make the curb about 16 in. high and sufficiently substantial to resist the impact of the car.

There are objections to such high curbs: their unsightly appearance and the difficulty of passing from one side of the street to the other. On the other hand, it is hardly practicable to build a fence or even a reinforced-concrete parapet wall sufficiently strong to withstand the impact of a high-power automobile.

A 10-in. curb is sufficiently high to take care of most accidents. But where there is a sharp curve on the approach or the bridge is very wide, so an unruly car would be liable to strike very nearly square, the higher curb is imperative.

As to motor trucks, which travel at a much lower rate of speed, the driver is likely to be aware of accidents to any part of his machine in time to stop before the truck mounts the curb.

Railings

Railings should be made to resist a lateral pressure applied at their tops equal to one-fourth the weight of a row of men leaning against it, or approximately 40 lb. per lin.ft. If the railing is not so constructed that it is impossible for men to climb upon it, it should be strong enough to sustain a vertical load of at least 100 lb. per lin.ft.

If the railings are on a sidewalk, there should be no opening more than 6 in. wide, on account of the danger of children falling, either by walking between the balusters or falling down and rolling underneath.

Bascule Bridge Acting as a Simple Truss Span

SYNOPSIS—The double-leaf bascule bridge of the Canadian Pacific Ry. over the new ship canal at Sault Ste. Marie, Mich., is of the trunnion type and has three special features: 1, it has chord locks which take live-load stresses and convert the two leaves into a simple fixed truss span when the bridge is closed; 2, it is the longest bascule bridge yet built, being 336 ft. c. to c. of trunnions; 3, to provide for expansion and contraction, one of the end towers (with bascule leaf and counterweight) is movable longitudinally, the movement being effected by hydraulic cylinders under control of the bridge operator.

The connection or locking of the leaves of a double-leaf bascule bridge, so that when the bridge is closed it is practically a simple fixed span, is a new development in bascule-bridge design. It is a special feature of the Canadian Pacific Ry. bridge over the new ship-canal approach to the locks at Sault Ste. Marie, Mich., which is the first structure in which this feature is embodied.

Live-Load Lock Connections in the Chords

While the bridge is notable on account of its size and for several features in its design, the main point of interest is in the connection of the meeting ends of the leaves. The most interesting detail is the lock uniting the bottom chords, which transmits the full tension stresses and connects the two halves of the chord into one continuous member. This lock, shown in Fig. 2, consists essentially of a vertically slotted socket on the end of the chord of one leaf and a T-head bar on that of the opposite leaf. As the bridge closes, this bar enters the socket and comes to a bearing against the face of the latter. Vertical flanges or guides bring these interlocking parts into proper position before they engage. Each lock provides for a maximum tension stress of 500 tons.

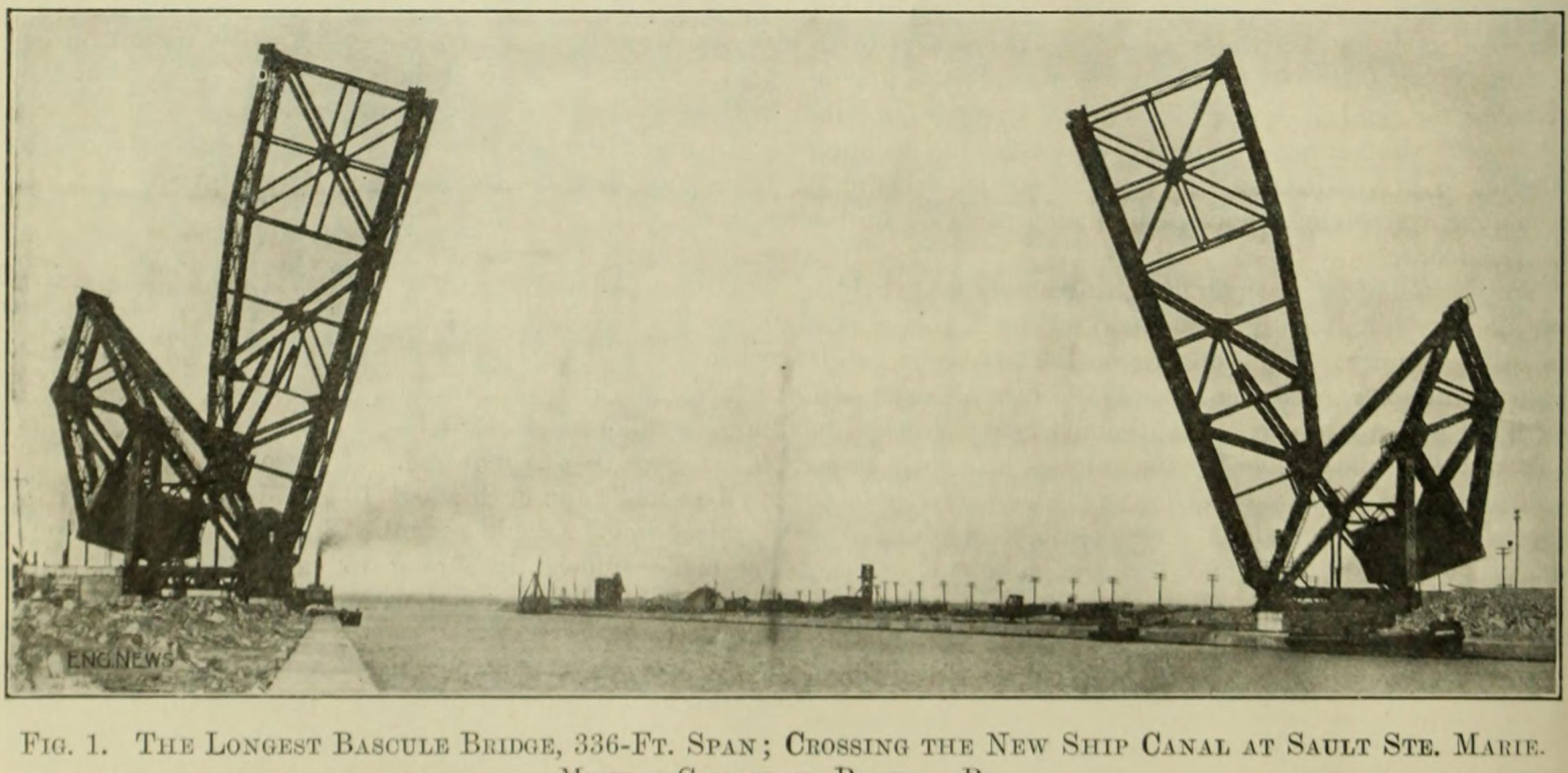


Fig. 1. The Longest Bascule Bridge, 336-Ft. Span; Crossing the New Ship Canal at Sault Ste. Marie, Mich.; Canadian Pacific Ry.

(This bridge is notable in having center locks which convert the two leaves into a simple fixed truss when closed.)

The socket and T-bar are heavy steel castings, with pin connections to the chords to provide for central transmission of the stress. Above the lock are buffers or spacer castings which prevent the leaves from coming so close together as to prevent engagement of the lock.

As the ends of the leaves approach when the bridge is closing, one leaf is kept slightly below the other until the bottom-chord locks engage, and the operating machinery then pushes both leaves down to their normal position, setting up an initial tension in the lock. The normal arrangement is that the sockets close down over the T-bars, and the leaf carrying the sockets is raised first to break the connection in opening the bridge. Above the socket is a stop casting which bears upon the top of the T-bar so that the leaf carrying the T-bars cannot be raised until the other leaf has been raised high enough to disengage the lock. This is shown in Figs. 2 and 3.

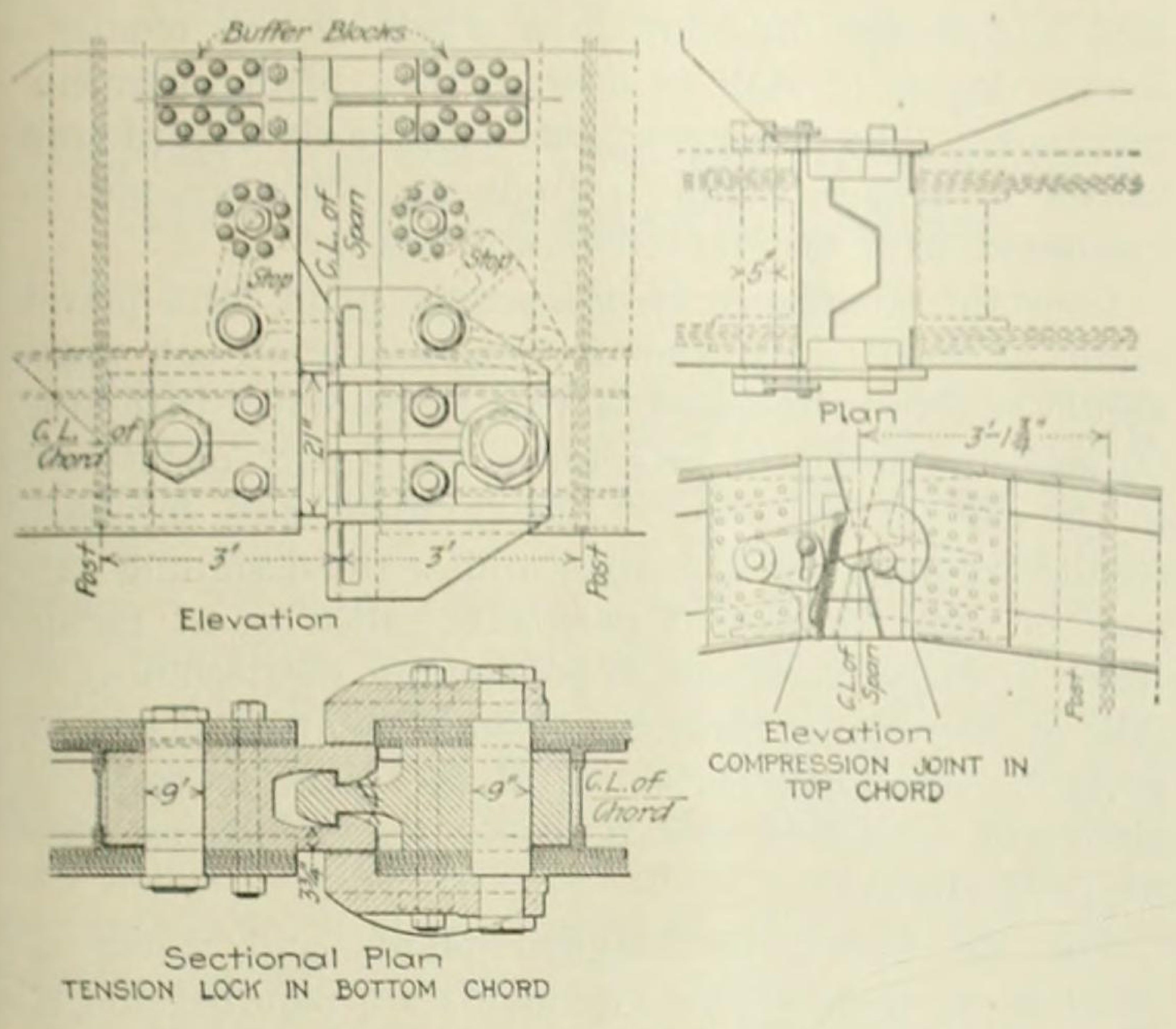


FIG. 2. CHORD LOCKS WHICH CONVERT THE DOUBLE-LEAF BASCULE SPAN INTO A SIMPLE FIXED SPAN WHEN CLOSED

Should it be necessary to reverse this sequence of operations, the stop casting can be swung back out of the way, and a similar casting above the T-bar swung into position. This bears upon the socket casting, so that the leaf carrying the T-bars must be raised first.

The top-chord connection (Fig. 2) is simply a compression joint, each chord having an end casting with finished face. One casting has a tapered tongue fitting a groove in the other casting, so as to hold the chords in line when closed. A hinge is provided in this compression joint to insure proper distribution of stress. For this purpose, there is a horizontal pin in the face of one end casting, which engages a semi-cylindrical recess in that of the opposite casting. This joint is designed for a maximum compression stress of 500 tons and a shear of 160 tons.

The interlocking of the operating mechanism and the signal equipment with the moving part of the drawbridge includes a hooked lever pivoted eccentrically to one of the end castings of the top-chord joint, and engaging a pin in the opposite casting. Until this hook is in proper position the railway and bridge signals cannot be cleared; and until it is released from the pin the operating mechanism cannot be put in service. This is shown in Figs. 2 and 4.

GENERAL FEATURES OF THE BRIDGE

While these chord locks constitute the most distinctive feature, the bridge is important in other respects. In the first place, it is the largest bascule bridge yet built,

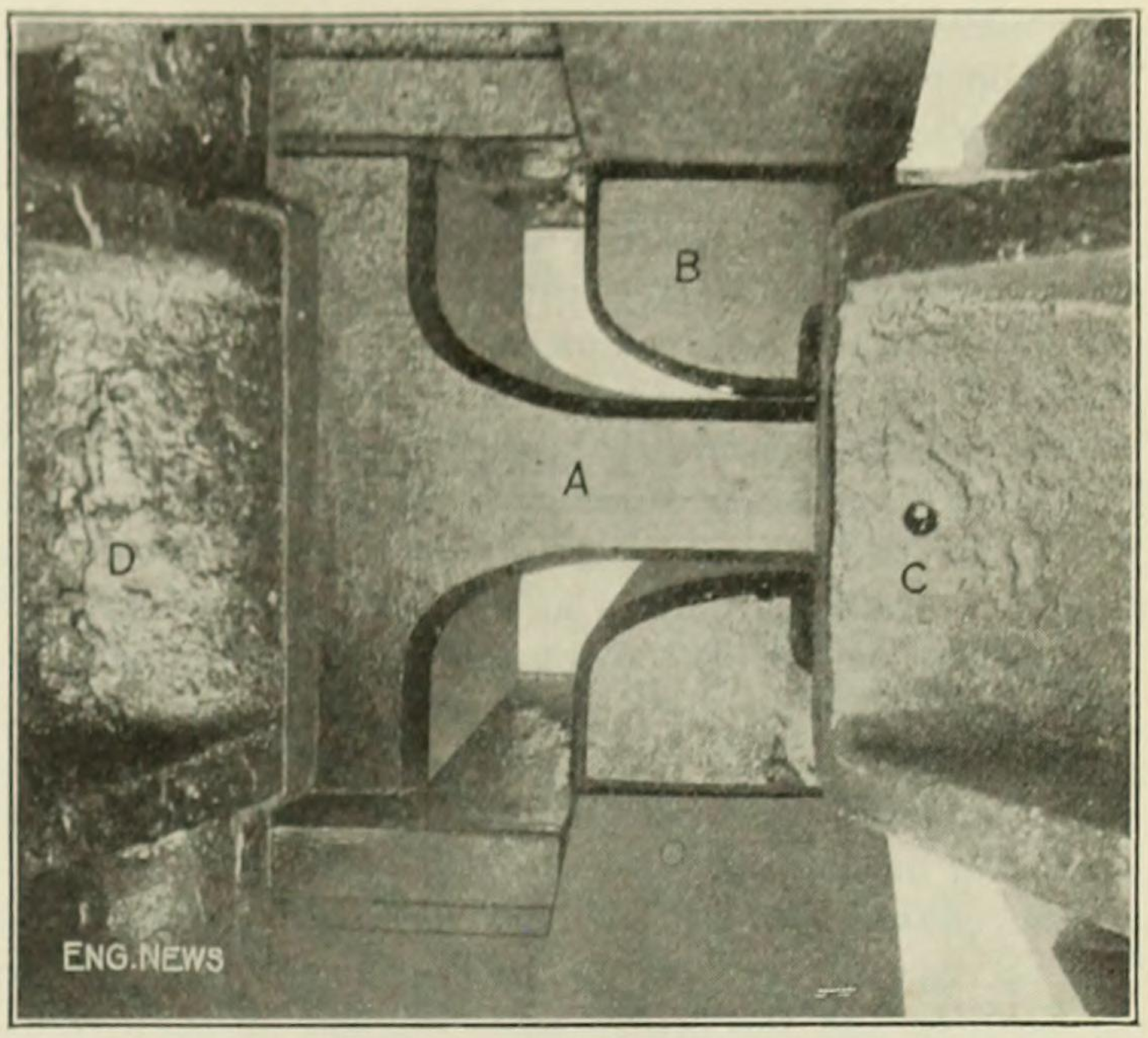


FIG. 3. TOP VIEW OF TENSION LOCK IN BOTTOM CHORD

(A) T-head locking bar on one leaf. (B) Socket casting on opposite leaf. (C) Stop block above socket casting which comes down on the T-head of locking bar. (D) hinged stop block which may be substituted for block C, coming down on the socket casting.

having a span of 336 ft. c. to c. of trunnions. It is a single-track structure, with through trusses spaced 20 ft c. to c. of chords. The floor is of the usual open-deck type, and has three guard rails between the track rails, to conform to the standard practice of the Canadian Pacific Ry. The bridge is designed for Cooper's E-50 loading.

This bridge is of the Strauss trunnion bascule type, with the counterweight for each leaf carried by a pair of counterweight frames which are mounted on a triangular tower and coupled by means of a link to the hip joints of the trusses. The arrangement is such as to give an exact balancing of the span in any position. The counterweights are massive concrete blocks. These drop nearly to the level of the rails and form a barrier when the bridge is open.

The bridge is operated by motor-driven gears mounted

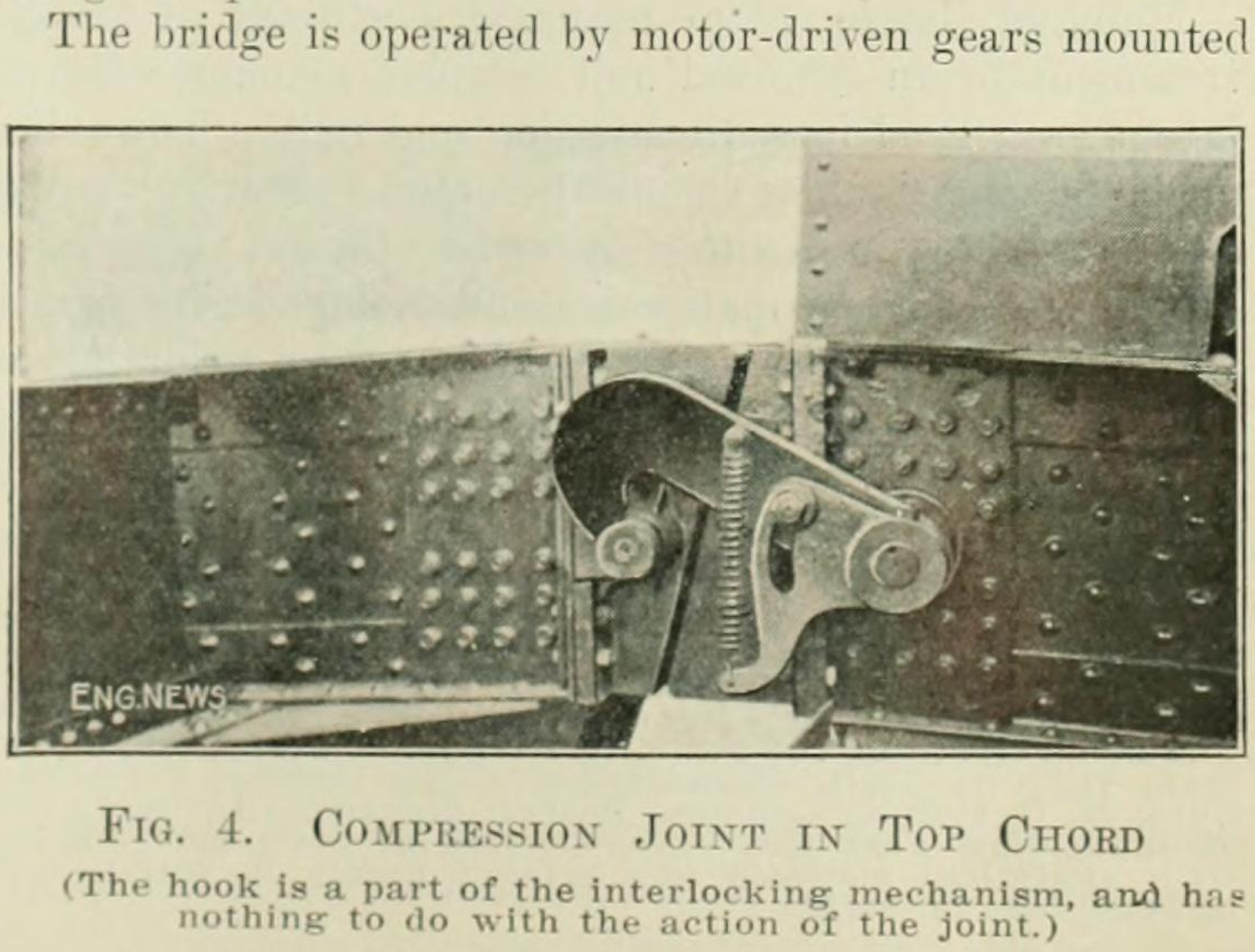


FIG. 4. COMPRESSION JOINT IN TOP CHORD

(The hook is a part of the interlocking mechanism, and has nothing to do with the action of the joint.)

over the portal of each leaf, the main pinions engaging with racks on horizontal operating struts hinged to the end towers. Each leaf has two motors capable of exerting a torque of 300 lb. at 600 r.p.m. and the bridge can be opened or closed in 75 sec. The time from the setting of the "stop" signals on the railway to the complete opening of the bridge is about two minutes. During the navigation season the bridge stands normally open, owing to the small number of trains as compared with vessels.

All operations are controlled from a tower on the south approach, the operator acting under orders from the harbor master.

To provide for expansion and contraction movements, the tower at the south end (carrying the leaf and counterweight frame) is mounted on rollers and has a maximum travel of 4½ in. This movement is effected by the expansion of the bascule span, but under certain circumstances it may be controlled by hydraulic apparatus, consisting of two horizontal cylinders 9x18 in. which are mounted on the pier, and whose piston rods are connected to brackets on the bottom of the tower. The cylinders work with oil at about 200 lb. pressure, the pressure being obtained by a hand pump in the operating house. This pump is locked until current is shut off from the bridge-operating mechanism.

The chord-locks for live-load stresses, as well as the general type of the bridge, are the invention of Joseph B. Strauss, and the bridge was designed by the Strauss Bascule Bridge Co., of Chicago. It was built by the Pennsylvania Steel Co. The design and construction were under the supervision of P. B. Motley, Bridge Engineer of the Canadian Pacific Ry.

Sewage-Works Operation*

One of the first and most important matters to be considered in the operation of a sewage-treatment works is the heterogeneous nature of sewage. Its composition varies widely in different towns, influenced by the ways of living and amount and kind of industrial wastes. Some works receive a sewage so fresh that original fecal matter, paper and fats are practically unchanged, while in others the solids have disintegrated and partly dissolved.

The hourly character and composition of the sewage may also vary from day to day, being uniform in one place and different in another. During storms the sewage collected by a combined system of sewers is increased in volume and its composition changed to a very marked degree.

Many of the forces of nature are utilized in sewage treatment in an involved and complex manner. Gravitation is utilized in sedimentation and in the hydraulics of the flowing liquids; chemical reactions occur in the use of precipitants, in disinfection and in the changing combinations of sewage materials; and biological forces are active in the digestion of sludge and in the oxidation of the dissolved organic matter.

In successful operation, all of these factors must be controlled. It is, therefore, evident that sewage-treatment works, particularly of any size, cannot be made automatic, but require constant observation and supervision by trained, skilled operators in order to accomplish the purpose for which the plant was installed and the funds invested.

The use of biological works for oxidation or the use of disinfection always requires more attention than simple sedimentation. Emscher tanks, which include sedimentation and sludge digestion in a single device, require a higher degree of skill to operate than plain sedimentation tanks. The presence of considerable volumes of trade wastes in sewage usually introduces difficulties not encountered with ordinary domestic sewage.

Constant attendance upon a sewage plant for a private estate or small institution is unnecessary. Such plants should be simply designed, so that an employee with other duties is required to give but a small part of his time to the care of the plant. But in such cases successful results are not always obtained unless the designing engineer or some competent person is called in at regular times to inspect and advise concerning the technical details of operation. Such inspections are particularly important during the early life of the plant to train the attendant to observe and interpret the conditions which required attention.

For the larger institutional plants and works for small towns more skilled attendants are required and the need for competent supervision more urgent.

In municipal sewage-treatment works of any magnitude the constant services of a scientifically trained man in charge is practically essential to success. The larger volumes of sewage treated afford greater potentialities for the creation of nuisance from bad odors if the works are not constantly kept in the best condition. The effect upon the receiving body of water is also greater and a deterioration in the quality of the final effluent may allow the development of conditions, such as nuisance in the water course or danger to water-supplies, which it is the very function of the works to prevent. And finally it is economical to pay a liberal salary to the right kind of man to keep the annual charges for operation and maintenance at a minimum figure by business-like management.

Records—The keeping of careful, thorough and neat records of operation is essential to efficient operation. State authorities charged with supervision over the condition of the water courses should require a uniform record. Such records from the operating point of view show the effect of changing methods of operation and enable the selection of the most efficient and economical procedure. Complaints of citizens can frequently be answered and explained away by reference to the records, and often well kept records have prevented suits or lessened damages.

Records, to be really valuable, should not be cumbered with useless data. The essentials should be carefully determined and made graphic wherever possible.

Neatness—Too much stress cannot be laid upon the importance of neatness and cleanliness in and around the works and the surrounding grounds. To accomplish its purpose this cleanliness must begin in the sewer system, for accumulation of decomposing matters therein will surely hasten decomposition to such a degree that at times no amount of care at the works can prevent the dissemination of bad odors. The cleanliness begun in

*Extracts from a Progress Report of the Committee on Sewage-Works Operation and Analytical Methods to the Sanitary Engineering Section of the American Public Health Association, presented at Jacksonville, Fla., December, 1914. The membership of the committee is: W. L. Stevenson, chairman, 412 City Hall, Philadelphia; C. B. Hoover, Columbus, Ohio; H. C. McRea; Langdon Pearse, Chicago, Ill.; George C. Whipple, New York City. The portion of the report dealing with analytical methods was printed nearly in full in our issue of Jan. 14, 1915.

The New Bascule Bridge Which Connects the Two Sault Ste. Maries*

THE completion of the new Bascule bridge from Sault Ste. Marie, Ontario, to Sault Ste. Marie, Michigan, on the Canadian Pacific Railway marks a new record in bridge construction, as the structure is the largest of its kind in the world, being 330 feet in length, and containing several features peculiarly its own. The rapidity with which the hinged on a steel tower, and is exactly counterbalanced on the opposite side of the tower. On the balancing structure there is a concrete block containing five hundred and fifty cubic yards of concrete, and weighing over one thousand tons. So exactly is each leaf of the bridge balanced with the outer counterweights that a very light power is necessary to be applied to raise

New Bascule bridge between Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario, on the Canadian Pacific Railway.

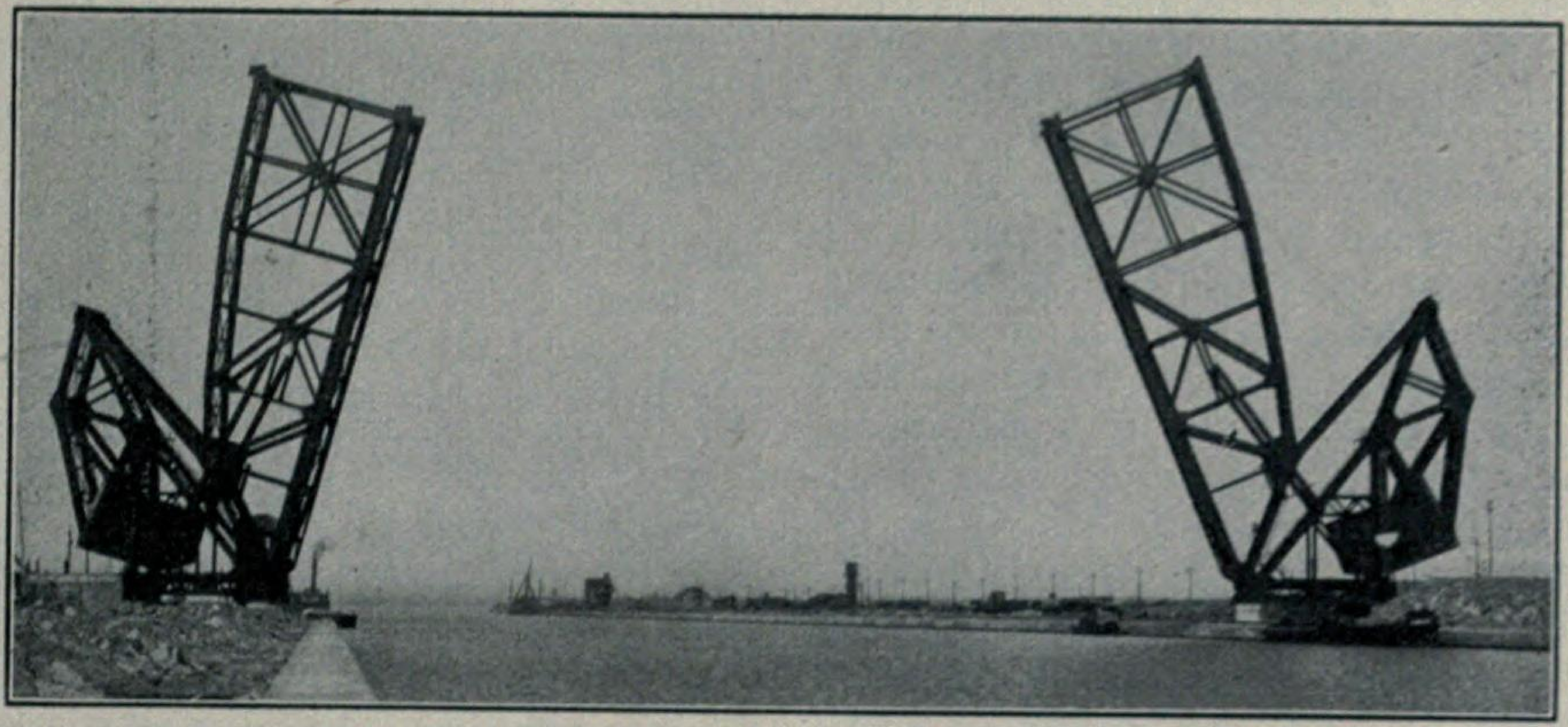
work has been constructed has been such that its opening last September was really ahead of the time when it was expected to be ready for the operation of the railway adjoining Canada and the United States at this point. The design of the bridge chosen was that submitted by the Strauss Bascule-Bridge Company, of Chicago, Ill., and the work has been carried out by the Pennsylvania Steel Company, of Steelton, Pa.

The accompanying illustrations will give some idea of the magnitude, as well as the intricate details of the structure. The first view is taken from the operating tower, and shows the south leaf of the bridge closed with the north leaf in the open position. Each leaf is

*From Railway and Locomotive Engineering, New York City.

the leaf and lower the counterweight, the one acting in equilibrium with the other.

The second view shows a general view of the bridge with both leaves centrally locked in place. It should be mentioned in this connection that the south leaf arch tower rests on rollers, allowing a six-inch transverse or side-swing movement to the entire southern leaf in either direction. The operation of this movement when it may be necessary is accomplished by hydraulic cylinders, and a suitable hydraulic hand pump is arranged so that the operator can force the liquid under pressure on either side of the plunger, and so eventually move the entire tower and attached leaf in either direction, so that the two leaves speedily and



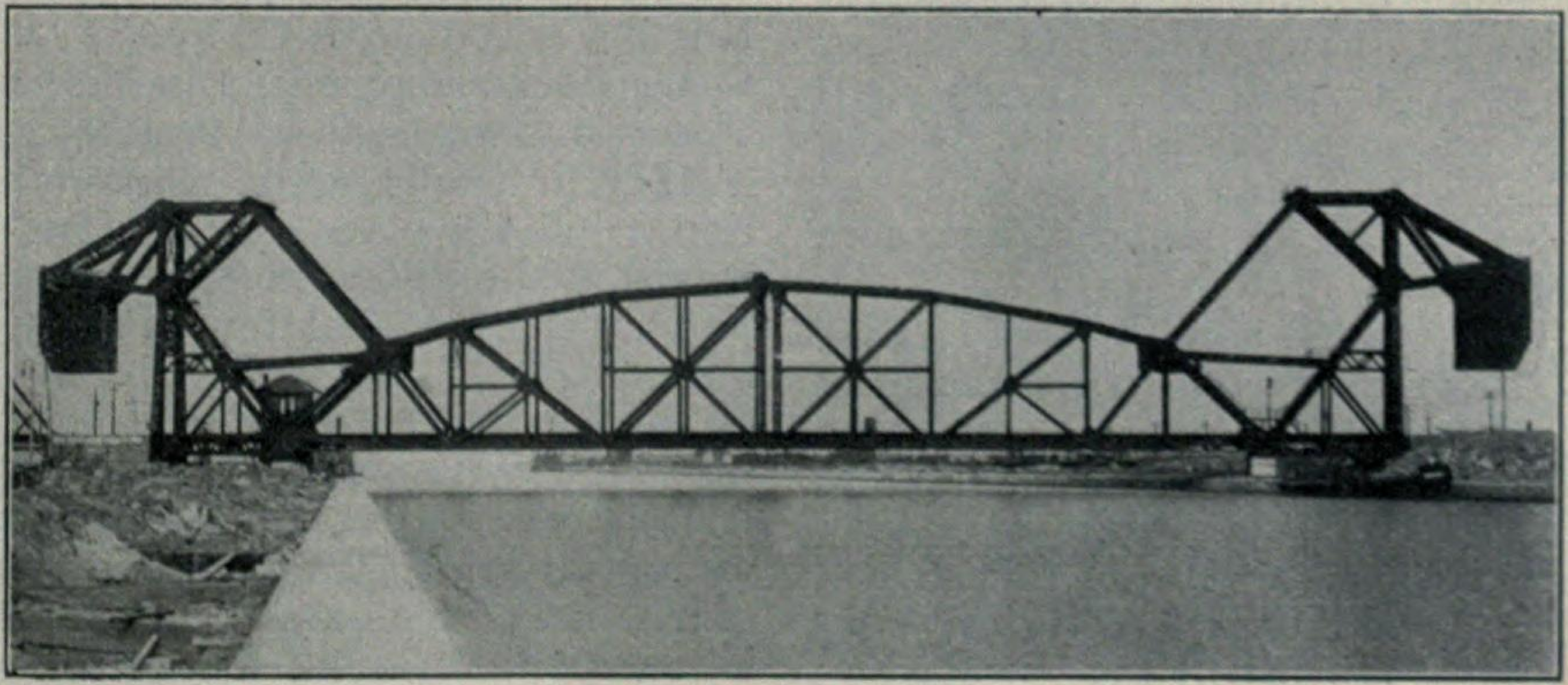
New Bascule bridge, Canadian Pacific Railway, with leaves fully opened.

exactly join in their necessary and perfect alignment.

The last illustration shows the bridge with the two leaves fully opened, and it may be added that while both leaves are opened to vessels of larger dimensions having deep draught, which consequently makes it necessary for them to keep in the centre of the channel. Vessels of lesser draught may safely pass through with one leaf open, but the opening or closing of both leaves of the great bridge is so easily accomplished, as we have already stated, that the expense of the movement is almost a negligible quantity, and only involves the light handling of an ordinary hydraulic jack. It may also be safely stated that as the balancing is so perfect, and the moving parts so massively and simply constructed, the possibility of any part of the structure getting out of order is reduced to a minimum.

The Canadian Pacific Railway is to be congratulated on the completion of the work, and we understand that others of this particular kind of structure are contemplated. It is not likely, however, that the others will be as large as the structure just finished. The tests have demonstrated the absolute rigidity and complete safety of the structure under weight many times more than will ever be placed upon it in actual service. While no expense has been spared in securing the best materials available, and the best workmanship under thorough inspectors, the manipulation of the vast structure is, as we have stated, exceedingly simple. One tower man is all that is necessary in handling the few mechanical appliances used in raising and lowering the leaves of the bridge.

More than $10,000,000 was spent on municipal work in Toronto last season according to a report presented by the Commissioner of Works, Mr. R. C. Harris. The following are details of this expenditure: roadways, $3,538,002.65; sewers, $2,972,481.74; water-works, $2,194,511.60; railways and bridges, $729,518.21; marine works, $26,264.17; miscellaneous, $1,445,405.77. During the year 89.90 miles of sewers were commenced and 60.7 miles have been completed. Forty-two miles of pavements and 54 miles of sidewalks have been laid. Five subways have been constructed in connection with the North Toronto grade separation. Twenty-six miles of water mains were laid, 22 street corners were rounded and 11 streets extended.



New Bascule bridge with leaves centrally located in place.