Telescoping Tower on Scow Shifts Arch Centers

Ten Steel Centers Used for Spans of New Harrisburg Bridge Across Susquehanna—Set Up Twice Under Each of 46 Arches —Scow Trips of 3,000 Ft. With 60-Ton Centers Assembled

ASSEMBLED steel centers for 66-ft. arches will be set up and taken down some ninety times by means of a floating erector employed at the Susquehanna River bridge of the Philadelphia & Reading R.R., at Harrisburg, Pa. This erector consists of a steel-frame tower mounted on a scow, and made of three parts which slide up and down on each other, or "telescope," so as to alter the height of the tower. A variation, between bridge ends of 24 ft. in the height of the spring lines above water level, made an alteration in the height of the center necessary for each arch. The telescoping feature of the tower provides for this adjustment of the center vertically, while the floating support is a most flexible means of conveyance from span to span and from side to side of the bridge.

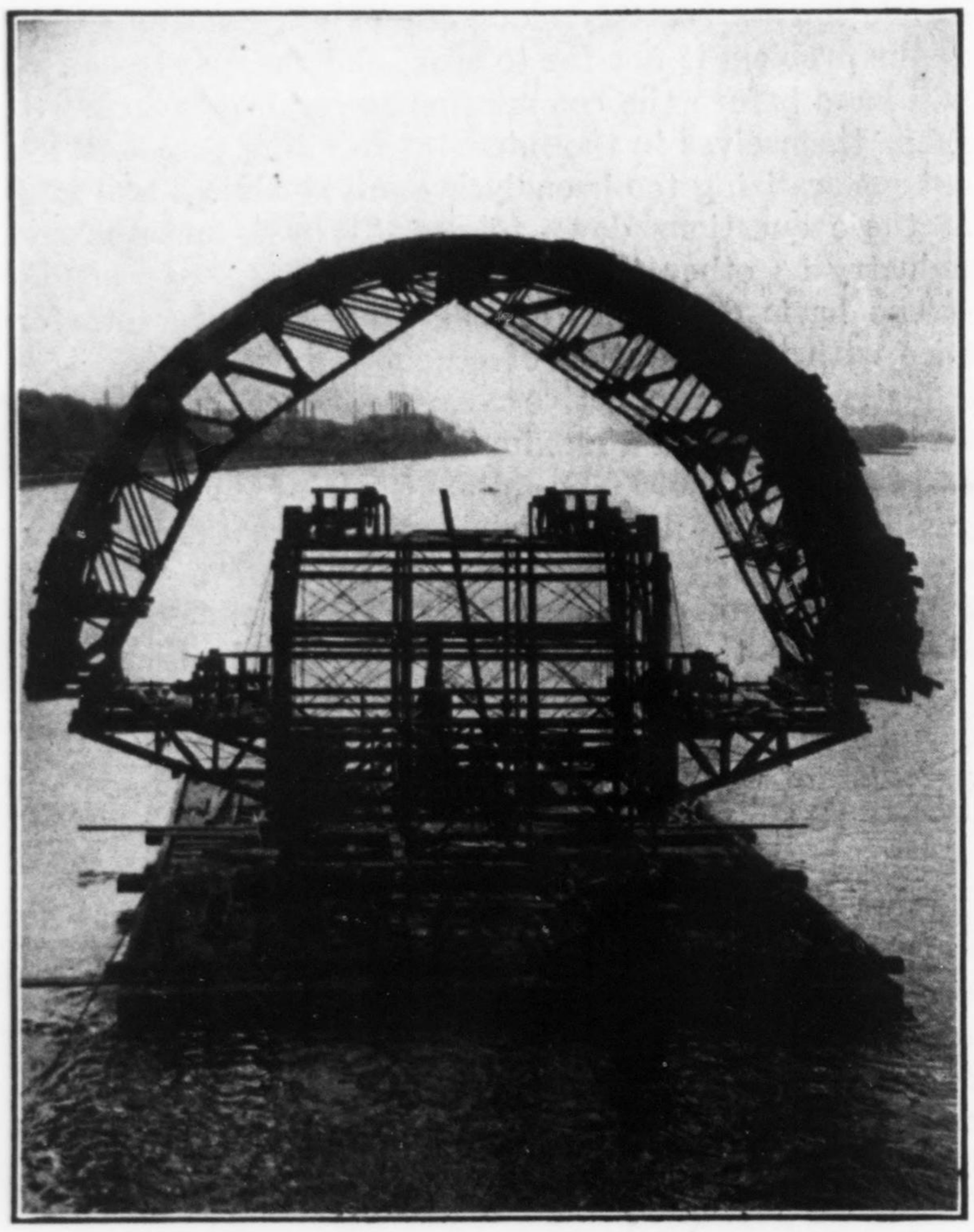


FIG. 1. CENTER ON ERECTOR MOVING TO NEW POSITION

There are 46 spans in the new bridge only two of which are wholly on shore. Under all the others, with perhaps a little crowding at the banks, scows can be floated. The clear spans are all 66 ft., but the two shore spans are 70 ft. 6 in., center to center of piers and the others are 73 ft. 3 in. The arches are circular with a 3-ft. ring at the crown. Between parapet walls the width is 31 ft. 6 in. and it provides for double tracks. One-half of the width comes directly in the place occupied by the present steel bridge so that the new bridge is being built a half at a time except the piers. These were built full size encasing and extending with concrete the old steel bridge piers and building additional intervening piers of concrete. The arches were built first for the half of the bridge not interfering with the old steel bridge. When the tracks are shifted to this half from the old bridge that structure will be removed and the remaining half of the concrete arch structure will be completed.

Half of the bridge being built at a time, the center for each arch has to be erected and taken down twice. With water under all but two spans and high water, drift, ice and navigation obstacles to fixed falsework, the natural thought was to plan a few centers which could be used repeatedly and to employ water craft as the means of shifting the centers. The hard usage of repeated shifts made steel the obvious material for the centers. For the same reason it was apparent that the arrangement for placing, removing and transferring the steel ribs ought to be of the erector type—a mechanism which would lift down the assembled structure, safely carry it to another place and put it up again, performing, incidentally, all the necessary adjustments. In these circumstances centers and erector were parts of a single problem in design and fabrication and were arranged to be handled together by the Blaw-Knox Co., Pittsburgh, Pa.

Each center consists of three steel-arch ribs with hinges at the crown. The ribs are assembled, completely braced and lagged, as a unit. In place they rest on brackets set into niches molded into the concrete piers. The view, Fig. 2, shows a series of centers in place, with the old steel bridge visible through them. When being erected, lowered and shifted they rest on

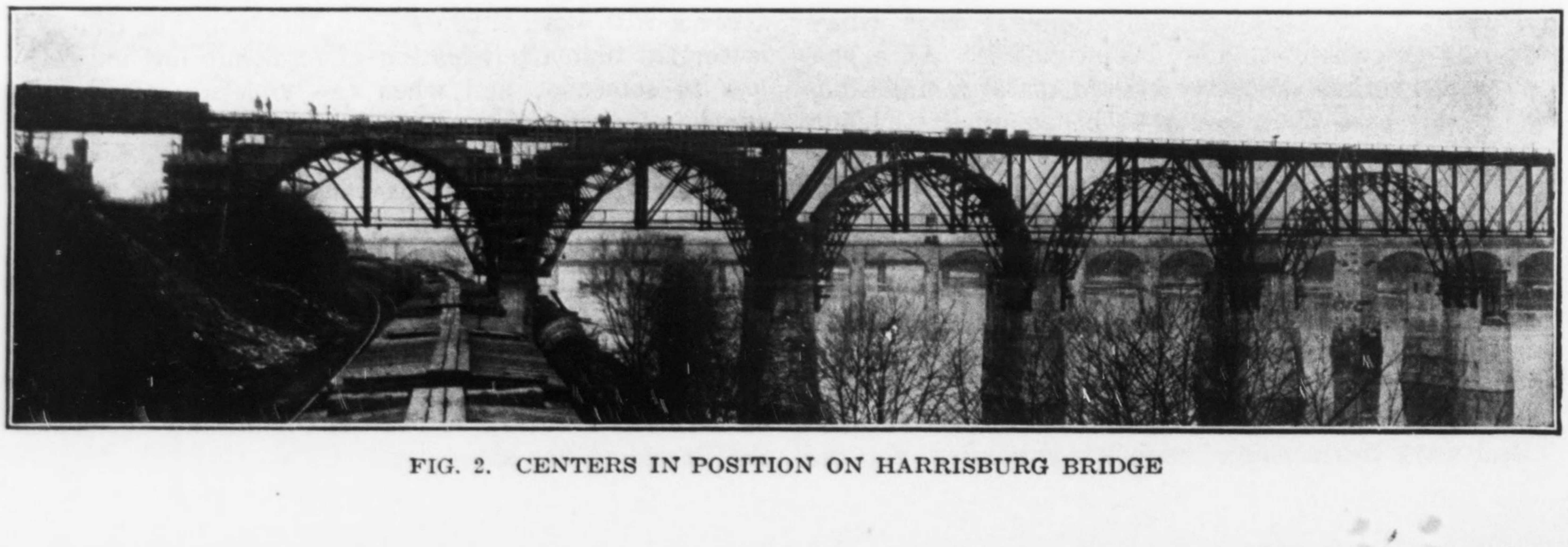


FIG. 2. CENTERS IN POSITION ON HARRISBURG BRIDGE

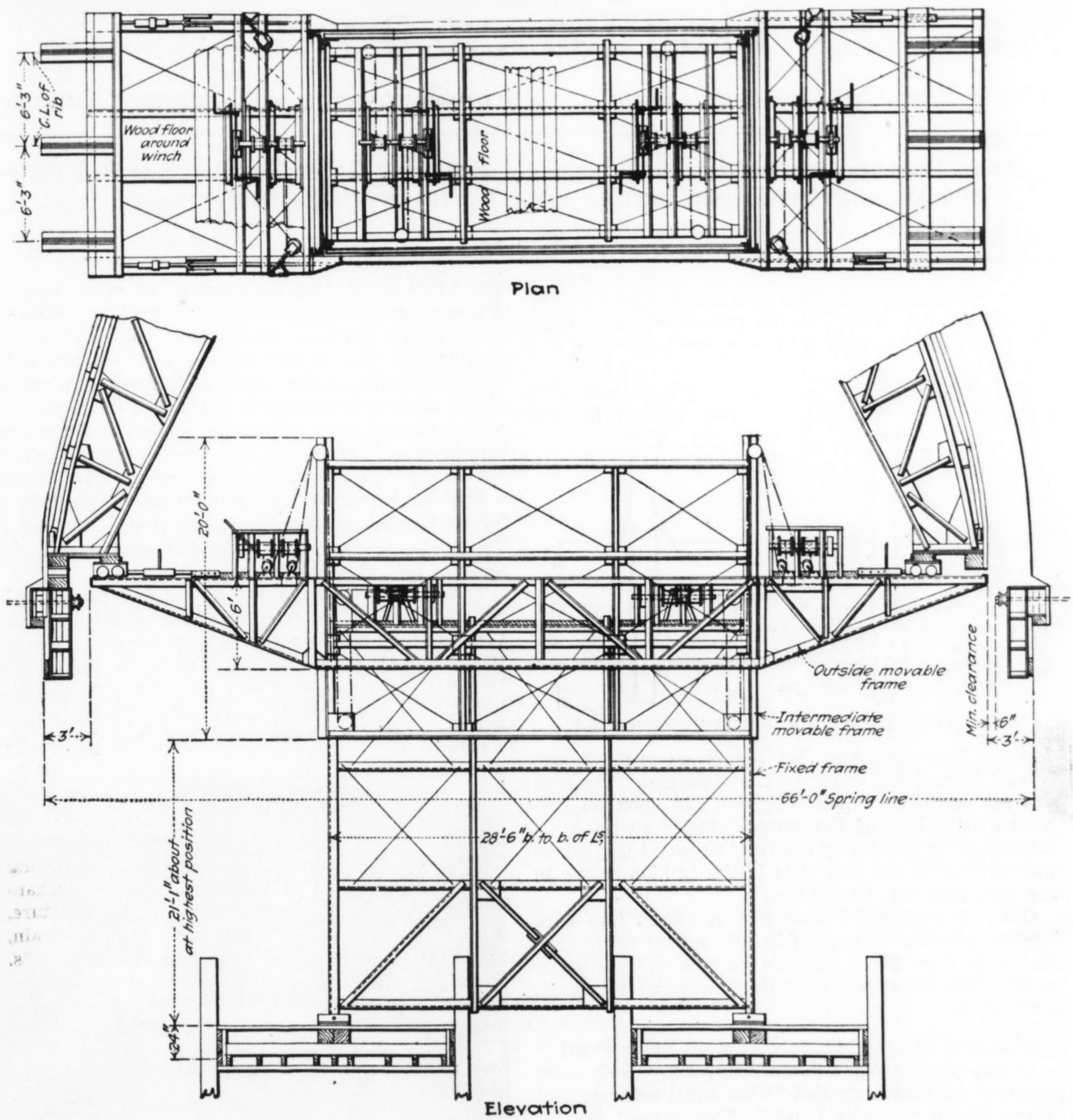


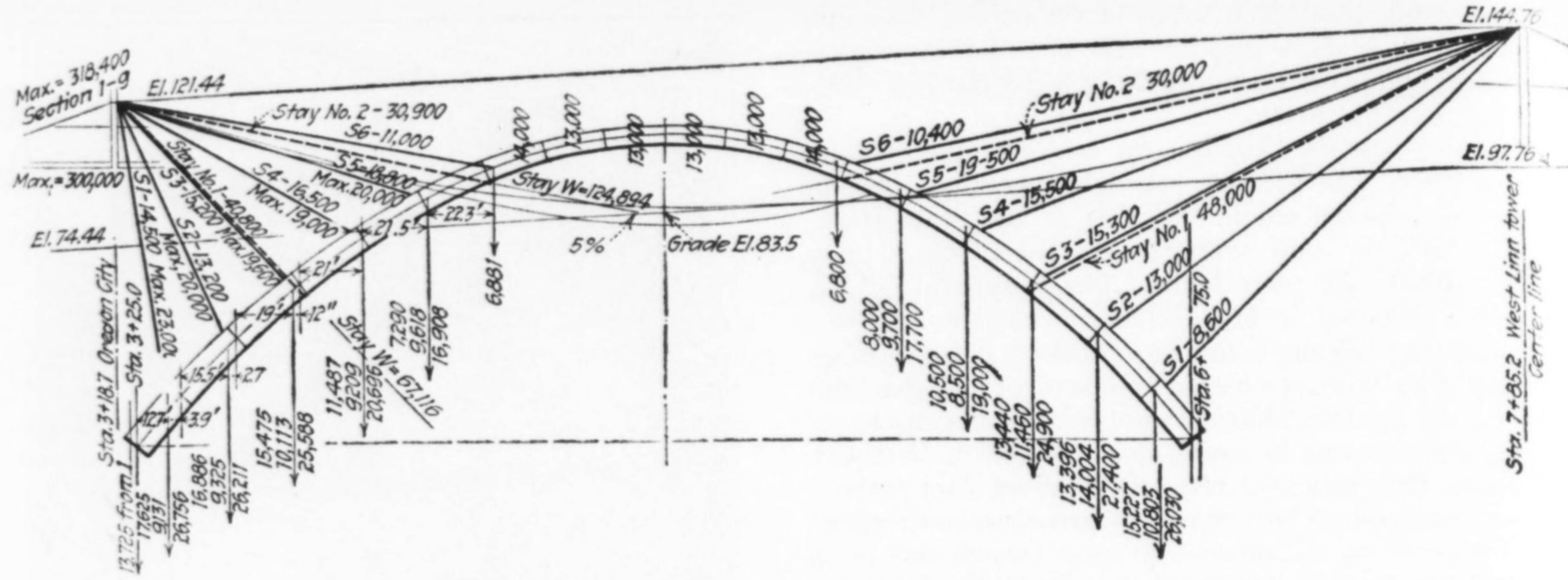
FIG. 3. DIAGRAM OF ERECTOR FOR MOVING CENTERS

the cantilever arms of the erector as shown by Figs. 1 and 3. Once assembled a center does not need to be dismantled and none of them were while one-half of the bridge was being built. In the considerable intervals between the building the first and second half, it was necessary to dismantle and store the centers.

The distinctive feature is the erecting tower. This is shown in general detail by Figs. 1 and 2. It consists of (1) a rectangular steel frame fixed on the scow; (2) an intermediate movable frame which slides up and down on the fixed frame, and (3) an outside movable frame, with cantilever arms, which slides on the intermediate frame. The movable frames are operated by winch drums operated by a worm drive so that the movements are always under control. Fig. 3 shows the position of the centers on the erector, on the left side when the center is in position for concreting and on the right side when it has been contracted for moving. For transfer from arch to arch the movable frames are lowered so as to bring down the center of gravity and make the load safe for towing. Fig. 1 shows the center in towing position.

A change of center from arch to arch requires about one day, including all adjustments and getting ready to concrete. To raise the center from its lowered position while being towed, takes about 2½ hours. Experience with the erector has demonstrated that for the work it has to do the structure has to be strong and rigid and there must be ample reserve power in the hoists to make operation easy and sure.

The contractors for the bridge are the James McGraw Co., Philadelphia, Pa. It was designed by the engineers of the Philadelphia & Reading Ry., Samuel T. Wagner, chief engineer.

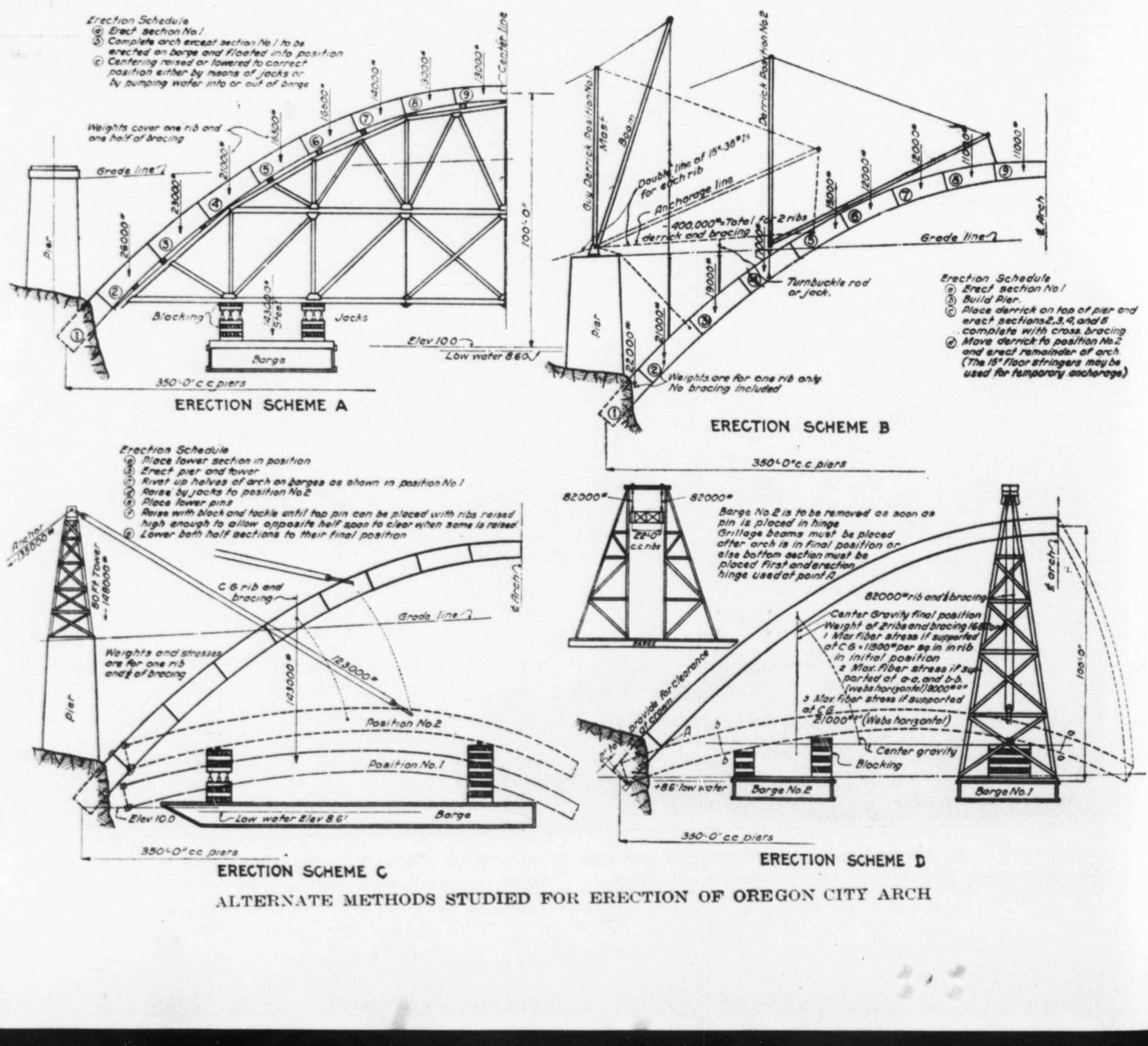


GRAPHIC REPRESENTATION OF THE CABLE STRESSES IN ERECTING THE ARCH

extreme end of section 3 and one at the extreme end of section 6. These stay cables were designed to carry the entire six rib sections independently of cables, S1 to S6 inclusive. The two stays shown were afterwards discarded in favor of one heavy stay cable at the end of section 4.

The central portions of the rib span (sections 7, 8 and 9) were placed on timber bents carried directly on the main cables of the old suspension span. One of the views shows the construction of these bents, the last section being placed at the time of the taking of this photograph. There is also a view of the completely swung rib with the central falsework removed from the main cable and a portion of the column and floor steel in place.

Tests of material cut from the main cable made in the laboratory at the time of erection disclosed an ultimate strength of 157,000 lb. per square inch. This, with an area of 13.85 sq.in., gave a breaking load of 2,174,450 lb.; while the maximum erection load under



ALTERNATE METHODS STUDIED FOR ERECTION OF OREGON CITY ARCH the worst condition amounted to 351,000 lb., thus giving an ample factor of safety. The radial cables were 1-in. plow steel having a breaking load of 38 tons. The stay cables were of 2-in. plow steel having a breaking strength of 140 tons.

In order to eliminate the difficulty of blocking the center sections to correct elevation, which would be caused by the varying deflection in the main cable, the six center sections were first loaded onto a platform between the bents and supported by the main cables causing the cable to take its final (or nearly final) position before the bent blocking was placed.

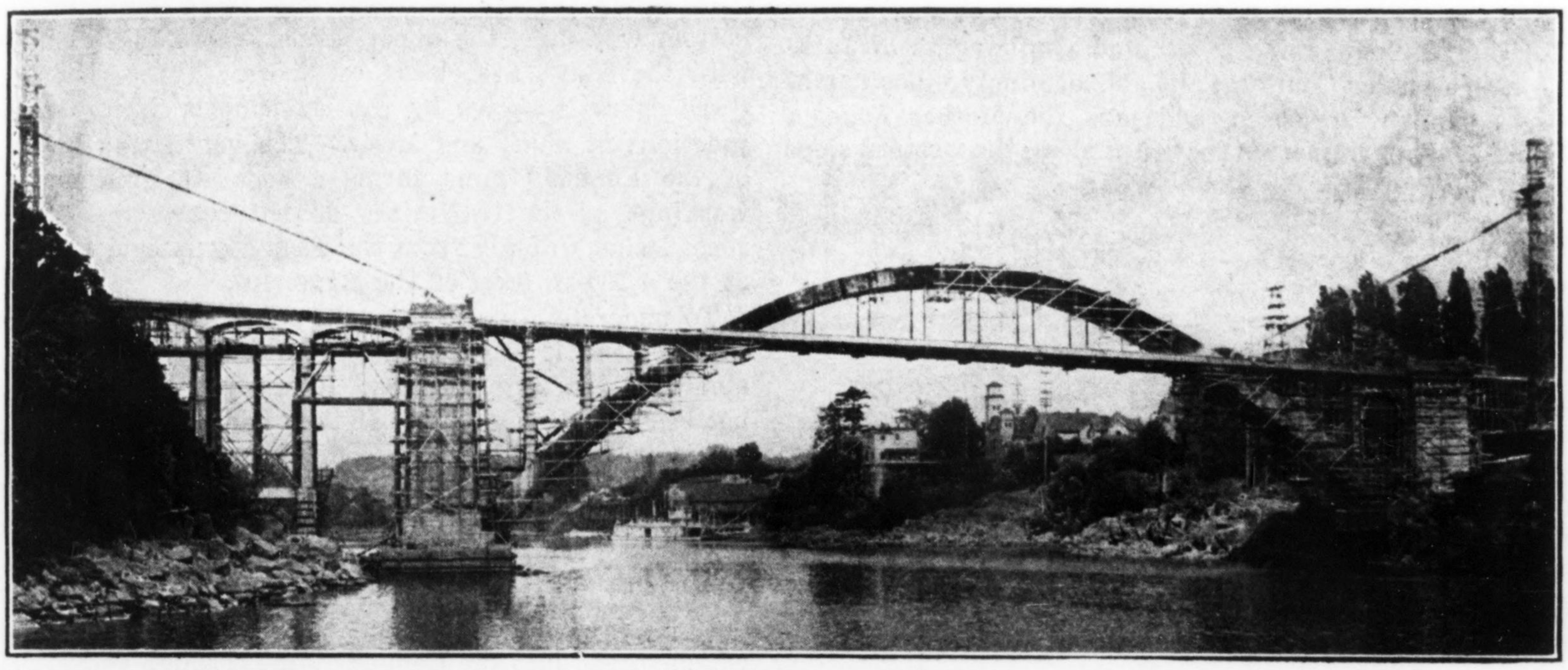
After the rib was swung, a portion of the remaining dead-load was added to the structure acting as a three-hinged arch. Subsequently, the ribs were fixed at crown and at skewback thereafter acting under live-load and the balance of the dead-load as fixed arch ribs.

Foundation Work—Some of the details of the construction of the main piers are worth describing. These foundations were on solid basaltic rock, one abutment being entirely in the dry and the other in about 8 ft. of comparatively still water. No problem out of the ordinary was presented by either foundation, the wet abutment being concreted in the dry through the unwatering of a double wall puddle cofferdam of ordinary type. Core drillings were taken for a distance of from 25 to 35 ft. below the surface to disclose the presence of any seams or pockets in the foundation material. The drillings, however, indicated nothing of this kind, yielding a very uniform and continuous core. Tested in the laboratory, these core specimens gave the following results:—

Maximum compressive strength —
15,300 lb. per sq.in. = 1,101.6 tons per sq.ft.
Minimum compressive strength —
11,050 lb. per sq.in. = 795.6 tons per sq.ft.
Average of maximum and minimum strength —
13,175 lb. per sq.in. = 948.6 tons per sq.ft.

In view of the fact that the resultant base pressure on the abutment, even under the worst possible live-load condition, falls within the middle third of the base and that the maximum extreme toe pressure amounts to but 4.9 tons per square foot, this type of foundation leaves little to be desired. The base rock was lightly shot and about 2 ft. of material removed in order to roughen the surface and remove any shattered or slightly seamed surface material and concrete placed thereon in the dry.

Personnel—Contract for this structure was awarded in June, 1921, to A. Guthrie & Co., Inc., of St. Paul and Portland, and construction work begun during the following July. The schedule of erection herein outlined operated with the utmost satisfaction to all parties concerned and from start to finish the program was carried through without a hitch. Credit for the admirable solution of the many erection problems encountered is due to the excellent engineering staff maintained by the contractors' and sub-contractors' organizations, to A. Münster, their consulting engineer, and to R. A. Furrow and C. P. Richards, who were in charge of the construction work for the Oregon State Highway Department, by whom the bridge is being built.



VIEW OF BRIDGE IN LATER STAGES OF COMPLETION

Canadian Canal Traffic Shows Increasing Tonnage

The July summary of Canadian canal statistics issued by the Dominion Bureau of Statistics, shows increased traffic in nearly every case. Total traffic through the Canadian and American locks at Sault Ste. Marie increased more than 26 per cent, over July, 1921, and also over June, 1922. The large increases were in wheat and iron ore; the latter totalling 8,942,659 tons, compared with 4,356,760 tons in July, 1921; 9,235,086 tons in July, 1920, and 8,912,609 tons in July, 1919. Wheat shipments for the month were 17,777,377 bushels as against 7,838,878 in July, 1921; 7,838,470 in July, 1920, and 7,100,008 in July, 1919. Coal shipments continued light.

Welland canal traffic showed a slight decrease from July, 1921, mainly in soft coal shipments and in American corn. Wheat shipments increased 191,291 tons or 6,376,000 bushels, while barley, iron and steel and pulpwood also showed increases.

On the St. Lawrence canal passenger traffic increased more than 44 per cent over that of July, 1921. Freight traffic also increase 23,256 tons or 4 per cent despite large decreases in coal and in corn and oats. Wheat, iron and steel, pulpwood, lumber and timber all showed substantial increases.