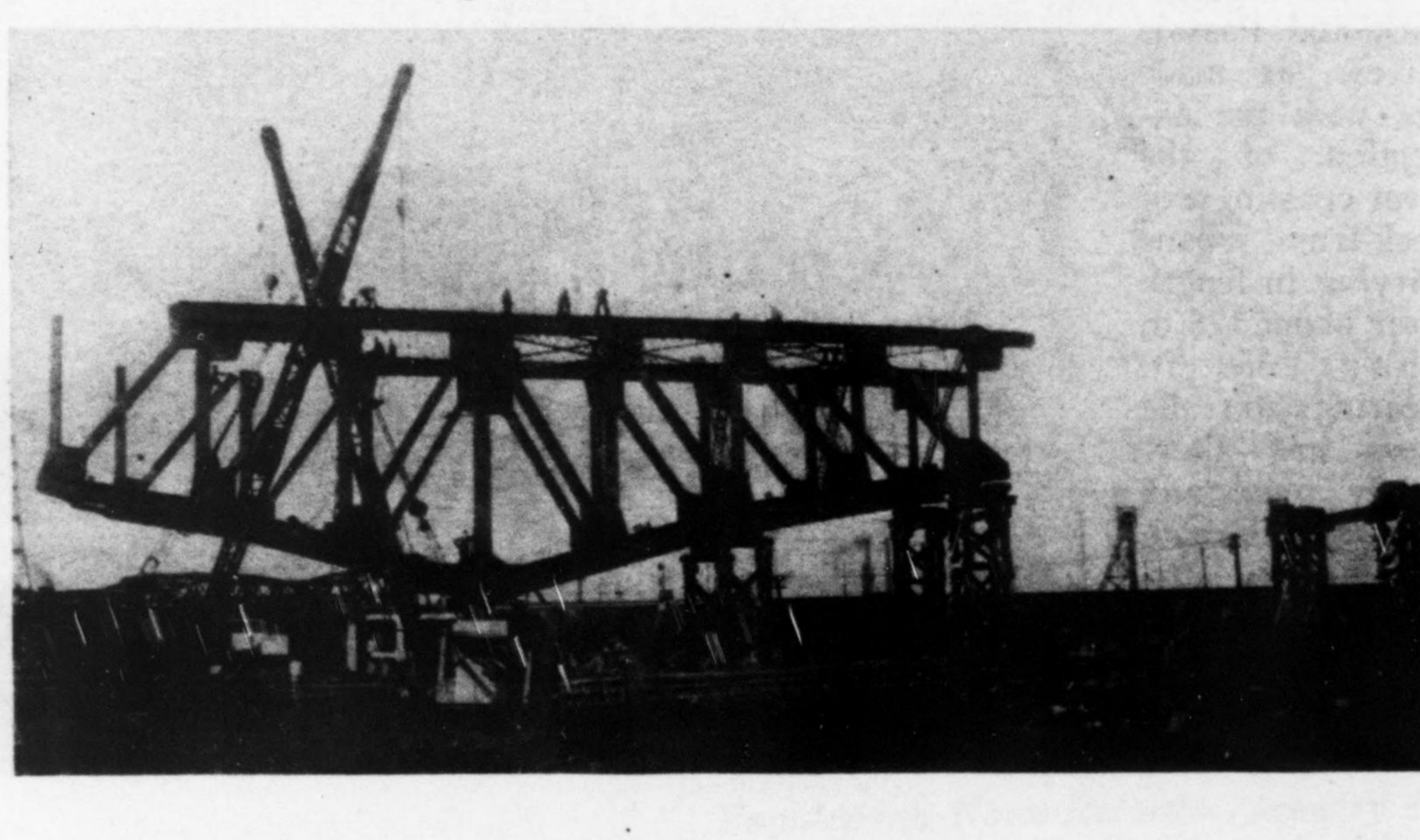
Fig. 2—Falsework locations on the American Bridge section. Cantilever trusses, with alternate spans carrying suspended portions, are typical for the full length of the viaduct.

The viaduct was designed and built by the New Jersey state highway department. The highway between Jersey City and Elizabeth was conceived and initially planned (with low-level movable spans over the rivers) by and during the administration of William G. Sloan, then state highway engineer, with Fred Lavis in charge of the Jersey City office. All studies, surveys, preparation of plans and specifications, as well as the supervision of construction, was directly handled by this office. For the final project with high-level river crossings, the direction of surveys, general supervision of design, preparation of contracts and specifications and supervision of the construction was under the direction of H. W. Hudson. Design details of the viaduct structure were in charge of Sigvald Johanneson. All of the work was under the general supervision of Jacob L. Bauer, the present state highway engineer.

American Bridge section

The contract held by the American Bridge Co. started with a 252-ft. skewed through span over the Pennsylvania Railroad and Hudson & Manhattan Railroad tracks in Jersey City and extended westward to the Hackensack River in nineteen deck-truss spans. A ramp, rising from east to west, was located under six of the spans near the center of the contract. These spans are four trusses wide. Elsewhere the viaduct in this contract is two trusses wide. A total of 23,000 tons of steel was required.

Fig. 3—Timber towers in the falsework bents and locomotive-crane erection characterized the American Bridge section.



Deck Trusses—The initial operation of the erection scheme used was to parallel the line of the bridge with two standard-gage railroad tracks, one on either side. These tracks were laid on a 7-ft.-high fill which had been built by the highway department with borrowed material during the period of foundation construction when the original ground proved too marshy to support the construction equipment. Steel was then brought in on cars by dinkey locomotives and, so far as most of the main material was concerned, was lifted direct from the cars to its place in the bridge by locomotive cranes. These cranes, of which there were five, had a capacity of 60 tons each and booms 85 to 110 ft. long. They erected the main trusses and enough of the floor beams and bracing to stay the structure until a 30-ton traveler with a 90-ft. boom working on the deck could fill in the remaining floor steel and bracing. An exception to this method of erection occurred on the four spans at the west end of the work, connecting with the high-level bridge over the Hackensack River. These spans, being too high for the locomotive cranes, were erected by the deck traveler.

Typical falsework layouts are shown in Fig. 2. Bents consisted of two timber towers about 8 ft. square, one under each truss (Fig. 3), tied together by wire-rope X-bracing. Hydraulic jacks were placed on the tops of the falsework bents for span adjustment. With the exception of the six spans in the ramp section, where piling was required because of the heavy load and an unusually soft ground condition, falsework was supported on 12x12-in. mud sills. Falsework layout varied somewhat in the different spans either as a result of foundation conditions or to clear obstructions. In general, however, either three or four bents were used in each anchor span, and either one or two bents in each suspended span. Erection began at the east end of the work and proceeded west.

The basic erection scheme was to erect two fixed or anchor spans first and then to erect the suspended span between. Thus, in starting out the work, spans 3 and 5 were first erected followed by spans 4 and 2. Then span 7 was erected followed by 6, etc. On an anchor span, locomotive-crane procedure was to erect the bottom chords and bottom laterals first and then fill in the web system and the top chords at the ends. The center section of the span was assembled last. For the suspended spans in which a single falsework bent was used, cantilever arms were erected out from either end, the bent set up directly beneath the center of the span and the suspended portion hung in two halves. Where two bents were used in the suspended span, the east half of the span and half the suspended portion were erected as a cantilever; then one falsework bent was placed at the center and another three panels from the west end, and the span was completed. A variation from both these procedures occurred in suspended spans where no falsework was used, the suspended portion of the trusses being assembled on the ground and lifted into place complete, using two locomotive cranes.

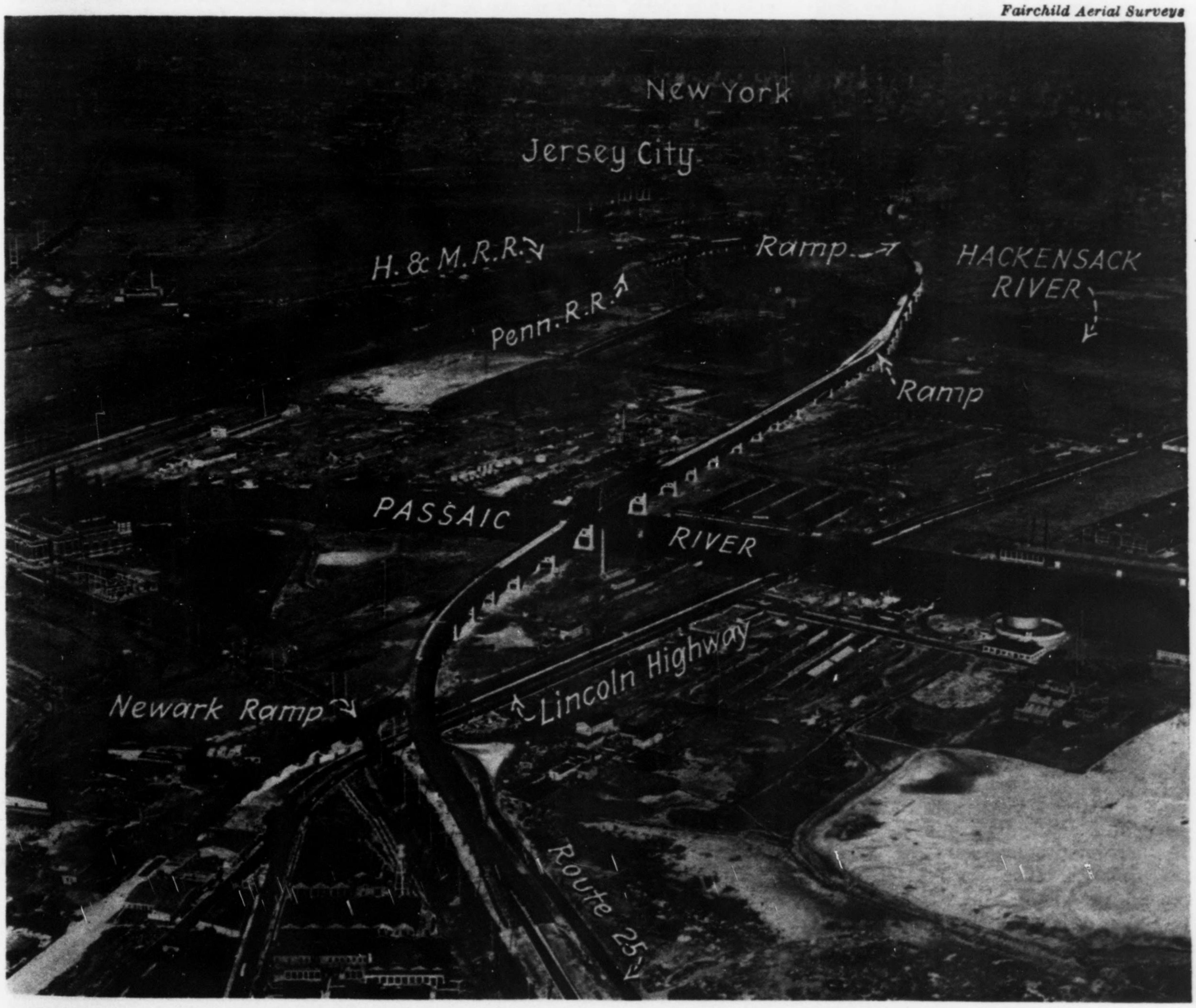
The six spans affected by the ramp were four trusses wide, the structure being about 90 ft. wide over all. For erecting this section of the viaduct, falsework bents were first placed under the two south trusses, which were erected with a locomotive crane. The falsework was then shifted to the opposite side of the structure, where two other locomotive cranes erected the two north trusses. The deck traveler filled in the floor steel and bracing as before, and in addition erected all of the steel for the ramp structure underneath.

As many as 32 riveting gangs were used on this contract at one time. A pressure of 135 lb. was provided for the riveting hammers, air being supplied from two compressor plants, one near the east end of the work and the other at about the center. In the east compressor plant three oil compressors, with an aggregate capacity of about 1,000 cu.ft. per minute, were utilized. At the central compressor plant there were two portable compressors and one oil compressor supplying about 700 cu.ft. per minute. At each of these plants, as well as at intermediate points along the work, air receivers were installed. Booster-pump plants lifted the air up to the deck and forced it along the pipe line to these receivers.

Railroad Truss—Although quite distinct from the deck-truss erection, work on the through truss span over the railroad tracks at the east end of the contract is worthy of note. Three or

Fig. 4—Viaduct 3 miles long over New Jersey Meadows. The sections built by the four steel contractors are: Taylor-Fichter, Jersey City end to the skew span over the Pennsylvania and the Hudson & Manhattan railroad tracks; American Bridge, the skew span over the H.&M. and the P.R.R. tracks and the 19 deck-truss spans west to the Hackensack; McClintic-Marshall, Hackensack River cantilever span; Phoenix, 8 deck-truss spans west of the Hackensack; McClintic-Marshall, 9 deck spans west of the Phoenix contract and the Passaic River cantilever span; Taylor-Fichter, deck spans west of the Passaic River, including the Newark ramp in the left foreground.

Fairchild Aerial Surveys



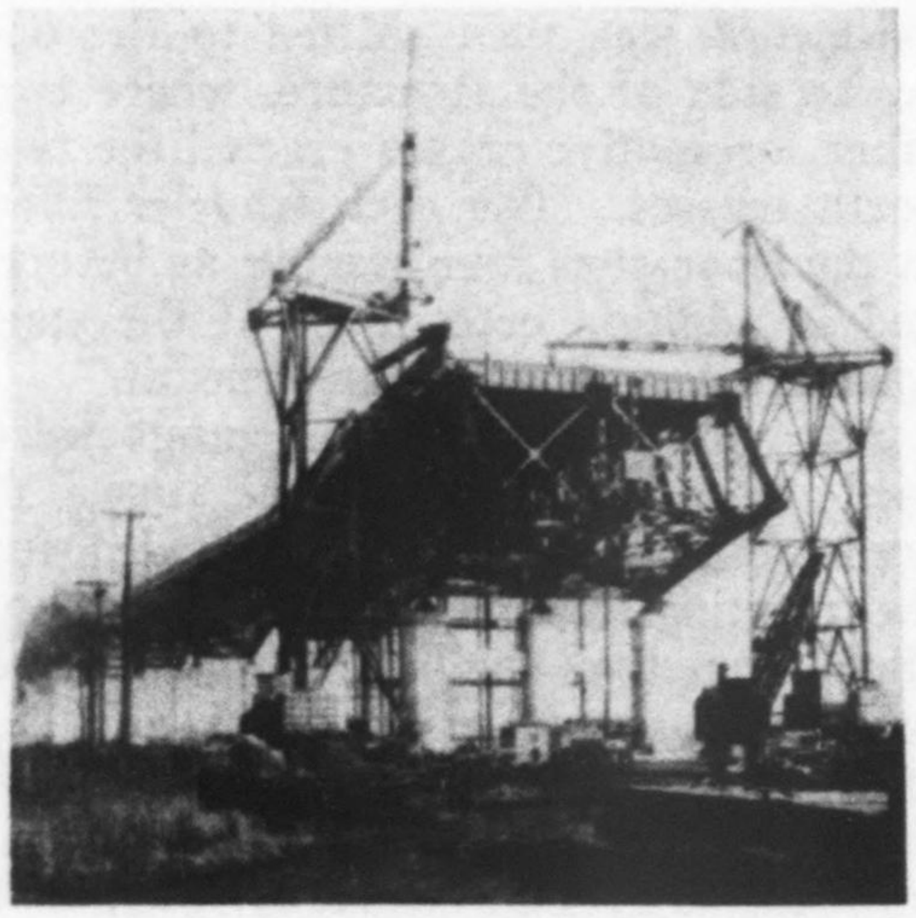


Fig. 5—Widening the viaduct to accommodate ramps required three trusses and in some places four instead of the two used elsewhere. View is on Phoenix Bridge section just west of Hackensack River bridge.

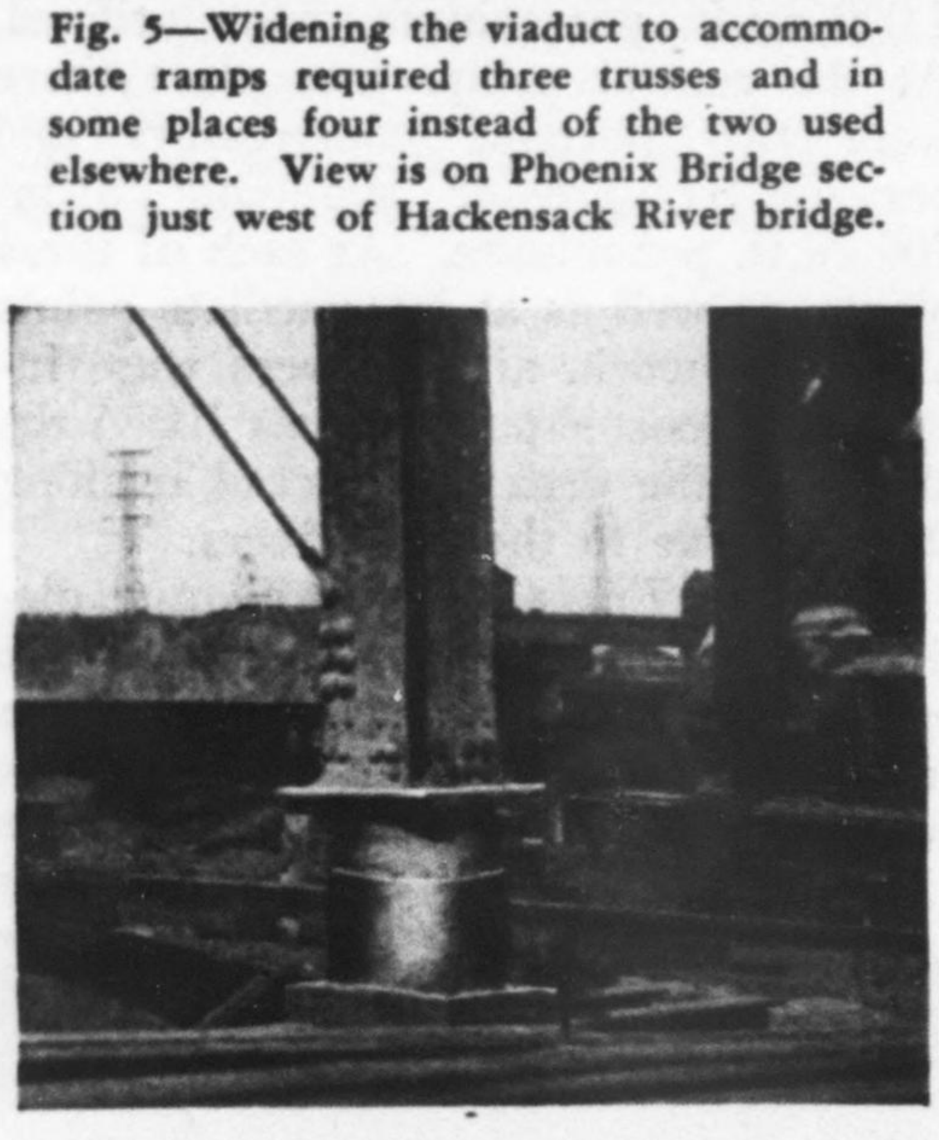


Fig. 6—Sand jack used under steel falsework bents on Phoenix Bridge section to adjust span and to swing it free when completed.

four spans of the deck-truss structure had been completed before the railroad span work was started. At the beginning, two 30-ton stiff-leg travelers with 90-ft. booms were assembled on span 3 by the locomotive cranes. One of these travelers, as previously noted, moved westward, placing the floor steel and top bracing in the deck trusses. The other traveler moved east to erect the railroad span.

A considerable skew in the span and the presence of the railroad tracks made uniformly spaced falsework impossible. Four bents of timber were utilized (Fig. 2), placed parallel to the railroad tracks. Two of these lines of falsework were set outside the track area on the west edge of a fill, and one was outside the track area on the east edge of the fill. The fourth bent was located between the tracks of the Hudson & Manhattan Railroad and those of the Pennsylvania Railroad. The exterior bents could be braced as towers, but this was not possible for the bent between the tracks, which consisted of a single line of columns tied together longitudinally at the top by cap timbers. The entire falsework system was tied together transversely by groups of heavy girder beams, which supported the trusses of the span at every second panel point. The result was an unusual layout in which neither the longitudinal nor transverse falsework caps were parallel to either the trusses or the floor beams of the span.

The erection traveler operated at one side of the center line of the bridge, while the other side was occupied by a narrow-gage material track upon which steel was brought out to the traveler on push cars. Because of this location of the traveler it fouled the web members of the trusses and thus could only place them as it was backing up. Accordingly, in erecting the span the first operation was to place the bottom chords and the floor system entirely across the structure. Then on the reverse movement of the traveler the web members, top chords and top bracing steel were placed.

For the American Bridge Co. the erection was under the general charge of J. B. Gemberling, eastern division erecting manager, with Dan McQuarrie as foreman and D. F. Fine as resident engineer.

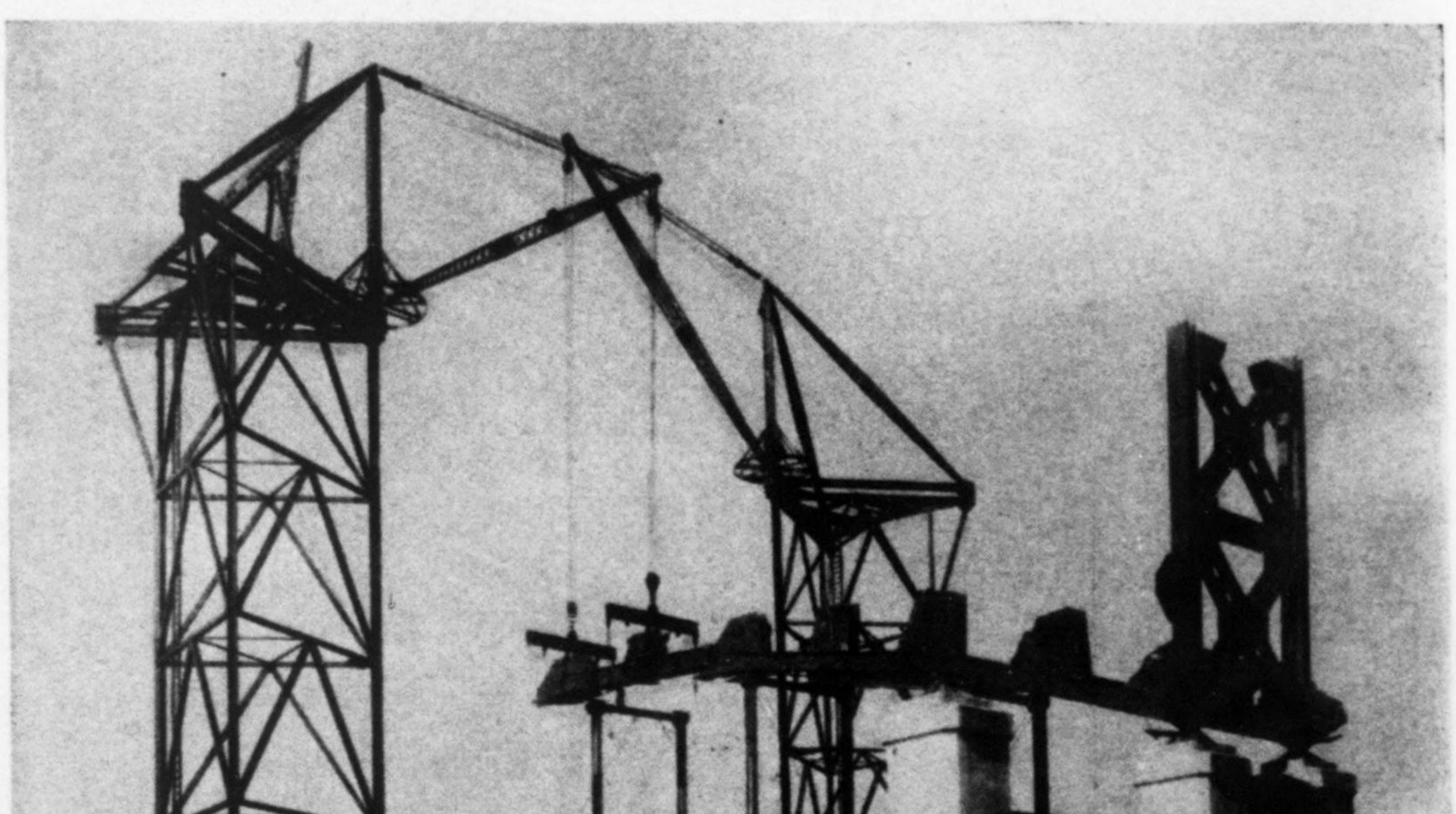
Phoenix bridge section

The portion of the work included in the contract of the Phoenix Bridge Co., extending from the Hackensack River west for about 2,400 ft., included eight deck-truss spans, with a maximum span length of 325 ft. and an average of 297 ft. The maximum height of the structure above the ground on this section was 128 ft. In general, the design was of the two-truss type but, because of a ramp, some spans utilized a three-truss and some a four-truss arrangement. Because of this varied construction the contractor decided to use ground travelers (Fig. 7) rather than a traveler on the deck of the structure. The only exception was that the suspended span connecting the first span with the Hackensack River bridge was erected with a light deck traveler, since the span was over the water.

The ground travelers, of which there were two, consisted of triangular towers 122 ft. high carrying 40-ton stiff-leg derricks with 75-ft. booms. Each tower was mounted on four standard-gage steel trucks, two traveling on an inside track placed close to the viaduct structure and two on an outside track, 28½ ft. distant. Because of the shoulders of a fill covering the viaduct right-of-way, it was not possible to place the inside track as close to the piers as was desired, and this condition made heavy counterweights necessary at the bottom of the towers to resist overbalancing effects. The power for each derrick was supplied by a 10x12 three-drum hoisting engine located in the base of the tower. The towers were made self-propelling by the use of a set of double blocks with a 1½-in. line. With this arrangement it was possible to move a tower the full length of a span in about 5 min. Fully equipped, each tower weighed about 225 tons.

Falsework included five bents for each anchor span of the cantilever construction and three bents for the suspended spans. Inasmuch as there was one falsework leg under each truss, in the two-truss layout each bent contained two falsework legs of rolled H-section members, in the three-truss layout three legs, and in the four-truss layout four legs. For truss adjustment the bents were supported on sand jacks (Fig. 6) resting on I-beams on timber grillage footings. Attachments were also provided for hydraulic jacks to be used in raising the trusses if this should prove necessary. The general plan was to set the falsework bents considerably above the required elevation, to provide

Fig. 7—Mobile-tower travelers erected the steel on the Phoenix Bridge section.

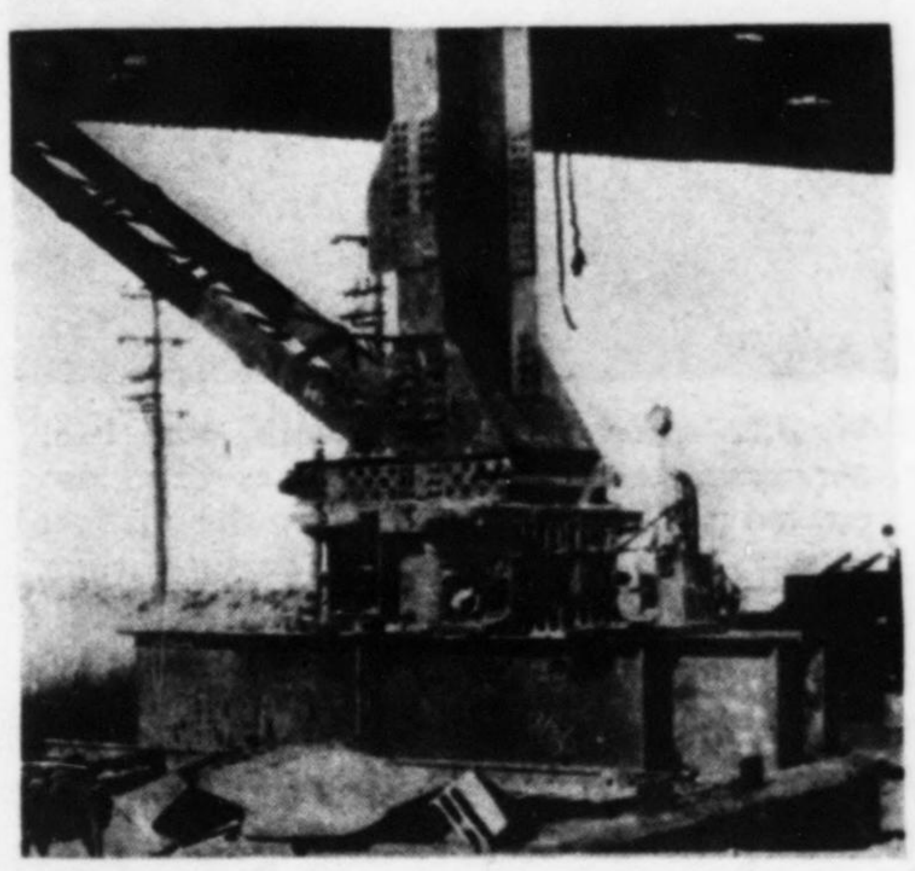


for settlement and for removal of the falsework in swinging the spans.

Erection started at the fixed end of the anchor span at the east end of the section. Falsework bents, bottom chords and bottom laterals were erected complete between the piers for this span, the chords acting as the longitudinal bracing for the tops of the bents. On the return movement of the traveler the web members were placed, or in some instances the web members, top chords and top laterals. On the third pass of the travelers the floor and railing were erected. The arrangement was sufficiently flexible, however, and the movement of the travelers was so readily accomplished that it was possible to vary the erection procedure at will without any sacrifice in efficiency. After two of these anchor spans had been erected the suspended span between them was filled in a similar manner. Two locomotive cranes, one for each traveler, kept the derricks supplied with steel.

In some cases falsework was moved forward to the next span without dismantling, although, because of the varying height of the structure, it was usually necessary to change the length of the falsework. This was possible since the legs had been specially designed with splices to provide a length corresponding to all locations.

Fig. 8 — Steel falsework on McClintic-Marshall section was supported on both hydraulic and wedge jacks.



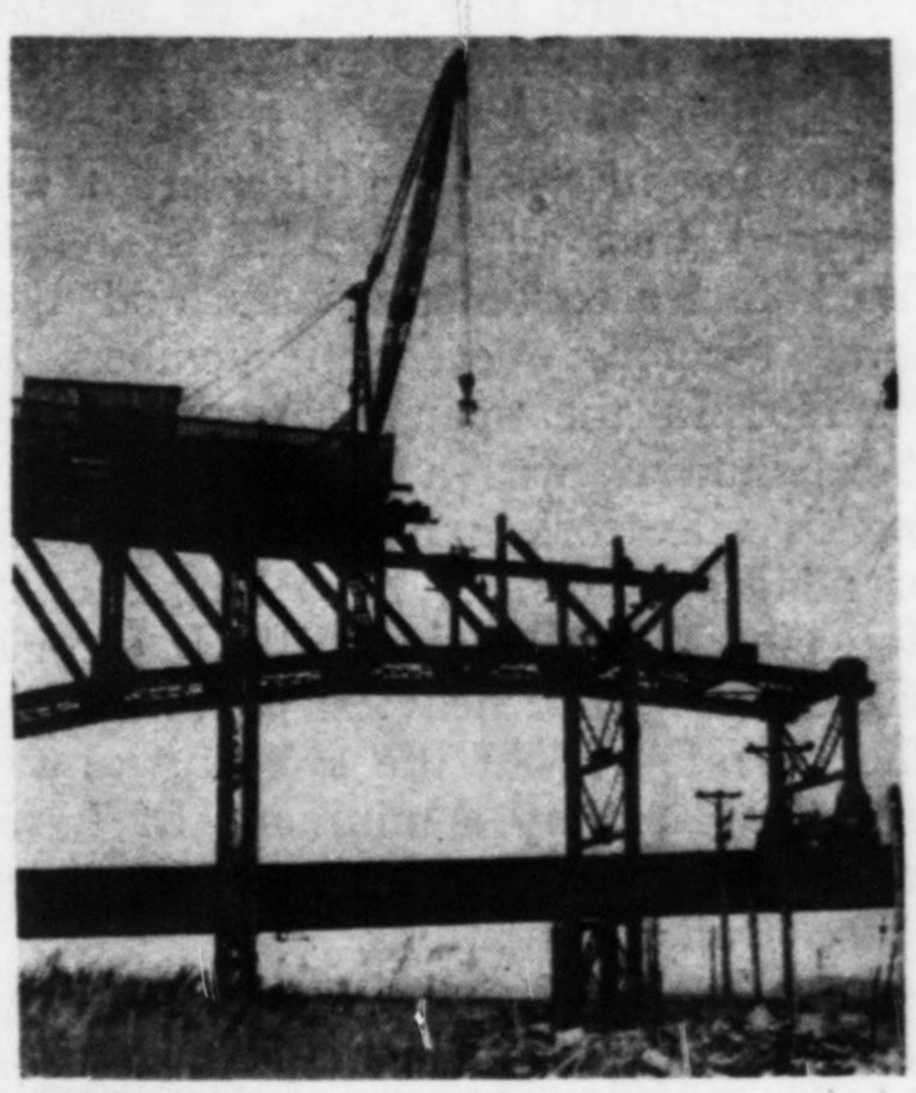


Fig. 9—Ramps introduced special difficulties. View is on McClintic-Marshall section where ramp required 148-ft.-span plate girders.

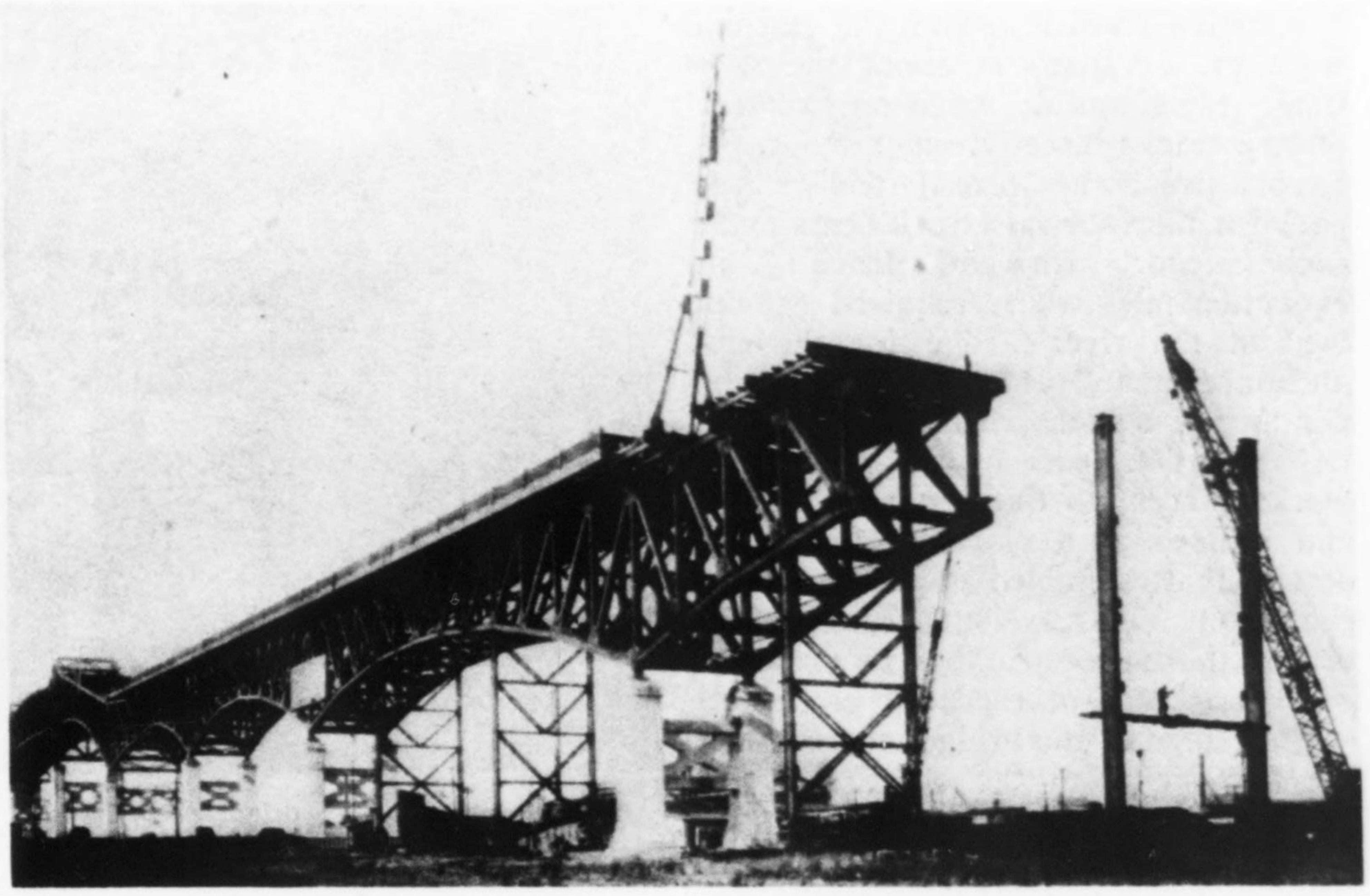


Fig. 10—Erection by deck traveler was the method adopted by McClintic - Marshall. Steel was brought in on a temporary track on the ground beneath the center line of the viaduct and lifted directly into place. Locomotive cranes set the falsework.

According to the contractor, the method of erection proved unusually efficient because of its great flexibility and because light falsework was possible inasmuch as the bridge did not have to carry any erection equipment. The relatively light load carried by the falsework also eliminated any difficulties with falsework settlement. Building the tracks for the travelers on the ground rather than on the structure made it possible to use common labor and to carry out the job more safely.

This contract involved about 17,500 tons of steel in which the heaviest piece handled weighed 55 tons and was erected by using both tower derricks.

General supervision of the field operations for the Phoenix Bridge Co. was in charge of J. F. Kinter, superintendent of erection. The scheme of erection was carried out under R. S. Foulds, engineer of erection. W. C. Bearce was foreman, and Frank W. Peirce was resident engineer.

McClintic-Marshall section

In the contract held by the McClintic-Marshall Corp. were included the two through cantilever bridges over the Hackensack and Passaic Rivers and nine deck-truss spans (of two-truss layout) connecting with the Passaic River bridge on the west and the Phoenix Bridge Co. section on the east. The length of the deck-truss section was about 2,500 ft., and the tonnage involved was 12,400. The longest span was 335 ft., and the maximum height above the ground 120 ft.

Deck-truss erection on this contract differed from the two previously described procedures in that a minimum of work was performed by ground equipment. Locomotive cranes set the falsework bents and the grillage pads and assisted in setting some 22-ton 148-ft.-span plate girders in a ramp (Fig. 9), but with these exceptions the erection was carried out by the A-frame deck traveler that previously had erected the west half of the Passaic River bridge.

Erection of the deck-truss spans proceeded from west to east. A temporary standard-gage track was laid on the ground the entire length of the work under the center line of the viaduct for material supply service. The traveler, picking steel directly from gondola cars, then erected everything complete as it advanced.

Steel falsework bents were used, consisting of H-section legs under each truss, braced apart by battened channel struts, with laced-channel X- and K-bracing in each panel. Steel grillages on mud sills supported the falsework legs, which were mounted on a system of hydraulic and wedge jacks for vertical adjustment (Fig. 8). Two falsework bents were used in each span, placed in general at the third points. Because of the weight of the deck traveler some of the joints between the cantilever and suspended spans had to be temporarily fixed, and in every span a temporary member was inserted in the third panel from the east end.

River Spans — The Passaic and Hackensack River crossings are duplicate bridges in design and were erected by identical methods. Each of the bridges involved 8,650 tons of steel. Each consists of a 550-ft. main span and 350-ft. anchor spans, 57 ft. wide center to center of trusses. Main-span clearance above mean high water is 135 ft. within the channel lines, while the highest steel placed was 210 ft. above mean high water. The Passaic River bridge was completed first. Its erection will be described, with only incidental reference to the Hackensack span.

Erection started on both the east and west anchor spans at about the same time. Steel was delivered on two temporary tracks directly under the spans. Locomotive cranes placed steel grillage pads for the four falsework bents under each anchor arm and drove 12-in. H-section piles where required (at one bent at the river's edge for the east anchor arm and at all four bents under the west anchor arm). As an initial operation, part of the steel falsework adjacent to the first pier was set and utilized as a platform for a guy derrick that assembled an A-frame traveler on top. This traveler operating on the deck of the anchor arm then removed the guy derrick and proceeded to erect steel to the center of the bridge where it met the traveler from the other side. A gasoline tractor erected the hand rail and top lateral system after the A-frame travelers had completed their work. For the main span the steel was delivered by car float and transferred directly into place in the bridge by the travelers.

On the Hackensack bridge (Fig. 11) the principal deviations from the above procedure were the use of steel H-section piles under all of the falsework bents and the erection of all steel direct from car floats. The steel H-section piles proved particularly adaptable to the conditions, for in some cases they had to be used in extremely long lengths, while in others practically no penetration was possible. In driving the piles, steel frames were used, acting initially as guides and later serving as permanent bracing for the piles. These frames were moved as units without dismantling them, as they were required for use under successive anchor arms.

For McClintic-Marshall the erection was under the direction of G. P. Bullard, manager of erection, with A. F. McLane as resident engineer and W. E. Omohundro and H. G. Reynolds as foremen.

Taylor-Fichter-section

Although the Taylor-Fichter Steel Construction Co. erected two sections, one at the extreme eastern end of the viaduct (under a subcontract with Charles T. Kavanagh, general contractor) and one (on its own contract) at the western end, only the latter involved the typical deck-truss construction. The east section comprised 6,000 tons of steel, largely plate-girder spans of 50 to 60 ft. in length, although there were also included four trusses of 120- to 220-ft. spans. Two of these were through spans over railroad tracks, and two were deck trusses over heavy traffic streets; the latter trusses adjoin on the east the through truss span erected by the American Bridge Co. This east section was erected by a 40-ft steam deck traveler with a 100-ft. boom, assisted by a crawler crane with a 45-ft. boom operating on the ground. Timber falsework was used except at the street crossings where steel was used instead.

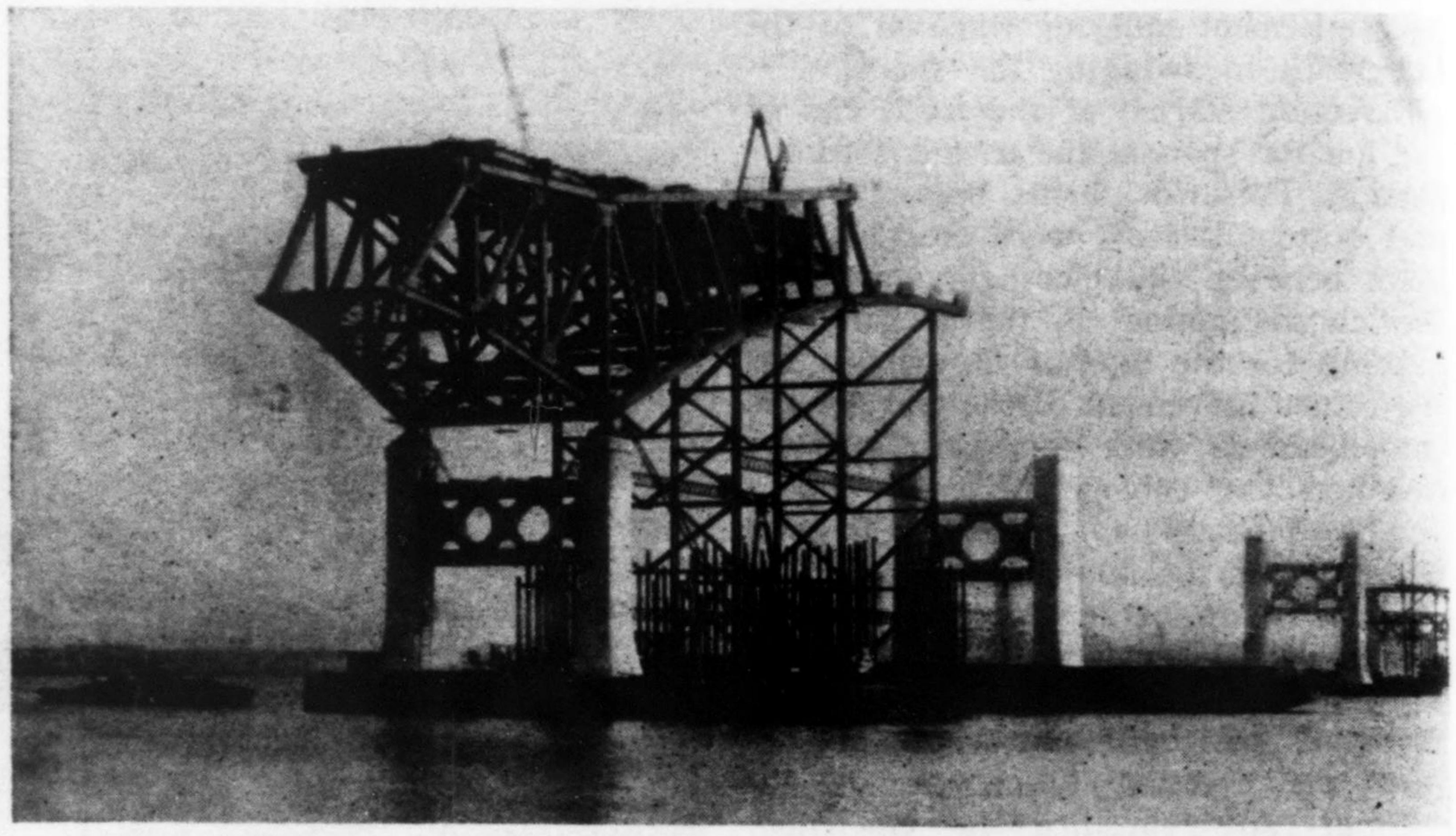


Fig. 11—Erecting west anchor arm of Hackensack River span. This bridge and the Passaic River crossing are duplicate structures.

The section at the west end of the viaduct included eleven deck-truss spans (two-truss layout), connecting at the east end with the Passaic River bridge. About 9,000 tons of steel was involved, which included a plate-girder ramp, providing an exit to the surface in Newark.

Erection of the deck-truss spans on this contract was carried out by deck travelers as on the McClintic-Marshall section, but with the important difference that gasoline crawler cranes with 90-ft. booms were used as supplementary equipment on the ground. These cranes, in addition to setting the falsework bents, also assisted in erecting the lower chords of the trusses. In contrast with the other contracts, no railroad track was laid on this section. Instead, temporary roads were built alongside the viaduct for use of trucks that delivered the steel and the crawler cranes that helped to erect it.

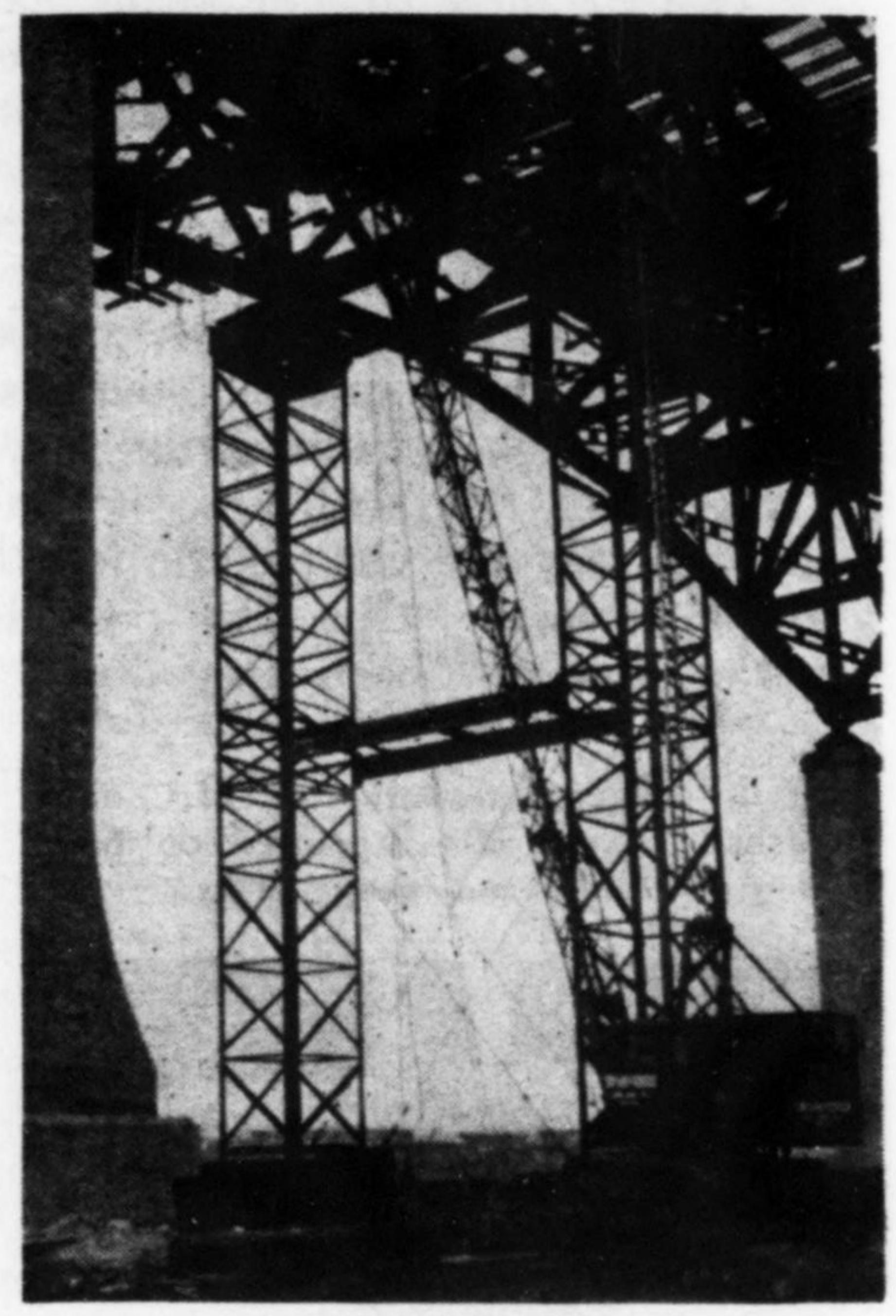


Fig. 12—Steel tower falsework, one bent per span, set by crawler cranes that also erected the lower members in the viaduct trusses, was used on the Taylor-Fichter section.

One 45-ton traveler with a 90-ft. boom started at the east end of the section, and another of the same capacity but with a 70-ft. boom and a narrower over-all width (since it was required also to erect the ramp later), started at the west end of the section. The two travelers met at the ramp intersection.

In contrast with all the other contracts on the viaduct, only one falsework bent was used per span on this section. This bent was located beneath the third panel point from the west end of the span unless special conditions made this impracticable. Each leg of a bent consisted of a structural steel angle tower about 10 ft. square, resting on a steel beam grillage and topped with steel beams upon which the trusses were supported on wedges and 200-ton hydraulic jacks. The legs were tied together transversely by wire-rope X-bracing. All falsework rested on wood piles. These towers, which were about 90 ft. high in the span adjacent to the Passaic River bridge, were designed to be reduced in length corresponding to the decreasing grade of the viaduct toward the west. In the last span the falsework was only about 30 ft. high.

The use of a single falsework tower required that all suspended spans be fixed for erection purposes and that some temporary erection members be inserted in the spans. Against these disadvantages was a considerable saving in falsework expense over the use of additional bents. Also longer erection pieces (up to about 100 ft.) could be handled. The heaviest pick weighed about 42 tons. At the crossing of the Lincoln Highway a minimum of falsework was an advantage on account of dense traffic conditions.

For Taylor-Fichter the work was handled by J. Lowenstein, president and chief engineer. H. O. Adelman was designing engineer, Samuel Kapelsohn general manager, John Grandan foreman, and A. Krohn resident engineer.