

Three New Allegheny River Bridges To Be of Unusual Type

Self-Anchored Chain Suspension Type Selected for Downtown Bridges Which Require Rebuilding

DESIGNS have been prepared by Allegheny County (Pittsburgh) for the superstructure of three new bridges across the Allegheny River, to replace existing bridges at Sixth St., Seventh St. and Ninth St. which interfere with navigation. Foundation work on the piers required for the new crossings is already in progress, contracts having been let a month ago. Bids on the superstructures have been asked for Dec. 22. The superstructure plans show a remarkable type of bridge, namely, a chain suspension bridge without anchorage, the chain pull being resisted by compression in the stiffening girder. A bridge of this type built across the Rhine River at Cologne, Germany, about ten years ago, is probably the only other example of the type in existence.

The Allegheny project is unique also in that three bridges of like design are being erected as a group, effecting, among other things, economy in design, fabrication and construction work.

Drawings of the Seventh St. bridge are shown here-with. It differs from the Sixth and Ninth St. bridges, which are alike, only by a few feet in span length and resulting minor divergences.

A hearing was held in 1916 by a board of engineers of the War Department, and this board subsequently recommended to the Secretary of War that six bridges over the Allegheny, within the city of Pittsburgh, be altered to give greater underclearance for navigation and a more satisfactory channel location. The struc-

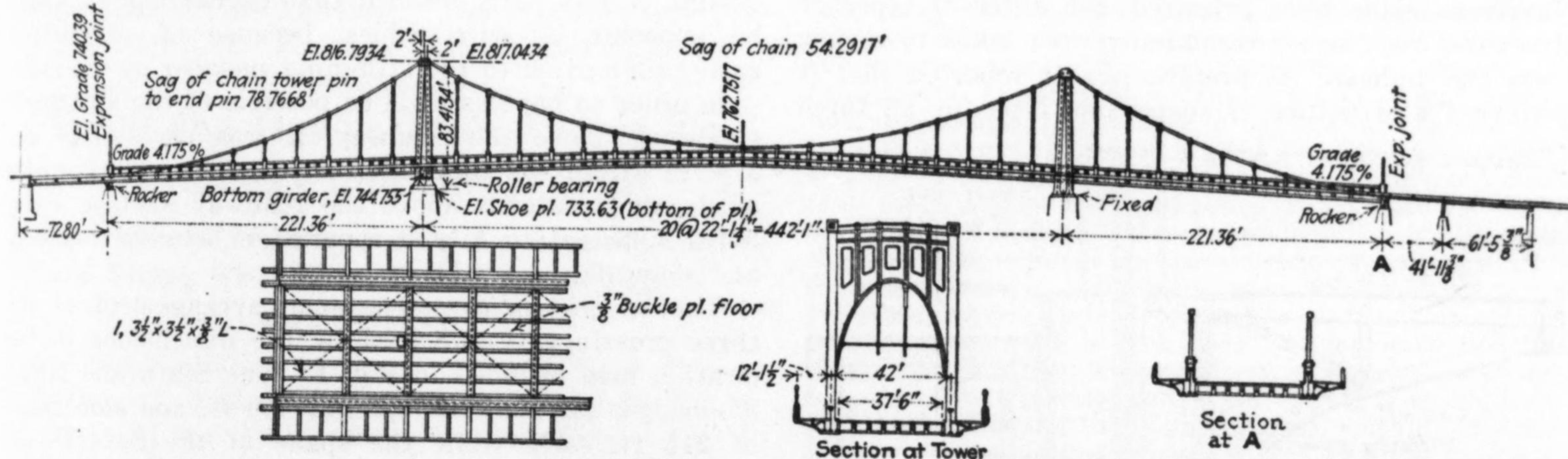
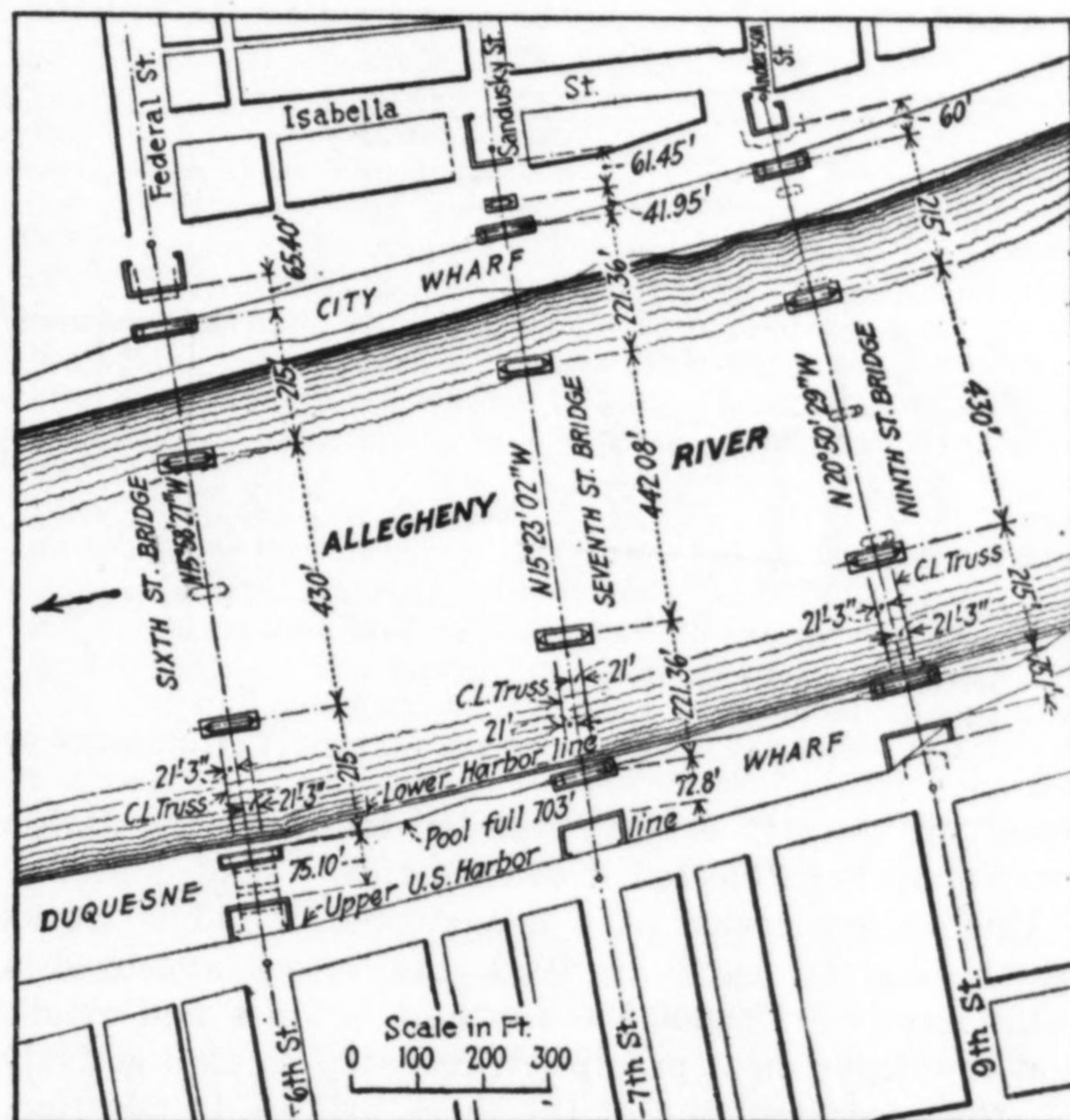


FIG. 1—GENERAL CONSTRUCTION OF NEW BRIDGE OVER ALLEGHENY RIVER AT SEVENTH ST., PITTSBURGH
The bridges at Sixth and Ninth Sts. will be of the same type and nearly of the same span length. The three bridges will be of identical appearance. The main cables are eye-bar chains. The bridge is stiffened by heavy box-girder members at roadway level. These girders also act as struts to resist the cable pull, eliminating the anchorage required by the ordinary suspension bridge. One of the towers is fixed to its pier; the other tower and the two ends have expansion bearings. The upper drawing shows the location of the three bridges.

The designs were worked out by the engineering division of the Department of Public Works, of Allegheny County, under the general direction of Norman F. Brown, director, and C. M. Reppert, assistant director. They were prepared by V. R. Covell, county engineer, and T. J. Wilkerson, consulting engineer, and A. D. Nutter, engineer of bridge design, of the bureau of bridges. However, the city art commission played a part in determining the type of structure, as indicated below. The following is in large part quoted from data supplied by Mr. Wilkerson.

Reasons for Construction—Eight or nine years ago navigation interests petitioned the War Department for improvement of navigation conditions in the Allegheny River at Pittsburgh. Most of the bridges over the Allegheny within the city had previously been owned by private corporations, but they had been bought by the county a short time before this petition.

tures in question were those at Sixth, Seventh, Ninth, 16th, 30th, and 43rd Sts. Reconstruction according to this recommendation was subsequently ordered by the Secretary of War; the order was suspended during the war, when the required steel could not be obtained, but was later renewed.

Four years ago replacement of the 16th St. bridge was begun, under designs prepared by Warren & Wetmore and H. G. Balcom. This bridge was completed a year ago. The 43rd St. bridge has been replaced by one at 40th St., just completed; this structure was designed by Benno Janssen and Charles S. Davis. The three important downtown bridges, however, presented so difficult a problem, on account of their heavy traffic, that little progress toward their reconstruction was made until the present year.

Selection of Design—Two years ago a design for the Seventh St. bridge was prepared by the county engi-

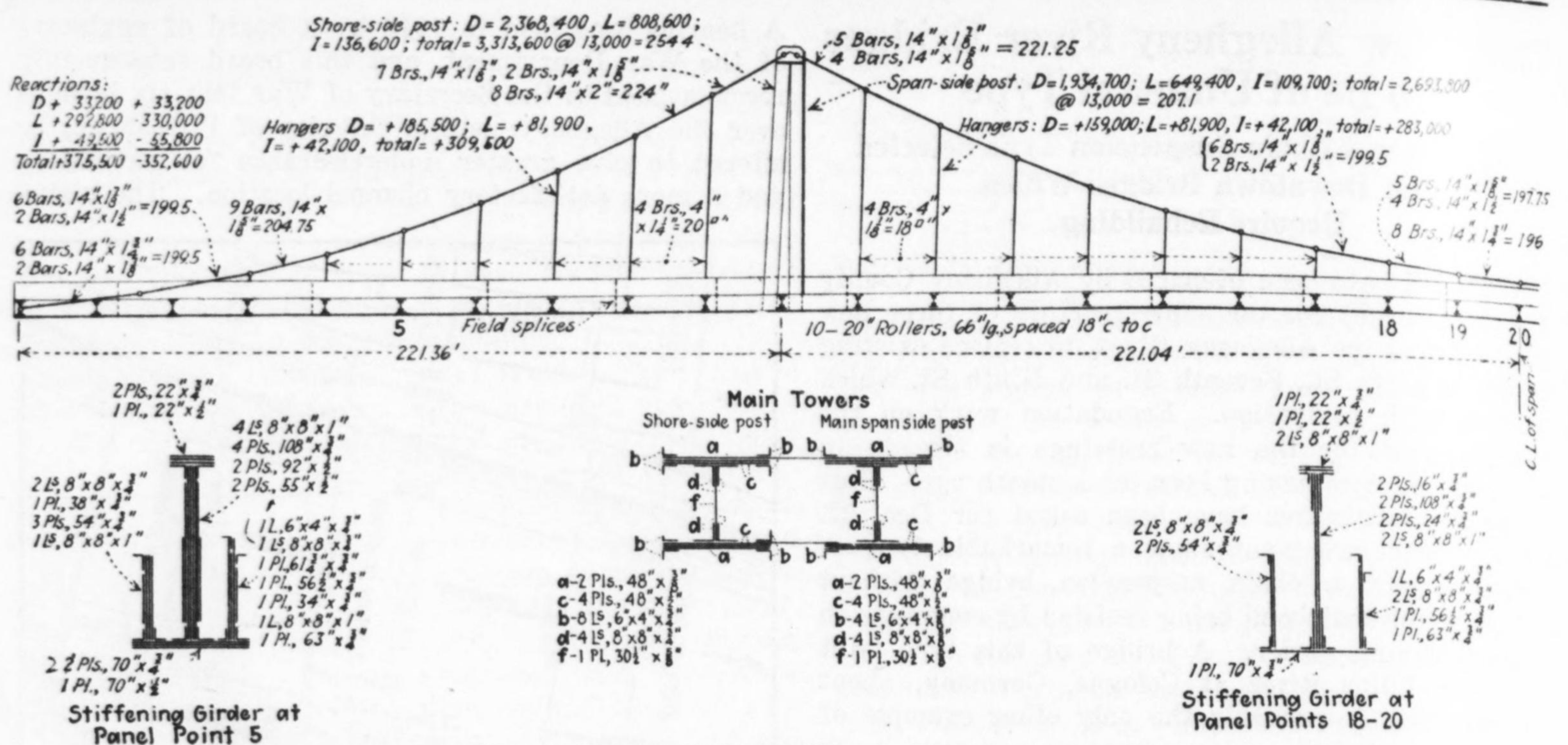


FIG. 2—PARTIAL STRESS SHEET OF SEVENTH ST. BRIDGE

neer, but the city art commission, to which the design was submitted, rejected it as esthetically inadequate.

Upon organization of a department of public works by the county, early in 1924, the voters approved a bond issue of \$29,000,000 for new bridges and roads, and the department promptly proceeded to plan actively for the reconstruction of the three bridges in question. Numerous plans were prepared, for different types of structure, and the art commission was asked to review them and indicate its preference. It reported that it preferred a structure of suspension type for all three

the north side and through the contemplated improvements on the south side. In the adopted type, anchorages are eliminated by utilizing the stiffening girder of the structure as a compression member to resist the horizontal pull of the suspension chain. The end supports thus are subjected to vertical forces only.

In working out the self-anchored suspension bridge design, it was early decided that eyebars would be superior to wire cables, because of permitting easier connection to the stiffening member at the ends.

In order to have as little as possible of the structural steelwork above the roadway, it was decided to use a plate girder for the stiffening member. This girder as designed extends above the roadway surface about 3 ft., sufficient to give a separation between roadway and sidewalk.

General Dimensions—The span arrangement of the three crossings is indicated by the dimensions in the location map included in Fig. 1. The Sixth and Ninth St. bridges have a main span of 430 ft. and side spans of 215 ft. each, while the spans of the Seventh St. bridge are 12 and 6 ft. longer, respectively. The drawings herewith, Figs. 1 to 3, refer to the Seventh St. bridge, but apply with only minor variation of dimensions to the other two bridges. As shown, the chain sag for the Seventh St. bridge is about 54 ft. 4 in. and the height of tower above pier about 83 ft. 5 in. The chains are spaced 42 ft. transversely, to accommodate a roadway $37\frac{1}{2}$ ft. wide between curbs. The sidewalks are cantilevered out. The roadway will take four lines of traffic (two lines of street cars and two lines of road vehicles).

Because of the large underclearance required at mid-span (47.1 ft. above pool level on a width of 180 ft.) and the low level of property at the approaches, the bridge roadway has unusually steep grades—4.175 per cent from either end to a point near the center, where a vertical curve connects the two grades. The stiffening girder follows the roadway profile, and thus has a camber of slightly over 15 ft. between ends and center. Since the two stiffening girders also resist the pull of the chains, they constitute a double strut, 885 ft. long curved to a middle ordinate of 15 to 16 ft., carrying an endwise compression of about 10,000,000 lb. The entire weight of the suspended structure is available

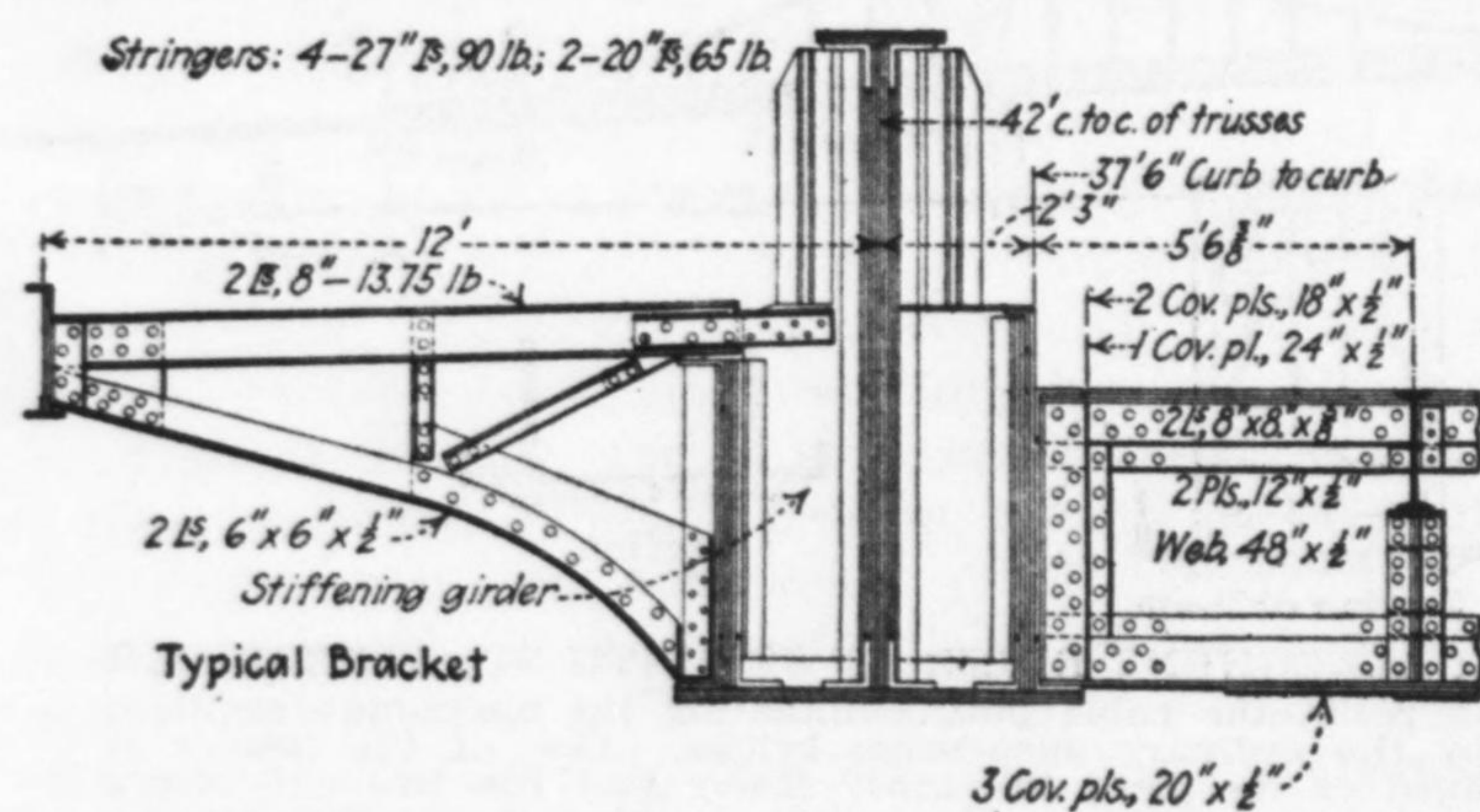


FIG. 3—CONNECTION OF FLOOR AND STIFFENING GIRDER
 The three-web box girder forms the stiffening member as well as the anchorage of the suspension chain.

sites. Thereupon the engineering division restudied the bridge sites with a view to adapting the suspension type. As a result, it selected the self-anchoring type of suspension bridge.

Past experience has indicated, it is stated, that suspension bridges in Pittsburgh are subject to slip of the anchorages. Rock is about 50 or 60 ft. below water. Space is not available for anchorages of the ordinary type of suspension bridge, as at both ends of the crossing in each of the three cases there are obstructions to carrying the cables to a satisfactory land anchorage. On the north side of the river a railroad track passes between abutment and shore pier, which would make it necessary to carry the cables over the track, while at the south end proposed wharf improvements interfere. It was therefore highly desirable to use a type of structure which would not require any portion of the main bridge to pass over the railroad track on

for holding it down against any tendency to buckle under this condition. The vertical load imposed by the chains on each main tower reaches a maximum of about 6,000,000 lb.

The three-web construction of the stiffening girder is shown by two cross-sections (minimum and maximum) in Fig. 2, where the make-up of these sections also is indicated. The central web is 108 in. deep, and the two side webs 54 in. and 63 in. deep, respectively. The maximum girder section is 1,109.13 sq.in.

The chains will be made of heat-treated eyebars, of minimum yield-point 50,000 lb. per square inch and minimum ultimate strength 80,000 lb. per square inch. Each chain is made up of 8 and 9 bars alternating, the bars being 14 in. wide and of varying thickness up to 2 in. The maximum section, at the tower top, comprises 7 bars 14x1½ in. and 2 bars 14x1 in., a total section of 229.25 sq.in.

The suspenders are attached to stirrups riveted to the vertical stiffeners of the stiffening girders. The floor construction comprises a simple floorbeam and stringer system carrying a concrete slab. Floorbeams and sidewalk brackets are riveted direct to the sides of the stiffening girders.

The bridges were proportioned for live-load equivalent to two 18-ton trucks and two 60-ton cars, together with a sidewalk live-load of 66 lb. per square foot. The total live-load is equivalent to 6,590 lb. per lineal foot of span. In proportioning the stiffening girders and cables, an impact factor of 16.9 per cent was applied to the live-load. The eyebars were proportioned for a unit stress of 27,000 lb. per sq.in.

What the Dawes Plan Means To Industry and the World

Some Extracts from Speeches By Hoover, Hughes and Young That Show How German Reparations Come Back To All of Us

A THOUSAND or more men in New York City on Dec. 11 tendered a dinner to Owen D. Young, chairman of the Board of the General Electric Co., in honor of his services on the so-called Dawes Commission, which last summer prepared the plan for reparations to be paid by Germany which has since been put into effect. At that dinner were given a number of notable speeches, too lengthy to abstract here, but some of the remarks so clearly indicated the importance of the reparations settlement to the world in general and to industry in particular that they are presented below.

How Industry Benefits—Secretary of Commerce Hoover sounded the keynote of the evening. He said in part:

While the adjustment [of the German reparations] primarily advances the welfare of the nations of Europe, it reaches far afield in the world. Unemployment and suppressed production anywhere in the world are in the long view a world loss. This restoration of confidence and hope and enterprise, this restoration of commerce, of productivity, and of employment, this relief of suffering in a great nation, is a world asset. As a people we also participate in its blessings. Some part of our growing demand for labor, some part of the increased prices already realized by our sorely distressed agriculture, have come from this restoration of economic vigor and hope in Europe. It is a great thing to have contributed so much of this achievement.

Some have doubted whether the enormous liabilities estab-

lished under this settlement can be discharged. There are those who have contended that no great external contributions from one nation to another can be economically sustained. Without debating this question I may be permitted to offer one thought in this connection. The payments provided in such settlements must find their substance from production and economic services rendered. These international obligations are huge burdens, but in the course of years any burden shrinks in weight in proportion as the productivity of a nation grows. When the world keeps peace it doubles its international trade once in nearly every score of years. The advancement of science, of invention, and of industry has shown an unceasing contribution to the productivity of peoples. The burdens of the Napoleonic wars were at that time also debated as being insuperable. It was contended that the world would break down under them, and yet a score of years later they bore so lightly that their dangers were no longer discussed. Indeed the processes of industry and commerce are the cells which heal the injuries of the economic world. They cannot multiply in the noxious air of conflict and political uncertainty. The settlement to which our guest has contributed so much clears the atmosphere, and the magical multiplication of these cells will quickly provide the strength to meet the burdens—if the world keeps the peace.

But beyond even these special occasions of vivid public service, Mr. Young has made a still further contribution to American life—perhaps the greatest of all his contributions. That is in his display of the fine sense of the responsibility which today rests upon those who administer our largest industries.

Manufacture and distribution on a vast scale are the foundation of our high standards of living and the general comfort of our people. They can be accomplished in no other way than through the development of great units of production. With their development have come innumerable problems of public relationship and public responsibility. We are in fact today witnessing a rapid evolution and perhaps a silent revolution in the relationship of great business to our social system. We are struggling to preserve the fundamental stimulus of action, of initiative and competition, to hold open the avenues of opportunity. At the same time we are struggling to gain the benefits of co-operative action. In this period of evolution nothing is more needed than clear vision of their public responsibilities on the part of our industrial leaders. For here is a triple trusteeship—a trusteeship to the owners who ultimately must be comprised from the savings of those who endeavor to provide security for their dependents and for their old age; the trusteeship for a vast body of employees that they should have stability in employment and a sense of security for work conscientiously performed, that they should have a growing standard of living and comfort, and full opportunities for recreation and education; and an equal trusteeship to the whole public who are served by the products of these enterprises. It is in the public interest that the product should be multiplied; should be given with every advantage of technical excellence and service and upon the best terms which can be attained with due regard to the two other strong obligations toward which our leaders must also look. This trusteeship goes even further. Constant gains to each group depend upon the elimination of waste and the constant development of science and invention, of increasingly efficient organization. Beyond this again these organizations must be held high in the business and ethical relations by the character of their leaders. They must be conducted in a fine sense of non-interference with human rights.

I know of no responsibility larger than that imposed upon the leadership of great industries, for from their leadership and their vision must come not only great contributions to our economic progress but upon it depend the solution of the many social problems which confront us. We have a real and growing measure of this sense throughout American industry. And Mr. Young has been the expression of this type of leadership.

What the Expert Does—Secretary of State Hughes contributed the following pertinent thought:

The greatest difficulty that we have in making democratic institutions work is in securing play for expert ability. Paradoxical as it may seem, we are too often overpowered by feebleness. In this instance talent has had opportunity,

Erecting a Self-Anchored Suspension Bridge— Seventh Street Bridge at Pittsburgh

Bold Method of Construction Adopted in Order to Avoid Falsework in Channel—Each Half Built as a Cantilever, with Temporary Diagonal Struts Between Chains and Stiffening Girder

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CANTILEVER erection was used in the construction of the self-anchored suspension bridge over the Allegheny River at Seventh St., Pittsburgh, completed some months ago. The highly original and bold structure was described in *Engineering News-Record* of Dec. 18, 1924, p. 995. Its unusual structural character created a remarkably difficult erection problem, which was solved most excellently by the American Bridge Co., contractor for the superstructure. The following brief outline of the method used has therefore been prepared, with the co-operation of P. J. Reich, the company's division engineer at Pittsburgh, and the following members of the county's Department of Public Works: T. J. Wilkerson, consulting engineer; A. D. Nutter, chief design engineer; H. K. Dodge, designer; and C. K. Harvey, assistant engineer in charge of field work.

A reference to the design will make the erection problem clearer. Fig. 3 shows an outline and some structural features of the bridge, reproduced from the earlier article already mentioned. It should be added that the new bridges to be built at Sixth and Ninth Sts. are of the same design, and almost of the same dimensions. The Ninth St. bridge is now being erected and should reach closure by early autumn.

Description—The bridge is a highway structure carrying four lines of traffic (two lanes for vehicles and two street-car tracks) on the roadway, and a cantilevered footwalk on each side. The roadway pavement consists of a 2½-in. layer of asphaltic concrete laid on a concrete base averaging 5 in. in thickness on ¾-in. buckle-plates, while the sidewalk pavement consists of a 1-in. surface of rock asphalt laid on a 5-in. reinforced-concrete slab. The dimensions of the main or suspended portion of the structure are:

Width of roadway 37 ft. 6 in. between curbs.

Width of sidewalk 12 ft. 1½ in. center of girders to center of railing.

Width center to center of girders and suspension system, 42 ft. 6 in.

Length of each side span, 10 panels of 22 ft. 1½ in.; 221 ft. ½ in.

Length of center span, 20 panels of 22 ft. 1½ in., or 442 ft. 1 in.

Height of towers, 77 ft. 11½ in.

Sag of suspension chain, 55 ft. 5½ in.

Grade, 4.175 per cent, with a vertical curve for 8 panels at the center.

The structure may be briefly described as a self-anchored suspension bridge. The suspension system consists of 14-in. eyebars extending from anchorage to anchorage, having two pins on the top of each tower, and carrying the roadway by 4-in. eyebar suspenders at the panel points. The stiffening system consists of triple-web plate girders placed parallel to the grade. The horizontal component of the stress in the eyebar chain is taken by the stiffening girders, while the

reactions at the ends are vertical. The girders are thus subjected to stresses due to bending combined with direct compression.

Erection of the Structure—Three principal methods were considered:

(1) To provide a temporary anchorage to support the suspension chain until the stiffening girders were connected up. This was discarded on account of lack of room for anchorage and unfavorable soil conditions, combined with the time element, which was an important factor.

(2) To erect the entire structure on falsework. This

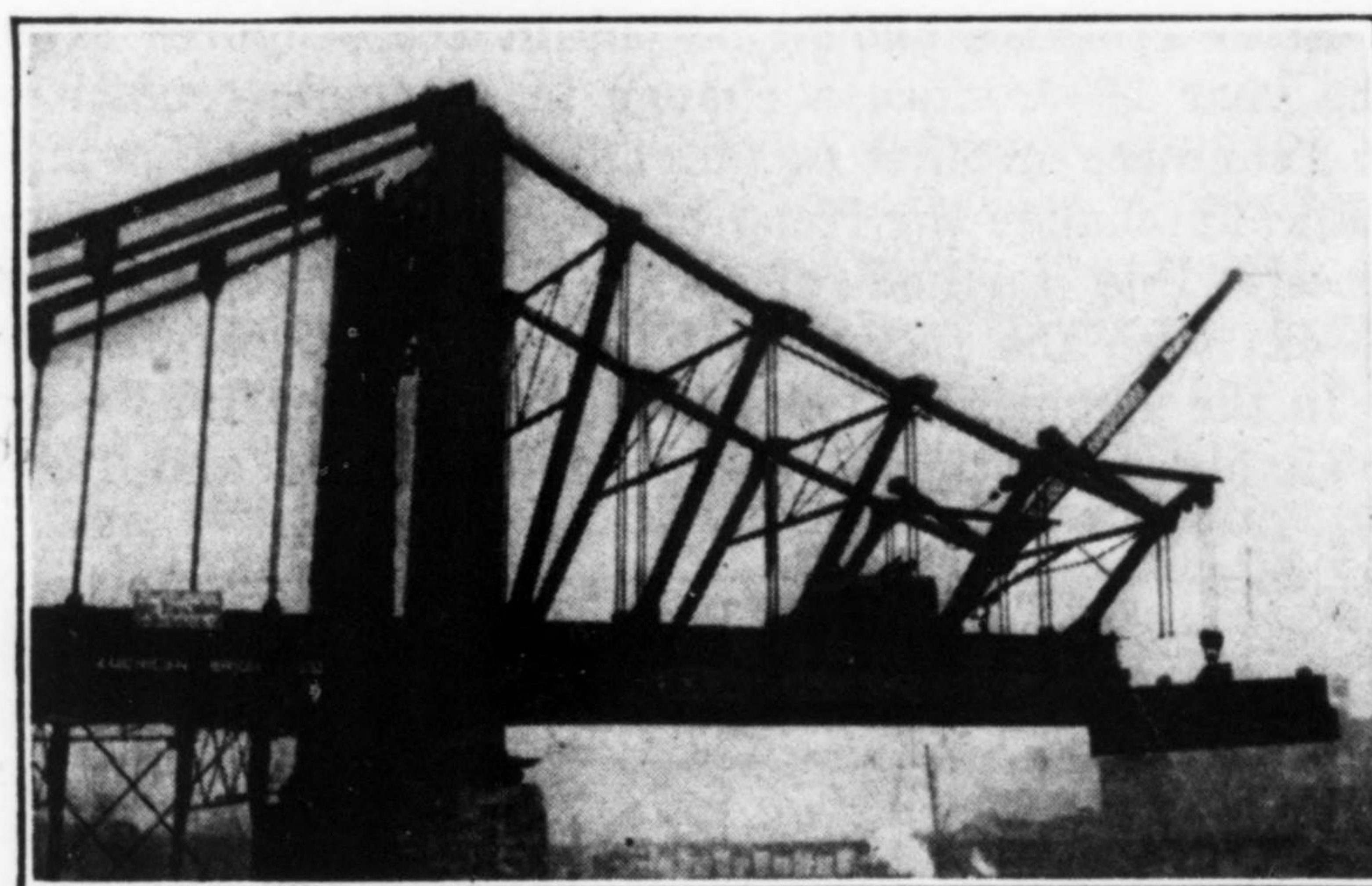


FIG. 1—SEVENTH ST. BRIDGE DURING ERECTION
View taken Nov. 17, 1925.

was not practicable because of navigation requirements; it would also have delayed erection about six months.

(3) To erect as a cantilever. This method was independent of temporary anchorages and practically independent of navigation and flood conditions.

The choice of method was left to the bidders, the only restrictions being those required for navigation and the time of completion. The American Bridge Co. was the successful bidder, and its engineers developed the third method, one never before used on this type of structure.

For convenience the sketch, Fig. 4, may be referred to. In the following description panel-points L_0 to L_{10} will denote the south or Pittsburgh half, and L'_0 to L'_{10} the north or Allegheny half of the bridge. Erection was carried on simultaneously from the north and south to the center of the bridge at L_{20} .

Wood piles carrying steel bents were driven at panel points 1 to 9 inclusive, those at panel points 4 and 7 being extra strong to provide for protection against floods in case the remainder of the falsework was carried out.

All material except that for the girder approach spans was delivered at the bridge site in steel barges, and picked up directly from them as needed for erection.

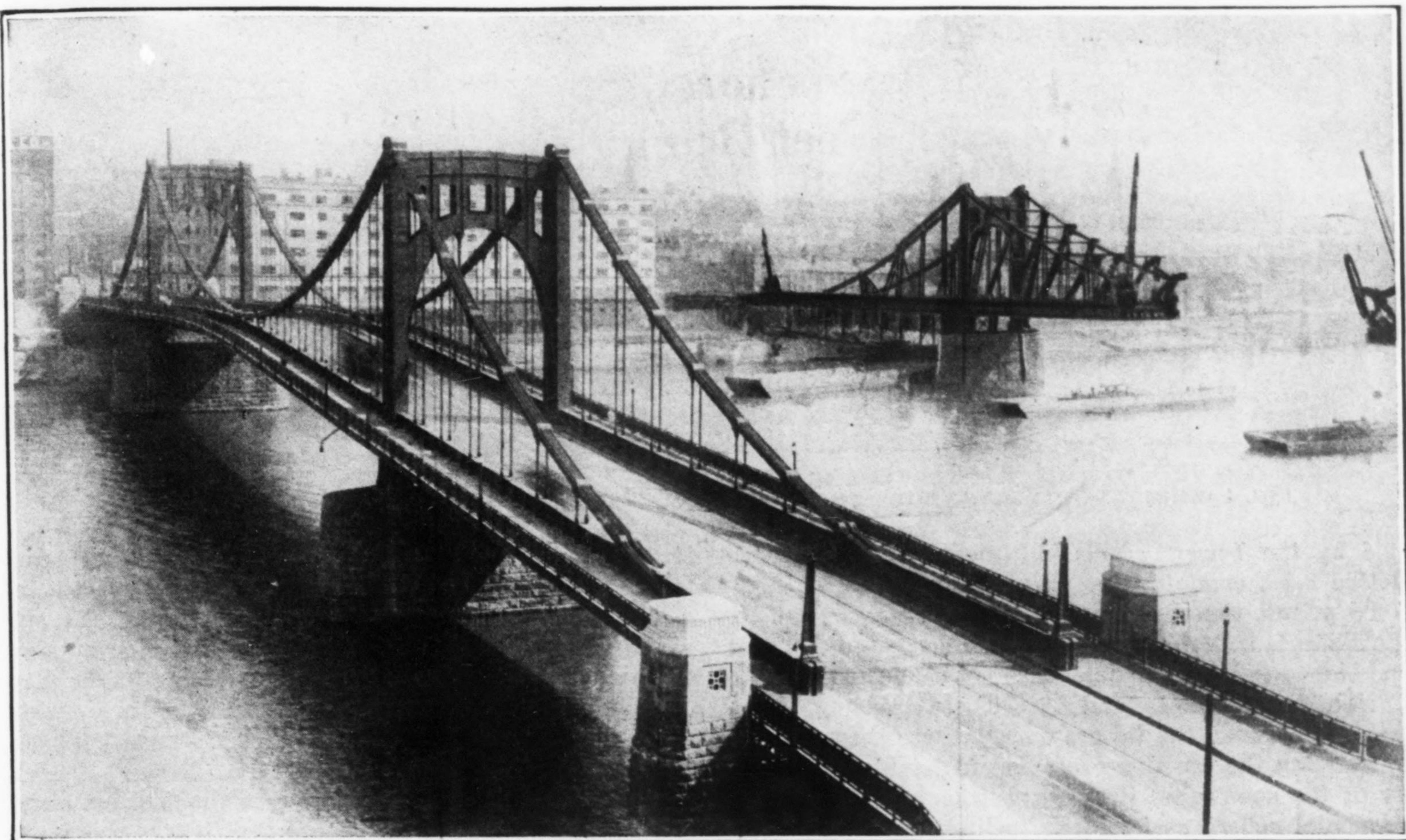


FIG. 2—SEVENTH ST. BRIDGE AT PITTSBURGH, COMPLETED

View taken July 21, 1926. The bridge was thrown open to traffic on June 17. Erection of the Ninth St. bridge is seen at the right.

The floor system was first erected from L_0 to L_{10} by locomotive crane weighing 100 tons, running on tracks on the erected floor, after which the stiffening girders and the eyebar chains were set. The girders were then jacked to their cambered position and the splices fully bolted up, the tower bases having been previously set. The towers were erected and held in position by adjustable struts joined at bottom to the stiffening girders.

The eyebars and hangers were erected in their final position from panel points 0 to 3. From panel points U_3 to U_6 and U_6 to U_7 , the eyebars were cradled and had their intermediate pins at U_4 and U_5 supported by the I-beam cradles. Points U_6 and U_7 were carried on special struts. Eyebars U_7 to U_{10} were similarly carried on I-beams supported at U_7 and the top of the tower, U_{10} ; the intermediate points U_8 and U_9 were car-

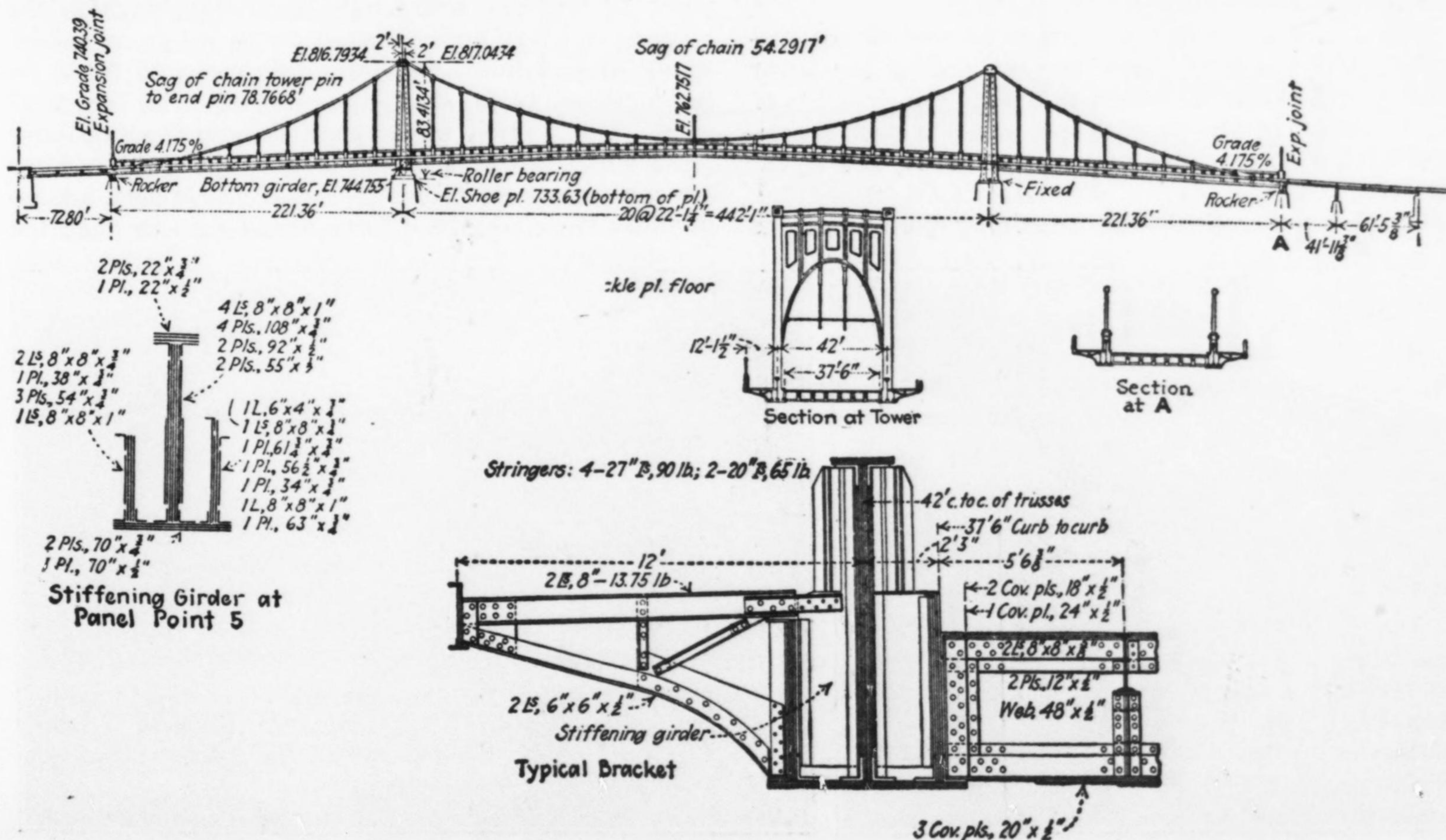


FIG. 3—GENERAL DESIGN FEATURES OF SEVENTH ST. BRIDGE, PITTSBURGH

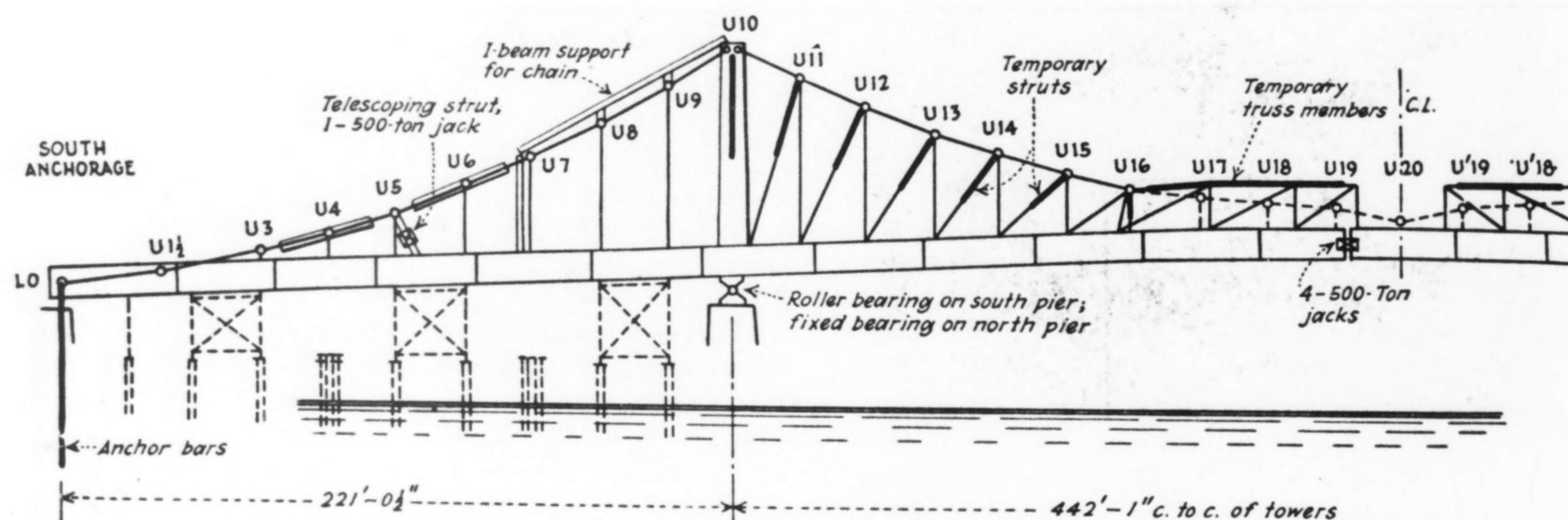


FIG. 4—ERECTION DIAGRAM, SHOWING TEMPORARY MEMBERS AND PROVISION FOR ADJUSTMENT

ried by the I-beam cradles by means of plates with slotted holes engaging the pins.

To permit the eyebar chains to be connected at U_{20} , the distance between the towers was decreased one foot and the bottom hanger pins were not connected at L_4 to L_6 inclusive and at L_{17} and L'_{17} . The decreasing of the distance between the towers one foot was accomplished by starting the erection of L_0 one foot toward the center of the span from its final position and setting the segmental rollers at L_{10} in an inclined position corresponding to this movement. The segmental rollers were then locked by temporary plates to prevent any further movement. The corresponding north part of the structure was erected in its final position.

The difficulty in connecting pins at U_{20} was due to the deflection of the cantilever, which was on a 4.175 per cent grade, and the cambered length of the members.

A telescopic strut, containing one 500-ton jack, so constructed that it could act either in tension or compression, supported the eyebar chain at U_6 , normal to the tangent of the curve of the chain.

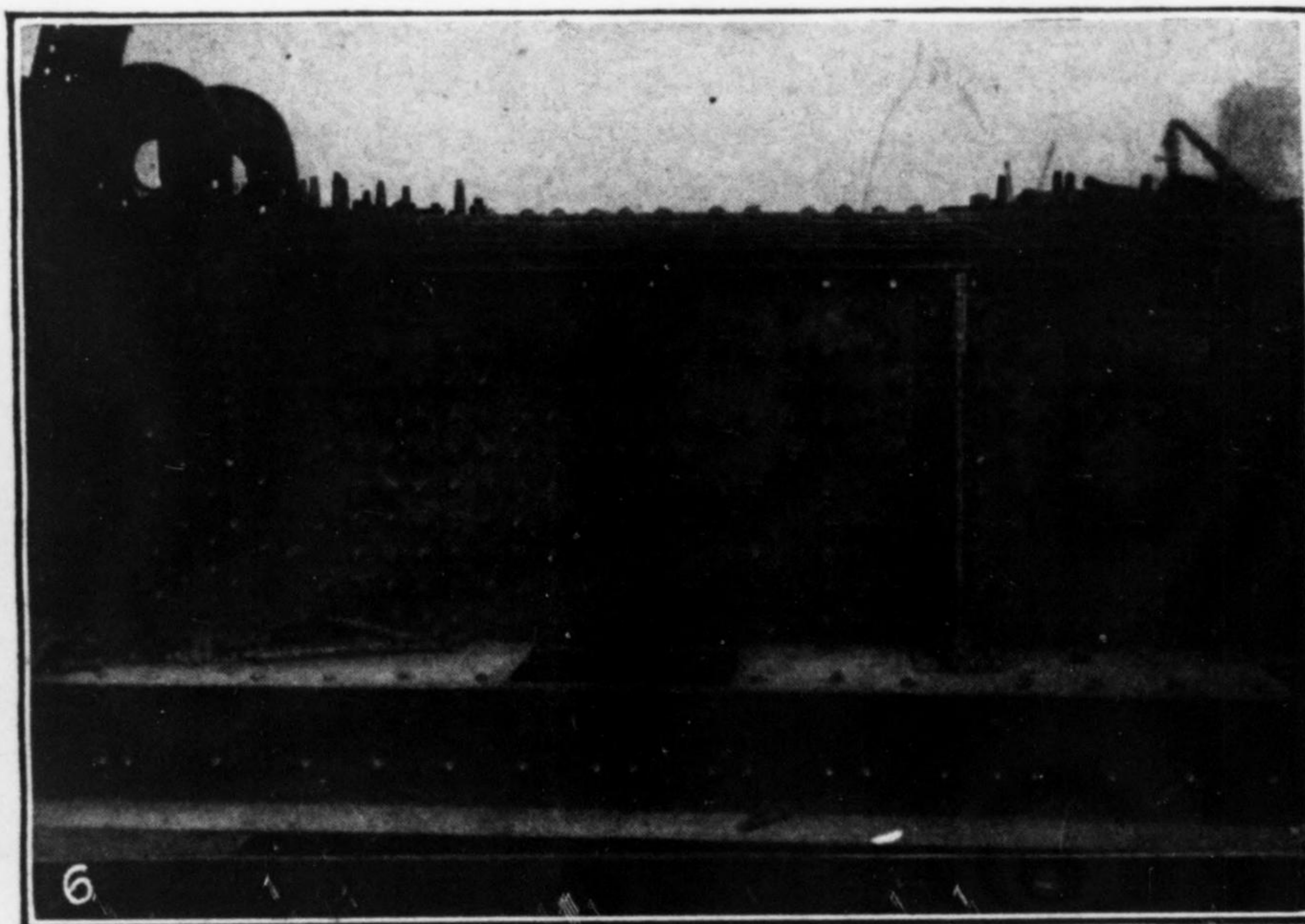
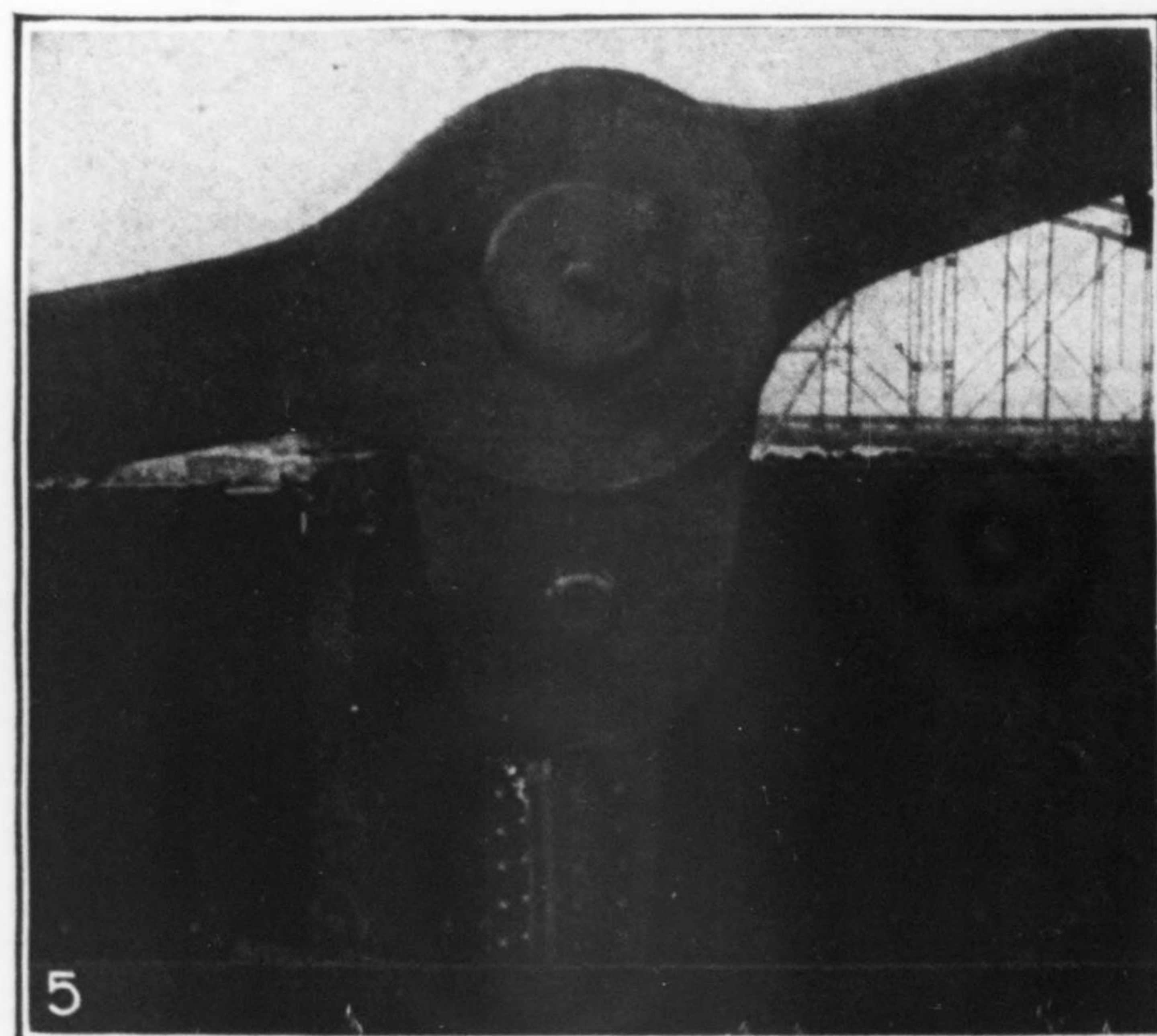
The function of this strut was to control the secondary stresses in the cantilever by pulling the tower back as deflections increased, to control the elevation of L_{10} to assist in the final closure, and to permit connecting the bottom pins at panel points L_4 and L_6 inclusive.

Cantilever Erection—The remaining portion of the

structure was erected as an ordinary cantilever arm, temporary diagonal erection struts being placed in panels 10-11 to 15-16 inclusive. The struts had pin plates at their upper ends, engaging the pins outside the bars, and temporary bolted connections to the girders at the lower ends. The erection stresses were of the same kind as the permanent stresses, but it was necessary to increase the section of the hangers U_{11} - L_{11} .

Beyond point U_{17} , the inclination of the erection diagonals would have been too flat, so that it was necessary to construct a truss having its top chord and web system entirely independent of any permanent material, the stiffening girders still acting as the lower chord. This truss was a second cantilevered arm attached to the first by means of a tie from U_{17} to the pin at U_{10} , having an effective depth of $16\frac{1}{2}$ ft., with the verticals placed ahead of the permanent panel points. This allowed the completion of the erection up to the splices located 3 ft. 8 in. beyond panel points 19 and 19'.

The nominal distance between these splices is 44 ft. $2\frac{1}{2}$ in. less 7 ft. 4 in., or 36 ft. $10\frac{1}{2}$ in., and as panel point 19 was one foot north of its final position the opening would be approximately 35 ft. $10\frac{1}{2}$ in. in length. The girder section L_{10} L'_{10} was fabricated 35 ft. $8\frac{1}{2}$ in. in length, or 14 in. short, thus leaving 2 in. for clearance. This section was supported from the cantilever truss while the eyebar chains were connected. Four 500-ton jacks were placed in each chord in such a manner that their combined force would pass through the



FIGS. 5 AND 6—TWO DETAILS—HANGER PLATE AND SPLICE OF STIFFENING GIRDER



FIG. 7—CANTILEVER END NEARING CLOSURE
Temporary truss framing was used near the middle to give increased depth until closure.

center of gravity of the cross-section of the stiffening girders. These jacks acted on suitable diaphragms, built into the chords near L_{10} .

With the center heavy girder section in place, together with the jacks, the locking plates on the roller shoes at L_{10} were taken off. The pins at U_{20} were then driven, completing the eyebar chain with practically no stress. The hanger pins from L_{17} to L'_{17} were then driven and, immediately following, the pins at L_4 , L_5 and L_6 and the corresponding pins on the opposite half were driven. Connecting these pins placed some stress on the bottom-chord jacks. Jacking was then started, converting the spans from cantilever to suspension type. The cantilever spans had the regular cantilever droop, so that, as jacking proceeded, the center of the channel span rose vertically and at the same time the south half of the structure was moved to its final position.

As the jacking stress approached the compression stress in the heavy chords (dead weight of steel plus erection equipment), the diagonals of the cantilever truss freed themselves, leaving the bridge a suspension span. At this point, the closing 14-in. section of the girder was entered, thus completing the stiffening girders. This 14-in. section was then restrained by adequate cover splices, all points riveted up and the jacks removed.

It was observed that when the span had reached its final position the stress as indicated by pressure gages on the jacks agreed very closely with the computed stress in the girders for the load then on the structure.

The erection of the steelwork of this bridge was commenced July 7, 1925; closure of the stiffening girders was made Feb. 9, 1926; and the bridge was thrown open to traffic June 17, this year.

Twelve-Mile Chilean Railway Has 62 Curves

A Chilean railway 18,700 meters or about twelve miles long, begun in 1924, from Pedegua to Petoroa in the Province of Aconcagua, has been completed and accepted. The new line cost approximately 3,000,000 pesos, is of meter gage, and in its twelve miles of length contains 62 curves.

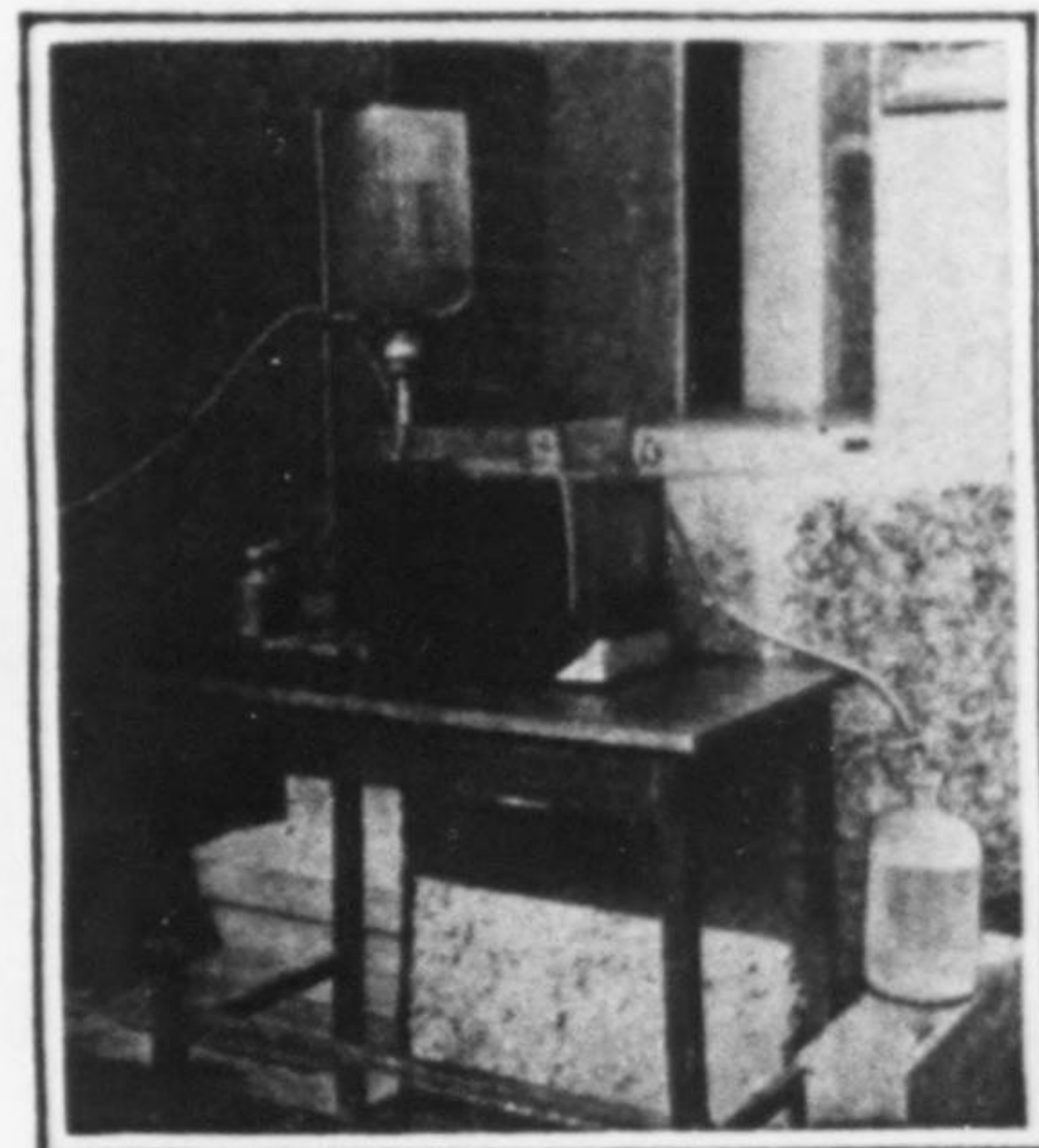
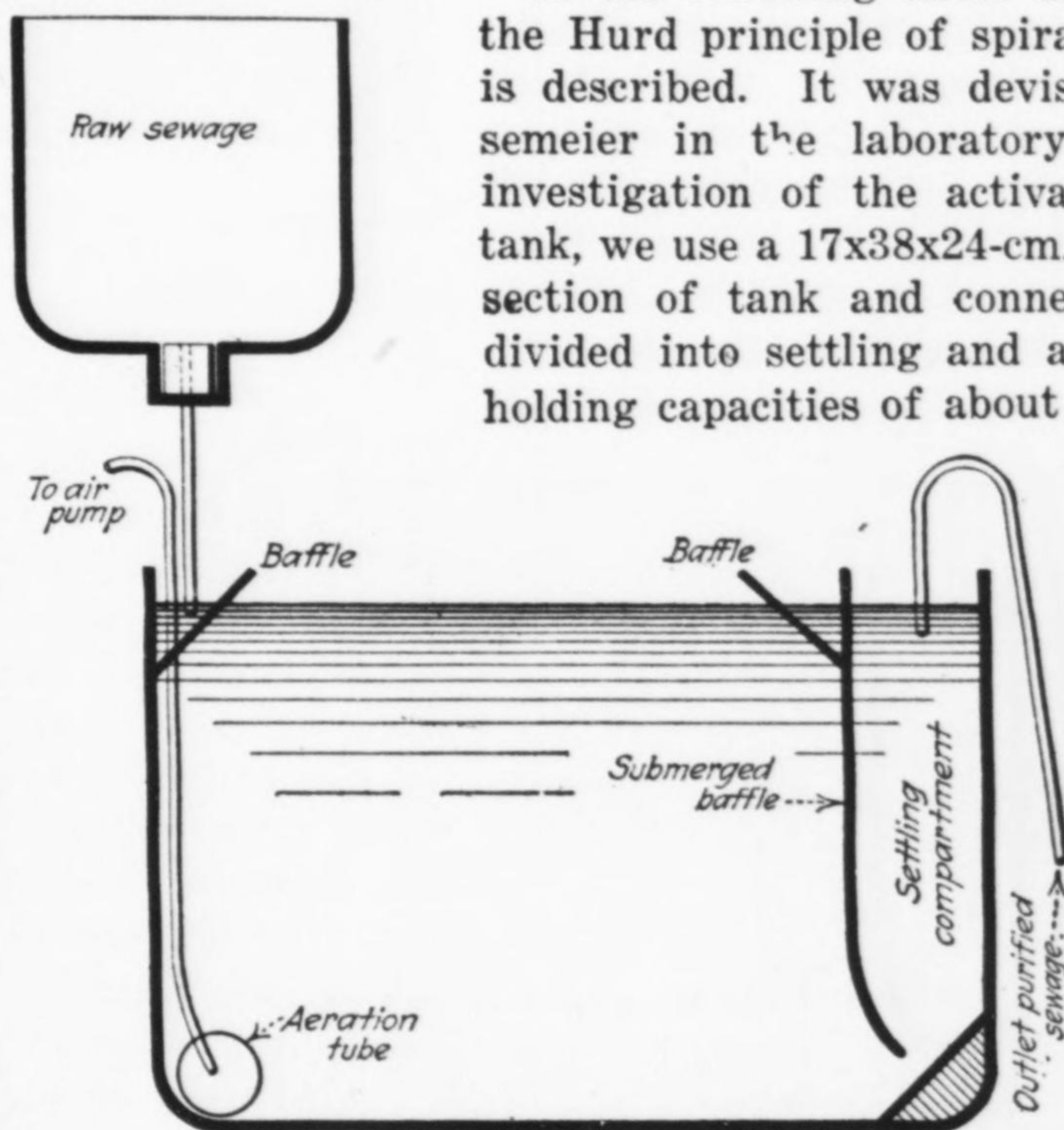
Apparatus for Activated-Sludge Tests at Essen, Germany

BY DR. F. SIERP
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Translated by Abel Wolman, engineer, Maryland Board of Health, Baltimore, with the co-operation of Dr. Karl Imhoff, engineer, Ruhrverband.

THE Ruhrverband is operating at its Essen-Rellinghausen sewage-works, a laboratory-scale experimental activated-sludge tank. Elsewhere in Germany, experiments with activated sludge are being made. Most of the testing tanks have a minimum of 0.5 cu.m. holding capacity. Even though such tests may not give the best basis for the construction of larger plants, there are many instances in which one may study the experiments on a small laboratory scale with profit. For such laboratory investigations, we have previously used either tall cylinders (about 1 m. high and from 10 to 15 cm. in diameter) or flasks, fitted with round filtros aerating plates.

In the following notes an apparatus making use of the Hurd principle of spiral flow with compressed air is described. It was devised jointly with Mr. Fransemeier in the laboratory of the Ruhrverband for investigation of the activated-sludge process. For a tank, we use a 17x38x24-cm. glass aquarium (see cross-section of tank and connections; also general view) divided into settling and aerating compartments with holding capacities of about 1 to 6 ratio. The dividing



APPARATUS FOR ACTIVATED-SLUDGE TESTS

wall has its ends inserted in rubber tubing cut lengthwise in order to provide a tight joint between the glass wall and the metal. At either end of the aerating tank there are two inclined baffle plates at the top arranged and fastened in similar fashion, so as to provide for the typical spiral flow of air and sewage. For air diffusion a chamois tube with an internal diameter of 2 cm. is used, which is connected by glass tubing with the source of air. In the upper part of the settling chamber there is a lead overflow pipe for the effluent.

The sewage flows continuously into the aeration chamber at the same rate as the effluent is removed, the rate being regulated by a pinch cock on the outlet of the supply flask. To obtain activated sludge, we aerate strong sewage 24 hours, allow the sludge to settle, remove the supernatant water and fill again with sewage. This is repeated for several days until we have from two to three volumes of sludge, when the operation may be started with the sewage that is to be tested.

We have used the apparatus for many tests with activated sludge. It has produced excellent results.