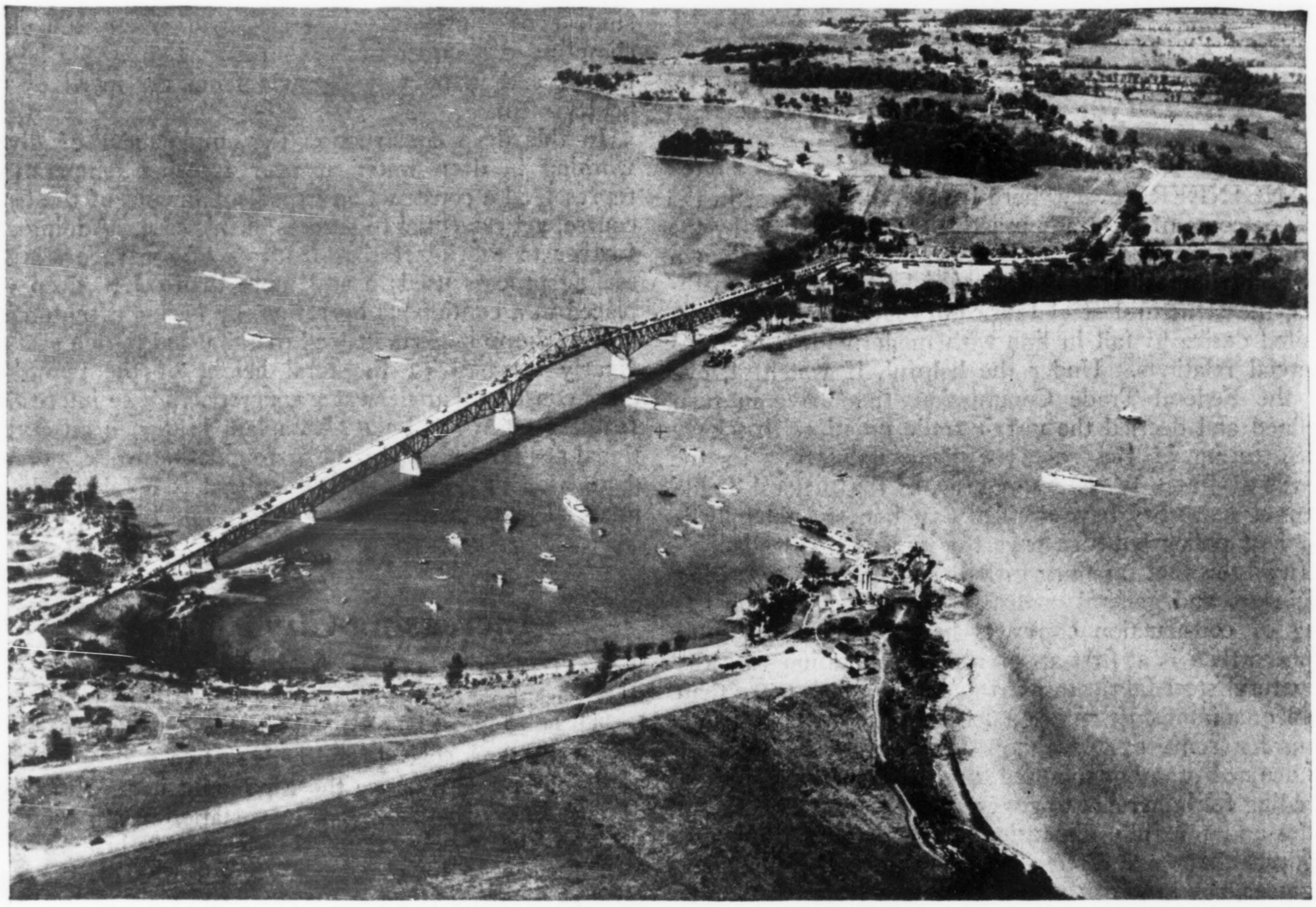
Deep Foundations for Lake Champlain Bridge Built With Open Cofferdams

Dump Buckets Place Concrete in 97 Ft. of Water for Piers of First Structure Across Historic Lake—Sliding Steel Bracing Used in Cofferdams—Cantilevered Spans Rotated Into Position for Closing



Fairchild Aerial Surveys, Inc.

FIG. 1—AIRPLANE VIEW, LAKE CHAMPLAIN BRIDGE

Deep open cofferdams with sliding steel bracing were used in building the piers of the first bridge across historic Lake Champlain between Crown Point State Park on the New York side and Chimney Point on the Vermont shore. Concrete placed with bottom-dump buckets sealed the cofferdams 97 ft. below lake level in six-day continuous pours. This steel bracing used in the deep caissons consisted of tiers of framed steel struts and wales, the lower tiers resting on the lake bottom and dropped to, and held at, predetermined levels by rods and cables as excavation progressed downward. Bids on the project were received for both pneumatic caisson and open cofferdam construction, with the low bid favoring the latter type.

The bridge, created as a toll highway project by compact between the states of New York and Vermont, provides the only highway structure across the entire 140-mile length of the lake and is located about 40 miles from the south end and 33 miles south of Burlington, Vt. It was opened to traffic Aug. 26. Approach from the New York side is through Crown Point State Park, between Crown Point and Port Henry, an area containing the ruins of old British and French forts, as well as the Champlain Memorial Lighthouse. The abutment on this side lies within the limits of the ruins of the earlier French fortifications. Across a narrow neck of the lake, only 1,500 ft. wide at this point, the Vermont abutment lies within the ruins of an equally historic French trading post, said to be one of the first in America. The original post house, with its 2-ft. log walls, later veneered with a 1-ft. thickness of brick, is still standing, just off the bridge approach fill.

Design—As can be seen from Fig. 2, the bridge consists of three 50-ft. deck-plate girder spans starting at the New York side, two continuous deck trusses of 225-ft. and 270-ft. spans, three continuous spans of two 290-ft. deck trusses flanking a 434-ft. span rising as a through truss to provide a 92-ft. channel clearance, a simple 270-ft. deck truss and five 50-ft. deck plate girder spans leading to the Vermont abutment. The deck is on a 5½ per cent grade up from each abutment to the channel span.

The abutments are U-shaped concrete structures, and the Vermont embankment approach is held in place by a well-laid dry stone wall. The trusses on the three channel spans are on 30-ft. centers, with the remaining trusses and plate girders on 18-ft. centers. The roadway deck is an 8½-in. concrete slab, 24 ft. between curbs, with the upper 1½ in. as a separate concrete wearing coat poured monolithically with the structural slab but separated from it by a wide-weave layer of burlap. This design provides for easy replacement of the wearing surface, expected to receive severe traffic wear because of the 5½ per cent grades and the winter operation of cars with tire chains. On each side of the roadway is a double concrete curb 17 in. high and a 3-ft. walk protected on the water side by a woven-wire fence on channel-iron posts.

The plate girders rest on steel bents on concrete pedestals, while the trusses rest on seven standard concrete piers, five of them in water. The two deepest piers are 48x16 ft. in area from El. —2 to El. 72. The cofferdams were sealed to El. 60. At El. 72 the piers step to 44x10 ft. in section, rise vertically to water level and then to El. 130 as slightly battered shafts, with semicircular ends. The water level of the lake is approximately El. 92.5. The other piers are similar in construction, 47x13 ft. in plan at the base, and decrease rapidly in height toward the shore as the lake bottom rises and the roadway gradient falls.

Cofferdam Design and Construction—A feature of the deep pier construction was the use of sliding steel frame bracing in the open cofferdams. The sites of piers 6 and 7 were previously dredged to El. 50, and a single row of spliced steel sheeting 98 ft. long driven inside of a timber guide frame to comprise the cofferdam walls. The bracing for the lower portion of the cofferdams, consisting of four horizontal tiers of framed I-beams, wales and cross-struts, was placed on the lake bottom within the cofferdam. The frames were 6 in. narrower in both directions than the dimensions of the cofferdam to permit sliding downward as excavation progressed. For bracing the portion of the cofferdam above lake bottom, wales and cross-struts were framed of I-beams and channels, with angle-iron posts of crossbracing, shown in Fig. 5. These frames, weighing 10 tons, were handled by two derricks and were hung from timbers placed across the tops of the cofferdams.

Excavating was done by clamshell buckets handled by the same derricks that drove the sheeting. As the excavation progressed the lower tiers of bracing dropped down. As each tier reached its proper level a diver inserted 1¼-in. rods tying it to the tier above. This scheme was used on all the river piers except on pier 8, where ⅞-in. cables running from each tier to the top of the cofferdam controlled the bracing.

No trouble was experienced in getting the bracing to slide downward except in pier 6. On the other piers the excavation had been kept fairly level within the cofferdam, but on pier 6 at one point the excavation in the center was allowed to get about 22 ft. below that on the sides. This caused the sheeting to bulge inward all around and made it difficult to slide the bracing past the bulge. Considerable work by divers was required to get the steel bracing in final position.

Because of the walers, the excavating bucket could not dig close to the walls, and in stiff clay it was necessary for a diver to use a high-pressure jet to trim off the layer of mud, sometimes 2 ft. thick, clinging to the steel sheeting. Much of this jetted material, in a semi-fluid state, was pumped out by 10-in. steam centrifugal pumps. The material excavated by clamshells was loaded on barges and dumped into a shallow bay near the bridge. All of the sheeting, except some on pier 6, was pulled with a special A-frame set on the end of a barge, capable of exerting a pull of 98 tons. All sheeting not pulled was burned off deep under water.

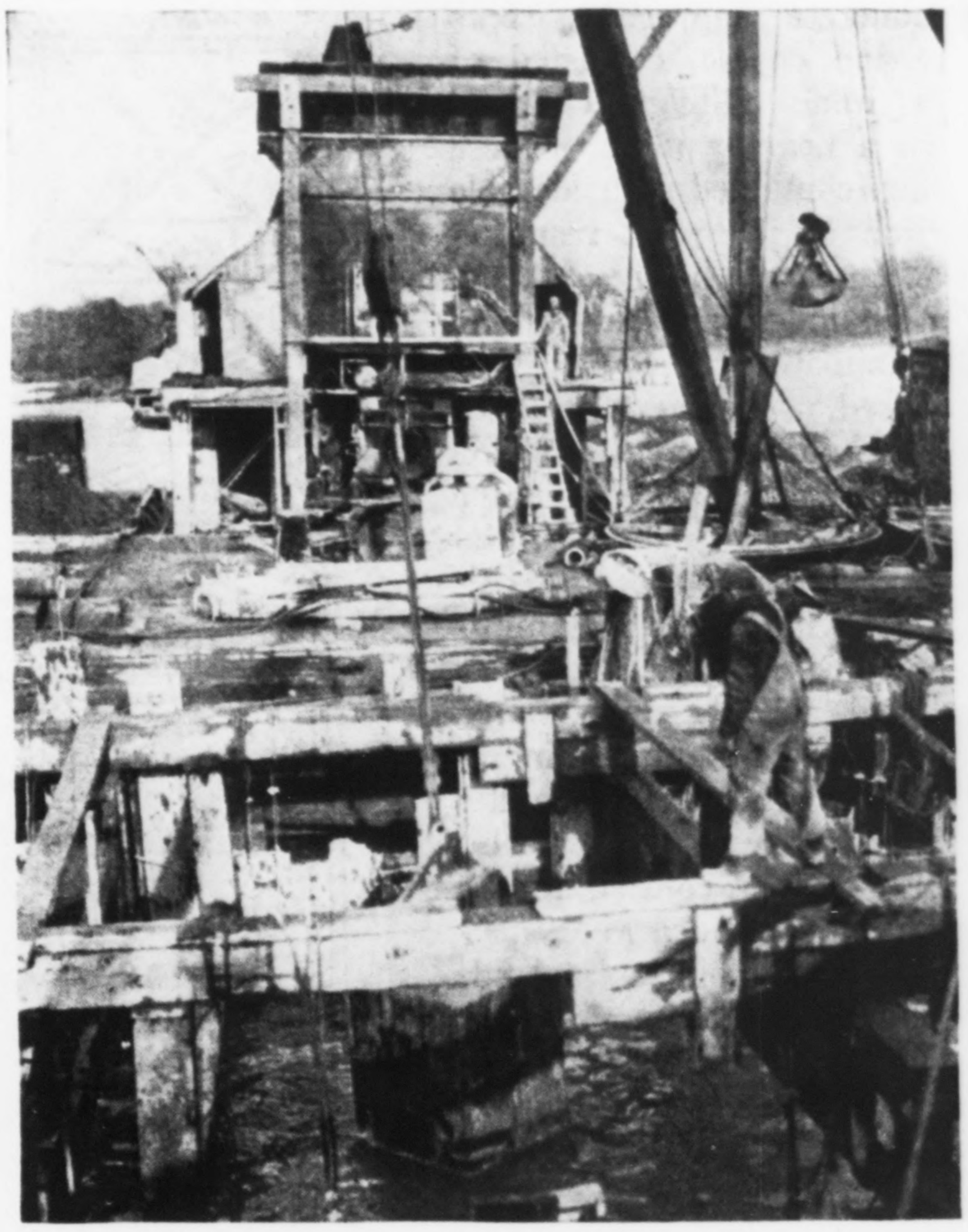


FIG. 3—POURING CONCRETE SEAL FOR DEEP COFFERDAMS WITH BOTTOM-DUMP BUCKET
Cables supporting steel bracing can be seen hanging from timber framing.

Divers inspected the rock bottom after the excavation was completed. In all the piers it was found that glacial action had roughened the ledge sufficiently to require no stepping or chipping. As the work was carried on in midwinter, the divers suffered considerably from cold water and high air pressures required on the deep piers.

Pier Construction—Concreting from the bottom to El. 60 on the two deep piers, and to El. 80 on the remaining piers, was done without pumping out by using a 1-yd. bottom-dump bucket for depositing the concrete. Care was taken to keep the buckets full to prevent wash. The buckets, handled by a derrick boat, dumped automatically as they struck bottom. Fig. 3 shows a bucket of concrete just entering the water. Continuous pouring was maintained on the seal once a pier was started, a six-day run being required for each of the deep foundations. After the seal had hardened, the cofferdams were pumped out and the pier shaft forms were erected and concrete was poured in the dry. The same dump buckets were used in placing the shaft concrete, the bucket being dumped by cross-timbers inside the forms.

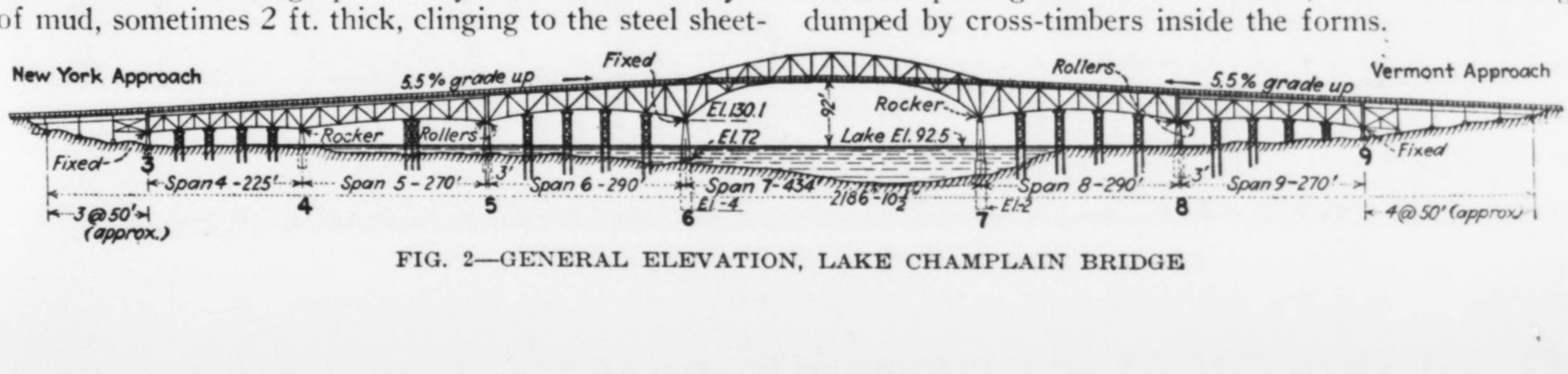


FIG. 2—GENERAL ELEVATION, LAKE CHAMPLAIN BRIDGE

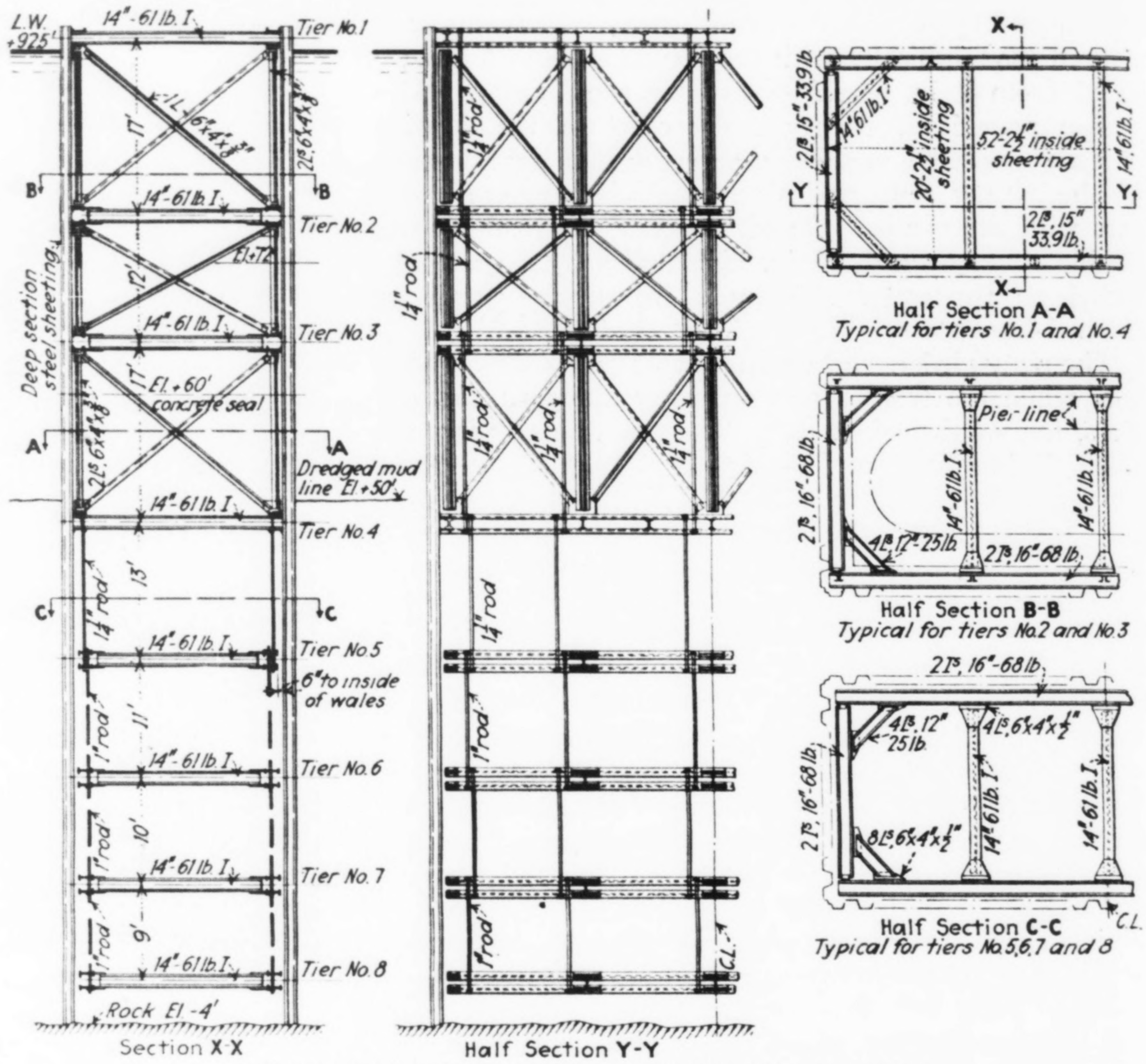


FIG. 5—DETAILS OF STEEL COFFERDAM BRACING

Concrete aggregates, both fine and coarse, consisted of iron mine tailings obtained from a near-by mine. These tailings contained a considerable portion of iron ore, resulting in an unusually heavy concrete. For the underwater concrete an approximate 1:1.8:3.6 mix was used, with 6.5 gal. of water per sack of cement. For the shaft concrete 7.7 gal. of water per sack was used, with the proportions approximating 1:2.5:5. Two minutes minimum time in the mixer was specified for the underwater mix, with 1½ minutes minimum allowed on the shaft concrete.

All concrete was handled by a floating plant, consisting of a steam stiff-leg charging derrick, a batcher bin and a 1-yd. gasoline mixer, all mounted on one barge. Aggregates and cement were delivered by barges, with the derrick boat that handled the concrete bucket also unloading cement.

Superstructure Erection—Interesting features of the steel erection were the delivery of material, the ingenious method of closing main span No. 7, the driving of 140-ft. falsework piling and the advantage taken of the continuity of the trusses in erection procedure. Most of the steel was unloaded at a railroad siding on the New York side 3 miles from the bridge site. All of the material unloaded here was trucked during the early winter season over poor roads at their worst. On the Vermont side the steel for spans 9 to 14 was unloaded 15 miles from the bridge site and trucked over equally poor roads with bridges blocked up on the ice to carry the loads. Steel for spans 8 and half of span 7 was carried out over the structure from the New York side, lowered to barges and transported to the Vermont side after the ice went out of the lake.

Four falsework towers of twelve 12x12-in. spliced piles each were driven for spans 4, 6, 8 and 9, as shown in Fig. 2. A tower composed of three falsework bents of ten piles each was driven for span 5, the span being cantilevered out from the New York side to the sixth panel point, blocked on the falsework tower, and then cantilevered to the pier. Span 7 was cantilevered out from each side, closing at the center. Some of the piling reached 140 ft. in length, driven part way before being spliced. Cables stretched between the tops of the piers carrying light timber stringers served as guides for the piles, which were driven by steam hammers hung from the traveler booms without the use of leads. Most of the falsework was erected while the lake was frozen over, the ice serving as a working platform and slots in the ice acting as bottom guides for the piles.

Erection was carried on from the New York side by a light corner derrick traveler, which received its material from a track on top and from the Vermont side by an 8-ton traveling A-frame or "jinnywink" traveler, which received material from barges below. Work was continued through the cold winter months without interruption.

Closing of Span 7—In erecting main span 7, which is

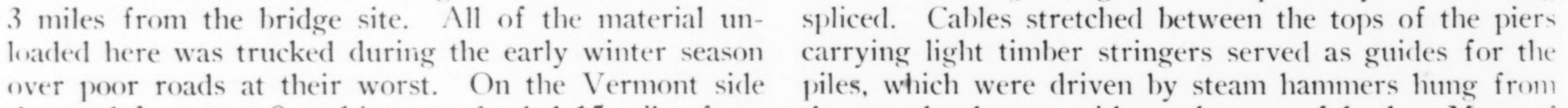


FIG. 4—TYPICAL CROSS-SECTIONS OF DECK

FIG. 6—POURING SIDEWALK AND CURB
Concrete handled by single high cars from central plant.

continuous with spans 6 and 8, closure was effected by keeping the ends of spans 6 and 8 low at piers 5 and 8 respectively, thereby keeping the cantilevered halves of span 7 high until ready to close. Then the low ends of the side spans were jacked up, rotating the two halves about the shoe pins on piers 6 and 7 and bringing the closing ends together. By temporarily omitting the roller nests and a cast-steel filler block in the expansion shoes of piers 5 and 8 the trusses were lowered at these points 20 in., which, through rotation of the spans about the shoes on piers 6 and 7, left an opening of about 13 in. in the top chord and about 7 in. in the bottom chord of the center panel of span 7, which, though subject to change by deflections and temperatures, could be varied by shifting the rocker shoe on pier 7 longitudinally. This shoe was shifted and span 8 jacked up until the bottom chords closed, with the top chords lacking about 1 in. of closing. The two side spans were then jacked simultaneously until the top chords closed, the shoe on pier 7 sliding back again.

When the steelwork was completed, the reactions at piers 6 and 8 for the load then on the spans were calculated and the ends of the structure raised by hydraulic jacks until the pressure gages indicated the desired reactions. The roller nests and cast-steel filler blocks were then inserted under the shoes, and the shoes were blocked to the desired height by steel shims.

Concrete Deck—For pouring the deck the contractor set up a central mixing plant at the end of the New York approach, using mine tailings for aggregates trucked in from the mine. One-half the width of the deck was completed before the other half was started, with the curbs and sidewalks poured separately. Concrete for the deck was delivered in high side hopper cars handled by narrow-gage gas dinkeys, as shown in Fig. 6. Wooden forms supported by horses resting on the bottom flanges of the floor stringers were used for the deck.

A new concrete road connecting the bridge with an existing hard road was built by the state on the New York side. Two unimproved roads lead off from the Vermont end, although the state expects to improve one of these to provide adequate access to the structure.

Personnel—Mortimer Y. Ferris is chairman of the Lake Champlain Bridge Commission, which was created by compact between the two states for the erection of the bridge. Fay, Spofford & Thorndike, Boston, as consulting engineers on the project, designed the structure

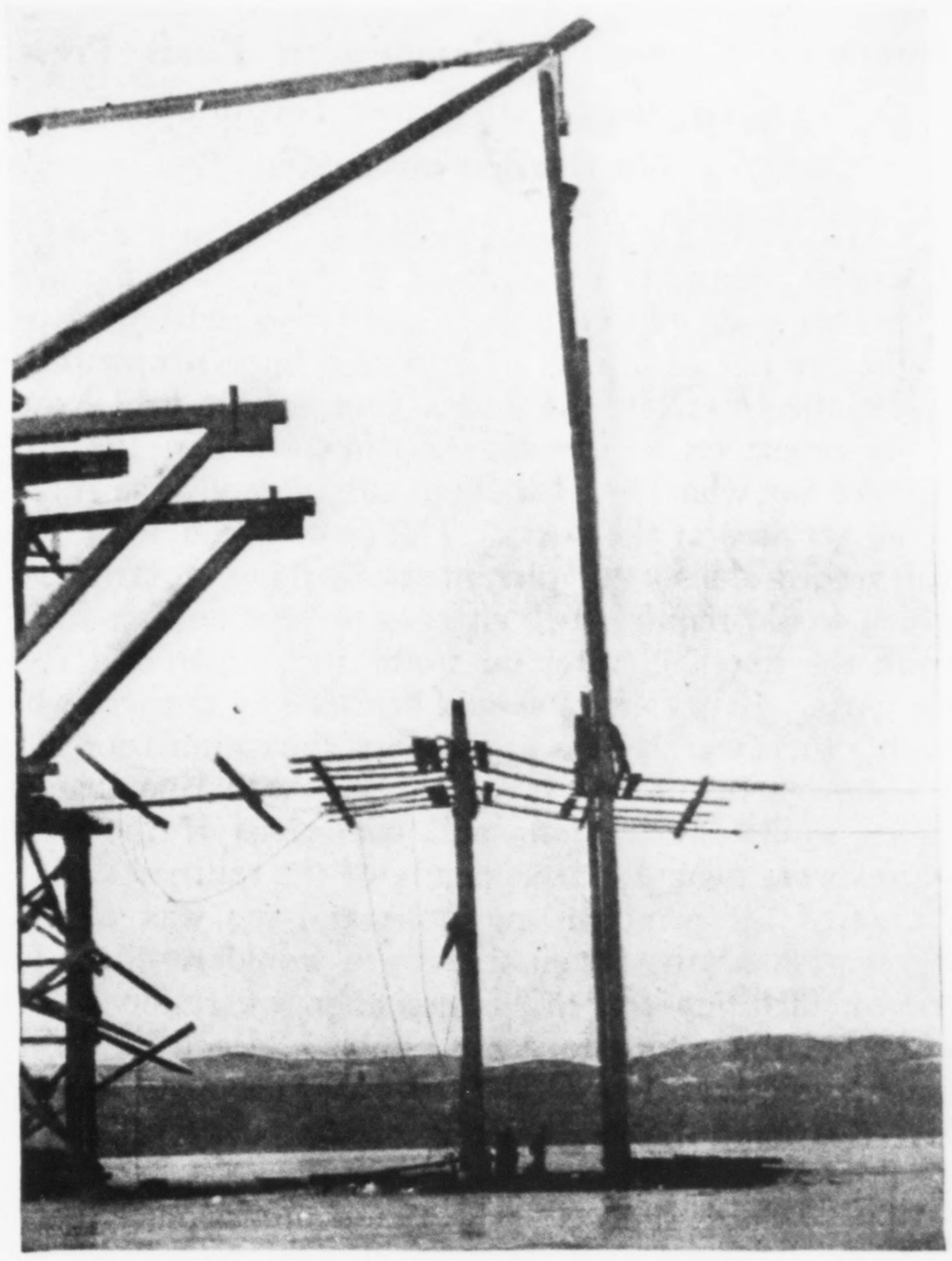


FIG. 7—DRIVING 140-FT. FALSEWORK PILING WITH CABLE GUIDES AND NO LEADS

and supervised construction. George L. Mirick was resident engineer until July 1, succeeded by John L. Lamson, both acting for the consultants. The Merritt-Chapman & Scott Corporation, New York, was contractor on the substructure, which was built under the direction of George Burrows, assistant construction manager, with Fred Logan as superintendent and W. H. Walker as engineer on the job. The American Bridge

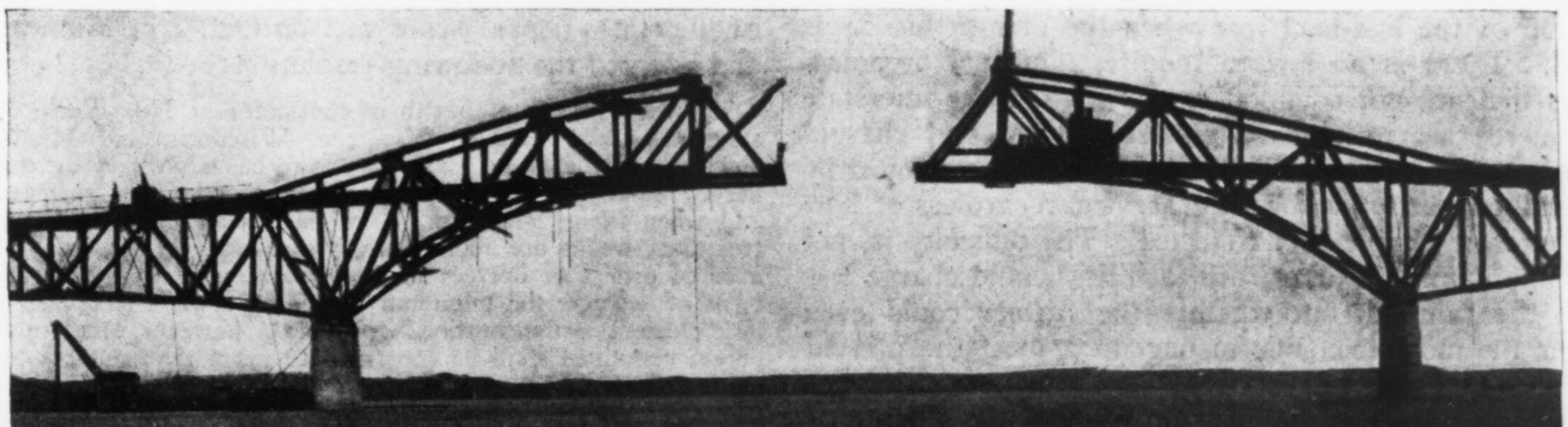


FIG. 8—ERECTION OF MAIN SPAN

Company had the contract for the superstructure, which was carried out under the direction of J. E. Wadsworth, division engineer; H. W. Troelsch, assistant engineer, and J. B. Gemberling, manager of erection. D. S. Fine was erection engineer, with D. M. Wood as foreman of erection. The Scott Bros. Construction Company, Rome, N. Y., was subcontractor on the deck concrete.

Separation of Railroad Terminal Charges Found Not Warranted

Interstate Commerce Commission Finds Present Charges at Rail-Water Terminals No Burden on Traffic

RAIL-WATER terminal facilities at Atlantic and Gulf ports appear to be adequate for normal traffic needs and charges on export, import, coastwise and intercoastal traffic are not so low as to impose a burden upon other traffic, the Interstate Commerce Commission held Nov. 9 in its report on an investigation instituted in 1921 into charges for wharfage, handling, storage and other accessorial services at the ports. The commission found that the record does not warrant prescribing a tariff rule which would require such charges to be stated separately from the line-haul rates on traffic moving to and from the ports. Every effort should be made by carriers when leasing their warehouses to shippers, the commission said, to obtain terms no less favorable than would be obtained under similar restrictions and conditions if the warehouses were owned independently of the railroad.

One of the principal questions at issue was whether segregation of the terminal charges would result in improved facilities for the interchange of traffic at the ports, but the record failed to establish, according to the commission, that the present rail-water terminal facilities have restricted the development of the port terminals or the flow of foreign commerce.

"The record shows," said the commission, "that a separate statement of the port charges by the rail carriers might enable municipal or private facilities to enter the field in affording car-to-shipside delivery at the ports. The carriers, however, would be required to observe their tariff charges, while the municipal or private facility might make varying charges for their services. That situation exists today at south Atlantic and many of the Gulf ports where the port charges are stated separately. Some of those favoring the segregation of the port charges state that the observance of the tariff charges by private facilities for the port service could be assured by having such charges published in the railroad tariffs and collected by the railroad in connection with the collection of the line-haul rate when the private facility is used. There is no law to require municipal organizations that are not common carriers under the interstate commerce act to observe published rates and charges except where the municipal organization is employed by the rail carrier to perform the service, regardless of how the rates or charges are collected. The difficulty is, not that the municipal or private facilities would charge less than the railroad, but whether the former could even under the most economic management meet the present low charges of the rail carriers."

With reference to the question whether the attempt of the railroads to meet the competition of the ports results in charges that are so low as to impose a burden upon other traffic, the commission said that the evidence does not support such a finding. Declaring that this question appears to assume unlawfulness if a railroad earns different degrees of profit on different services or on different parts of the same service, the commission points out that, manifestly, the freight rates on many commodities from interior points to the port are insufficient to cover the mere cost of transfer from cars to shipside at the port. Discussing the contention of private and municipal warehouse and rail-water facilities that charges for the use of railroad-owned facilities are so low that it is impossible for them to meet railroad competition, the commission said that the railroads are under no obligation to make their charges with the view to insuring a profit upon operations of other public terminals and that there can be no violation of the law when carriers fail to place their charges on a basis which will enable their competitors to take away their business. The railroads argued that the terminal services are incidental to the line-haul service and that the charges for such services stand therefore in an entirely different light from those of private or municipal facilities that rely entirely upon the charges derived from the port services for their revenues.

Airway Maps Available

The U. S. Coast and Geodetic Survey is establishing a mailing list in order that those who indicate the desire may be notified promptly when new (or new editions of) airway maps are available for sale. No charge is made for this service. At present, this bureau is publishing airway strip maps to the scale of 1 to 500,000, or about 9 miles to the inch, covering an area 80 miles wide along established airways. These strip maps show streams, roads, railroads, towns and elevations, and emphasize features of importance to air navigation such as airports, auxiliary landing fields, beacons, high-tension lines and magnetic courses. They are compiled from topographic maps of the Geological Survey, highway, post route, state and county maps, and from information supplied by organizations and individuals. Flights are made over the area covered to check the accuracy of the compilation. The Coast and Geodetic Survey is the distributing agency for these maps as well as the strip maps of the air corps of the United States Army. The price is uniform at 35c. per copy with a reduction of 10c. per copy on orders for twenty or more maps.

Steps to Prevent Pollution of the Great Lakes

Matthias Nicoll, Jr., New York state commissioner of health, announces that steps have been taken by the health commissioners of various states to prevent pollution of the Great Lakes. The health commissioners of the states named below met on Oct. 2 in Minneapolis and adopted the following resolution:

> The departments of health of the states of New York, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin and Minnesota, signators to the Great Lakes drainage basin sanitary agreement, hereby agree relative to the treatment of municipal sewage that (1) when advice is sought, (2) when plans of municipal sewage-treatment works are submitted for approval, or (3) in the issuance of orders or decrees to municipalities relative to the treatment of sewage, the minimum degree of sewage treatment shall be "efficient sedimentation," provided, however, that nothing herein contained shall be construed to mean that suitable higher degree of treatment may not be required as needed for the protection of the public health nor construed as hampering or interfering with the discretion of each state health department in details of sewage projects such as minor sewer outlets, storm-water overflows and the like.