A Bascule Bridge of New Type and Its Construction

Varying Effective Length of Hanger Link Maintains Balance—Bull-Wheel and Worm-Gear Operation—Toe Locks Eliminated—Creosoted Lumber Framed and Bored at Mill

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SEVERAL unusual features distinguish a new bascule highway bridge at Mystic, Conn., completed last year. It is the first bridge of a newly developed type, in which the counterweight rotates through a considerably smaller angle than the span. At Mystic the counterweight rotates through an arc of only 69 deg. while the span is traversing a full right angle. This is accomplished by means of a double-pivoted short link forming part of the hanger link, and a stop on the moving-leaf girders which changes the effective length of the hanger link during the motion. The small angle of rotation of the counterweights permits of their being placed symmetrically about the center lines of the balance beams without interference with the tower, and keeps girder, tower, balance beam and counterweight all in the same plane, obviating the necessity of carrying loads transversely.

A bull-wheel method of operation is used, which incidentally locks the span in its closed position. Worm gears are successfully employed, eliminating the noise of high-speed spur gearing. Special details were introduced to permit the concrete sidewalks and wood-block roadway paving to be raised with safety to the vertical position. The counterweights were poured in their high position with a small under-support. Framing and boring of the creosoted lumber at the mill was used with success.

General Description—The completed bridge consists of four through plate-girder spans; the main or movable span of 84 ft. 8 in., a tower span of 23 ft., and two simple approach spans. (Fig. 1 shows profile and plan of bridge.) The bridge is on the New York and Boston Post Road and carries traffic of large volume and heavy weight, including motor trucks and a single-track interurban trolley line, together with considerable pedestrian traffic. To meet the traffic needs, a roadway width of 33 ft. in the clear was provided, with a single trolley track in the center. The roadway is paved with creosoted wood block. The sidewalks are 5 ft. wide and are paved with a 3-in. reinforced-concrete slab. (Fig. 2 shows a cross-section of the movable span.)

Selection of Type—In the selection of the particular type of bridge for the opening, various types of movable spans were considered. The required channel width was 75 ft., with a clear vertical height of 135 ft.; this relatively great height of channel clearance compared to the length of span excluded the vertical lift. The extreme width of the bridge, practically 50 ft. over all, would require a swing span at least 210 ft. center to center of end wedges if the bridge were made symmetrical with both arms of equal length. However, as buildings at both ends of the bridge extended up to and in some corners in front of the abutments, and a symmetrical swing span would have extended about 25 ft. over the west abutment, a bobtail swing would have been required, which in turn was prohibited by the location of the center pier and the channel.

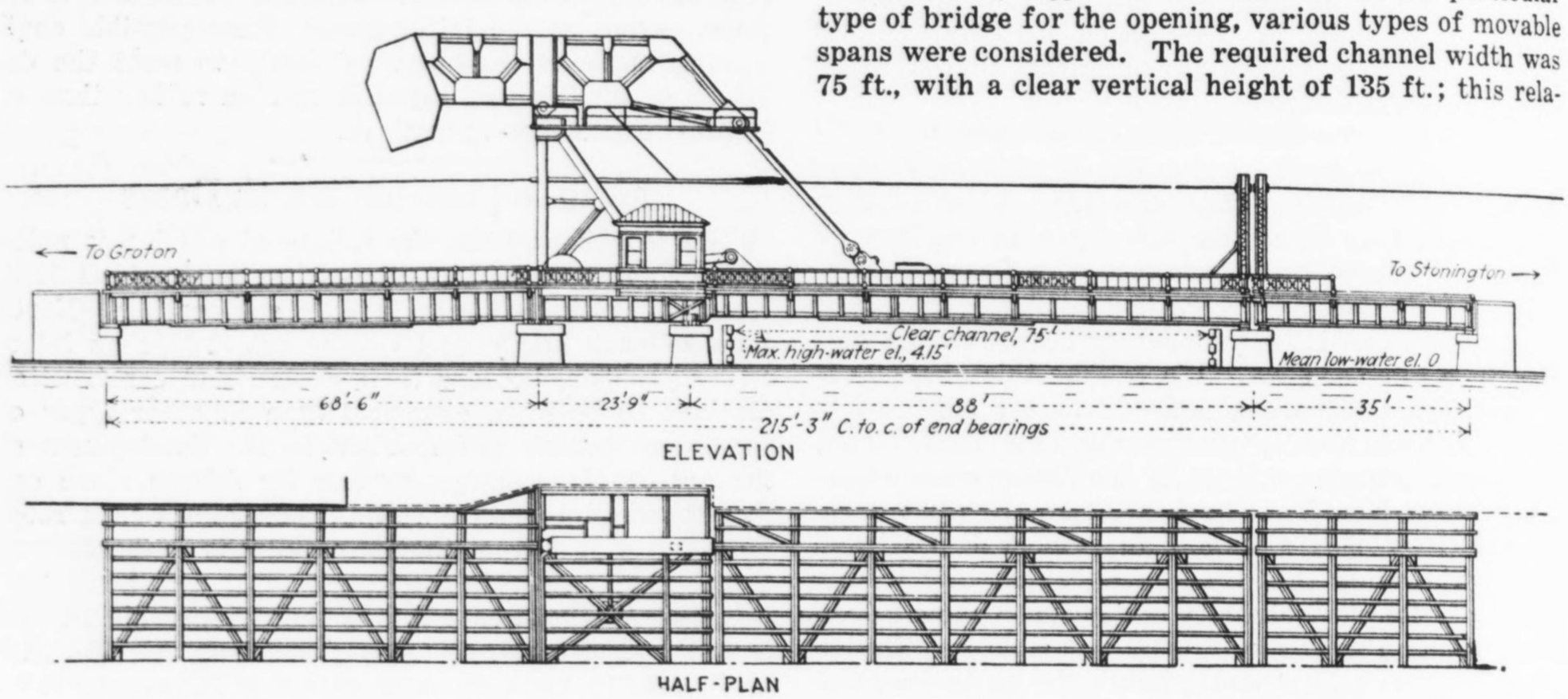

FIG. 1—GENERAL PROFILE AND PLAN OF NEW BROWN BASCULE HIGHWAY BRIDGE AT MYSTIC, CONN.

The elimination of the swing and vertical-lift types necessitated the use of some kind of a bascule, and after careful consideration and comparative estimates it was decided to adopt the Brown "balance-beam" type. There are several advantages of this type over the older forms of bascule, and as the bridge at Mystic is the first of its kind to be built a short description of the method of balance is of interest.

The movable span is counterbalanced by two concrete weights placed on the center lines of the main girders and carried by balance beams in the form of trusses which rest on trunnions at the tops of the tower bents. These trusses are about 60 ft. long over all, and their forward ends are connected with the plate girders of

the moving span by hanger links or suspenders consisting of eyebars and short links having double sets of pivots at the span end. (See Fig. 3.) Butt blocks or stops are suitably placed on the upper flanges of the movable-span girders to make contact with the short links at the proper time during motion, and thus change the point of rotation of the eyebar hangers from one set of pivots to the other. This system of multiple pivots is the important distinguishing feature of the new Brown type.

Fig. 4 is a diagram showing the action of the pivots and butt blocks as the span rotates through its 90 deg. of motion. Between positions I and II of the span (see Fig. 4), or for about the first 38 deg. of motion, the hangers rotate about the primary pivots *A*. The butt blocks then make contact with butt castings on the short links, preventing their further rotation about pivot *A*, as shown in position II. From this position throughout the remainder of the opening, the eyebars rotate about the pivots *B*, on the ends of the short links.

It will be noted in Fig. 4 that in the closed position of the span, when its center of gravity is horizontally in front of its trunnion, the center of gravity of the counterweight is well above the level of the balance-beam trunnion, and that in the open or 90-deg. position, when the span is vertical, the counterweights are considerably back of the vertical tower legs and entirely clear them; that is, the span has rotated 90 deg. while the total angular motion of the counterweight is only 69 deg. Throughout the entire motion no attempt is made to keep the lever arms or the angular motions of the span and of the counterweights about their respective trunnions equal or similar in any way, the balance being maintained entirely by selection of the pivotal points *A* and *B* so as to reduce and increase the respective lever arms of the hanger links about the balance beam and the span trunnions in proportion as the moments of the counterweights and the span vary about their respective trunnions.

There are several advantages with these two pivotal points of rotation. The counterweights, not having to pass between the tower legs, can be built centrally over and integral with the balance-beam trusses; thus all the stressed members from girders to counterweights are maintained in the same plane, saving a considerable amount of steel usually required for lateral transfer of forces or of counterweight loads. The counterweights being in two sections entirely disconnected, no rigid bracing is required between the balance beams. Light bracing only is required, which though rigidly providing against lateral overturning of the beams yet allows a slight flexibility of motion in the planes of the trusses and thus provides against the possibility of binding of trunnions or pins and against inequality of stress in the hangers due to the usual slight inaccuracies in lengths of members and in lining up of trunnions in the field.

Again, there is great latitude in the choice of the positions of the points *A* and *B* while retaining the practical balance throughout the motion. In the Mystic

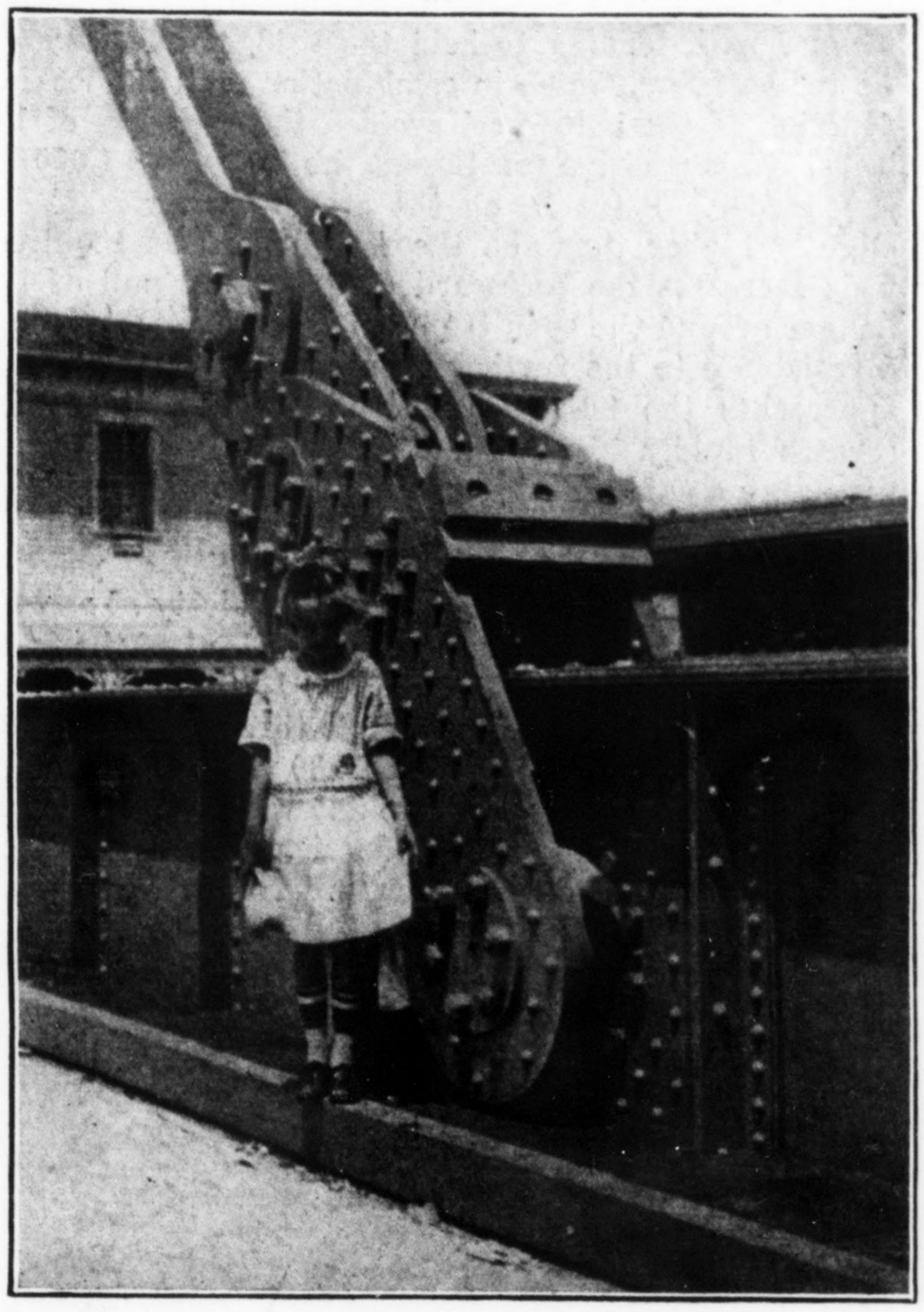

FIG. 3—SHORT LINK AT BASE OF MAIN EYEBAR HANGER

This link in conjunction with the butt-block on the girder, in the foreground, changes the leverage of the counterweight as the span rises.

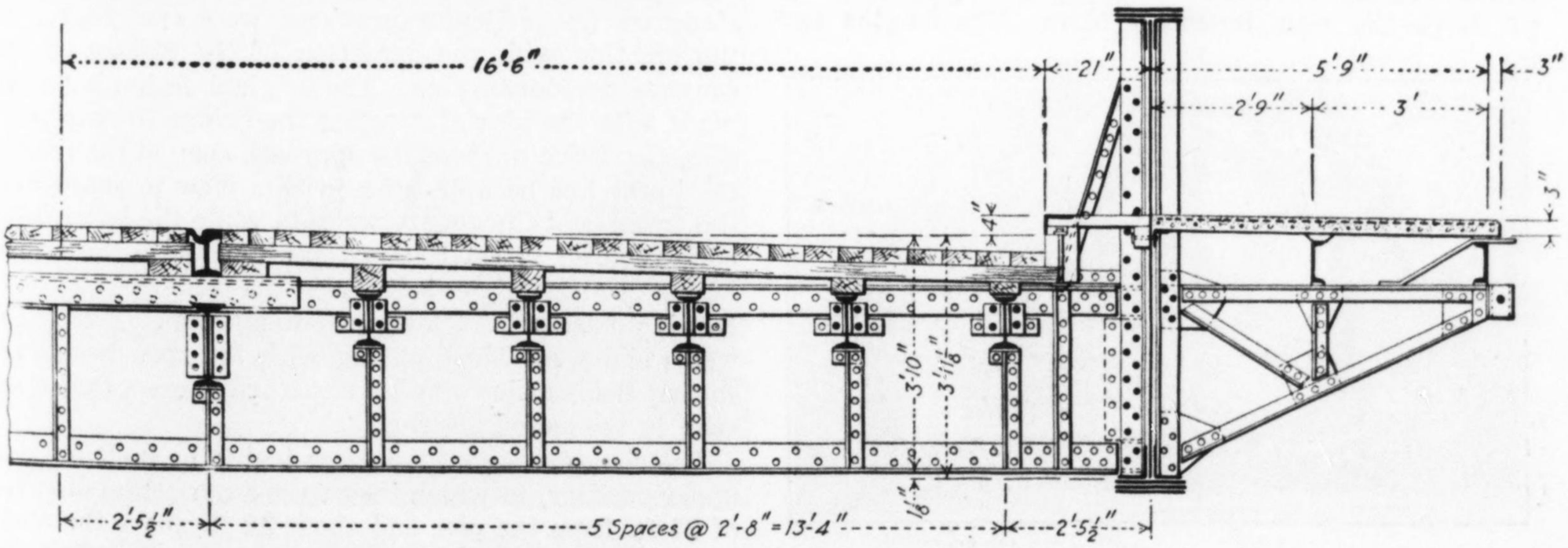

FIG. 2—HALF CROSS-SECTION OF BASCULE SPAN

design point *A* was so chosen as to provide an unbalance when closed, tending to hold the bridge well down on its toe bearings, which in combination with the locking function of the bull-wheel avoided the necessity of toe locks. This positive reaction at the toe end is 1,000 lb. per girder. Point *B*, on the other hand, was placed slightly higher than the theoretical position required. This increases the backward or downward pull of the hanger around the span trunnion (see Fig. 4), offering a resistance to the further opening of the bridge as it approaches the 90-deg. position. The resistance increases rapidly if the span passes the vertical, thus providing a safety factor against the span being blown or operated backward against the tower.

A further advantage is the adjustability of point *B* by shimming in the butt block to obtain nicety of balance or to compensate for a change in dead load of the floor.

Power Equipment and Machinery—On the Mystic bridge the main source of power is three-phase 60-cycle alternating current delivered at 2,200 volts to the bridge site, where it is transformed to 220 volts. Operation is by two 36-hp. motors of the induction type, one on each side of the tower span, placed on unit frames with worm-gear units of a ratio of 20 to 1. By the use of worm-gear units the operating machinery was made so compact

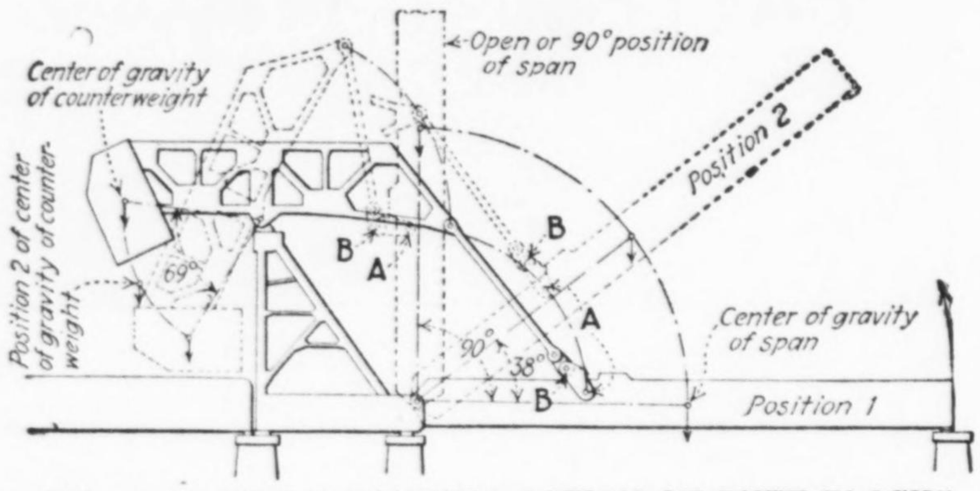

FIG. 4—DIAGRAM SHOWING ACTION OF BUTT BLOCKS

as to enable it to be placed below the sidewalks on the tower span, because from this worm reduction only two spur gears were required to reduce to the pinion which meshes with the teeth on the periphery of the bull-wheel. An additional advantage in the use of worm gears is that they avoid the necessity for high-speed spur gearing, and hence the operation of the bridge is remarkably smooth and noiseless.

The bull-wheels and their pinions are in the planes of the tower bents, and the forward ends of the bull-wheels are connected by links or "connecting rods," which straddle the front legs of the tower, to operating pivots on the main bascule girders. The lengths and

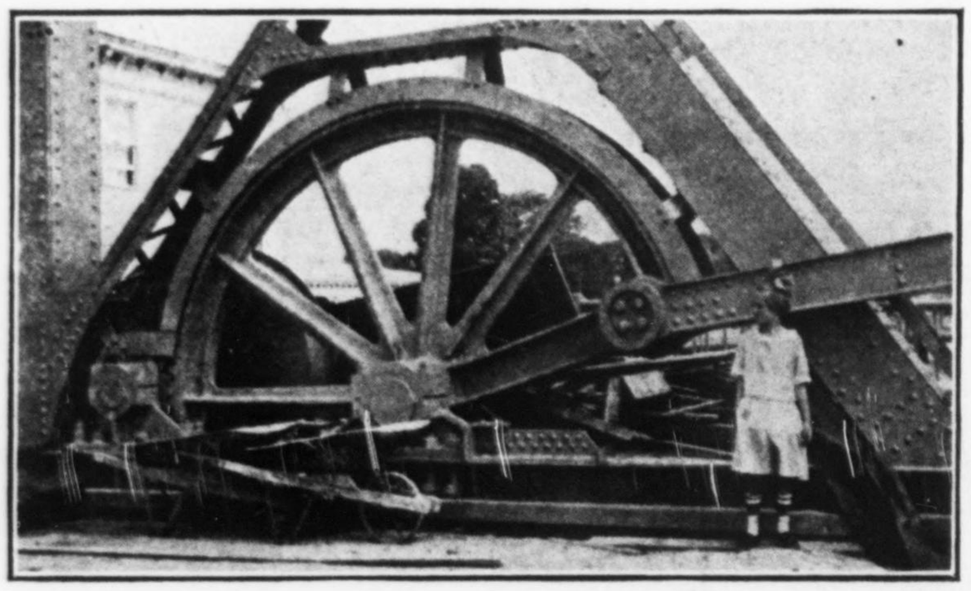

FIG. 5—BULL-WHEEL

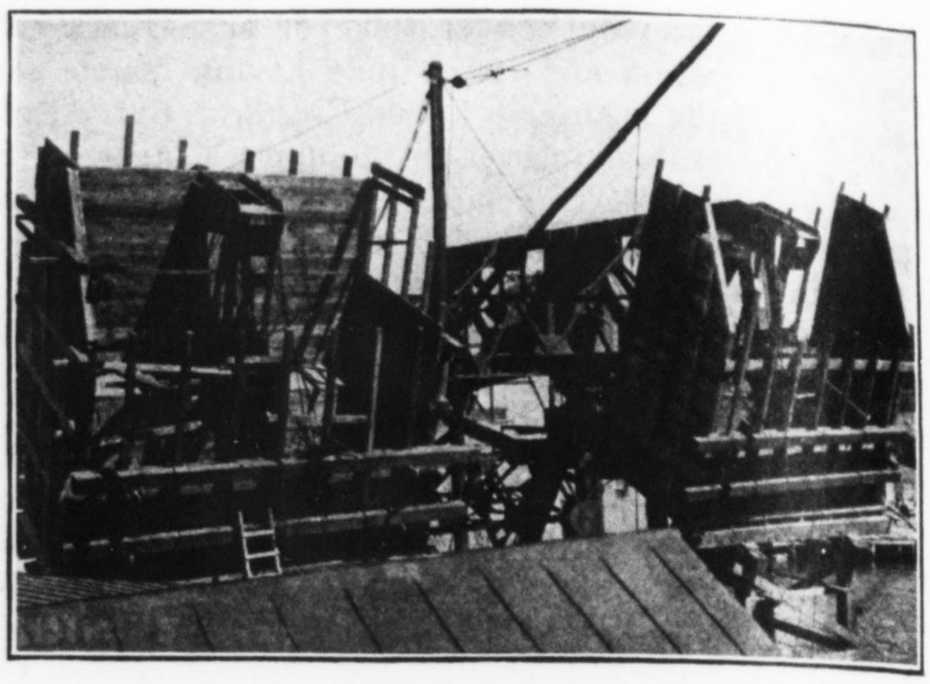

FIG. 6—FORMS FOR COUNTERWEIGHTS

positions of these links are so adjusted that when the bridge is in its closed position they are practically on dead center with the axles of the bull-wheels, thus locking the bridge in this position (see Fig. 5). This bull-wheel lock in combination with the unbalance of the span, already described, enables toe locks to be dispensed with. The bull-wheels also provide greatly increased leverage at the two extreme positions of the span. As the operating links approach the dead-center position at the extreme ends of the run, the combined leverage of the machinery approaches infinity and the speed of the span approaches zero. This permits very gentle seating of the span with motors running at constant speed. In fact if, through inadvertence on the part of the operator, the motors should continue to run after the span is seated, the links will pass the dead-center position and open the bridge, instead of stalling or short-circuiting the motors. Likewise in open position, when the span offers the greatest wind-sail area, the operating links have reached the other point of increased leverage, which condition combined with the automatically increased unbalance of the span makes it an impossibility for the span to be overturned against the tower, regardless of the wind velocity.

The two independent machinery reductions on each side of the bridge are connected by the usual transverse shaft. The motor shafts are equipped with solenoid brakes, and in addition emergency air-brakes are provided on each end of the tranverse shaft. Either set of brakes may be used independently. The usual emergency hand operation is also provided.

Erection—On account of the extreme simplicity of the structure no particular problems were encountered in the erection with the exception of the placing of the concrete counterweights. The original design had been made with the idea of erecting the bridge in open position, for which purpose the approach span at the rear of the tower had been designed with a view to supporting the forms and the counterweights while the latter were being poured in their lowest position, with the center of the counterweight 9 ft. from the center of the pier. But it was found much simpler to lay the concrete sidewalks and wood block paving with the span horizontal so that the decision was later reached to erect the entire span in the closed position.

The counterweights therefore had to be built in their upper position, in which they were a horizontal distance of 24 ft. from the pier and about 32 ft. above the roadway. The approach-span girders were not sufficiently

strong to support the entire weight in this position with the additional framework required. The solution of the difficulty was to carry the greater part of the load from the balance beams.

This was accomplished by putting up light staging on the approach span, sufficient to carry the weight of the forms and also the weight of a 2-ft. bottom slab of concrete; then, before pouring this bottom slab, wire guys or tie ropes were attached to the top of the balance beams and brought out through the bottom of the forms. After the bottom slab had set, the remainder of the concrete was poured. Fig. 6 shows the counterweight forms.

The requirement that the span must open to 90 deg. necessitated considerable care in the laying of the wood-block paving and the concrete sidewalks. Each individual block on the lift span was separately nailed to the sub-planking with a wire nail through the center of the block. In addition, horizontal angles about 10 ft. apart were laid on both roadway and sidewalks, to act as shelf angles supporting independent 10-ft. sections of the wood-block paving and concrete when the span is in the open position.

A special feature in connection with the field work was the boring and framing of nearly all of the creosoted lumber at the mill, although cutting and boring before cresoting was not required by the specifications. Steel erectors are averse to handling creosoted lumber, and it was therefore decided to relieve them of a large portion of this work. The spiking pieces, curb guards, ties and other miscellaneous lumber were framed and bored before creosoting, so that very little field work was necessary, the principal part being the boring where steelwork or other bored lumber was used as a templet. The lumber was given marks at the mill similar to shipping marks on steelwork. The erection department was well pleased with this method of handling the lumber, as it saved considerable expense and time besides relieving the erectors of an uncongenial task.

Conclusion—The total weight of steel in the bridge is about 400 tons; the weight of the moving leaf complete is about 200 tons. The concrete counterweights weigh 400 tons, while the total weight of the moving parts is about 650 tons.

The bascule and tower spans were designed by Thomas E. Brown & Son, consulting engineers, for Waddell & Son, who were consulting engineers to the state highway department for this portion of the work. The approach spans and the substructure were designed by the state highway department, L. G. Sumner, chief draftsman. The substructure work was done by the J. E. Fitzgerald Co; the structural steel superstructure and machinery were fabricated and erected by the American Bridge Co.; and the concrete counterweights were placed by the C. A. Sibley Co. The bridge was built for the state of Connecticut under direction of Chas. J. Bennett, formerly highway commissioner, R. L. Saunders, formerly deputy commissioner, A. W. Bushell, district engineer, and A. R. Collier (now state supervisor of bridges), resident engineer.

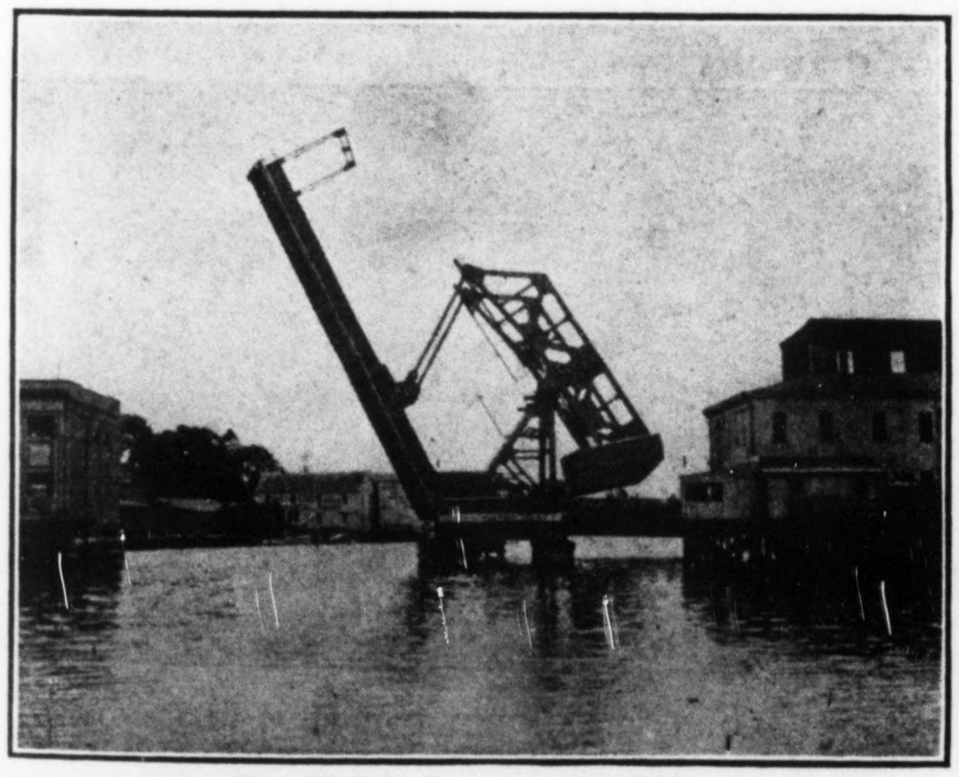

FIG. 7—MYSTIC BASCULE PARTLY OPEN

Camp Site Sanitation in Wisconsin

DUE to the thousands of tourists who camp out in free sites maintained by cities as one of the summer attractions for patronage, attention has been given in Wisconsin to safeguard public health and insure comfort for the patrons. In a recent bulletin issued by the State Board of Health the following essentials in campsite sanitation are noted:

(1) Provide a safe water supply such as wells or springs protected from pollution. Have the water analyzed before the season opens.

(2) Adequate sanitary toilet facilities should be maintained.

(3) Provide garbage and refuse receivers and a daily disposal. If there are no containers, bury or burn the waste.

(4) Maintain clean premises and equipment.

(5) Enforce rules conspicuously posted governing use of grounds.

(6) Eliminate fleas and vermin by every means available.

(7) Employ a caretaker and give him authority to enforce sanitary regulations.

It is encouraging, say the health officials, to note that the municipalities boosting campsites are shaping their plans toward the observance of these rules and in not a few places have these ends been achieved.

Syracuse Garbage Reduction Works Reopened

The Syracuse garbage reduction works, which were shut down for some months, were reopened in the latter part of June, after having been remodeled. The works are being operated under a five-year lease made after the city had advertised for bids. The contract, which included also a certain amount of remodeling, was awarded to the C. O. Bartlett & Snow Co., Cleveland, Ohio, which organized the Cobwell Reduction Co., a New York corporation, to carry out the terms of the contract. The city pays the company $30,000 a year to cover both operation and amortization of the cost of remodeling the plant, the capacity of which was increased to 125 tons per day or more than double the original capacity of the plant as built by the city. In the plant as it now stands, the garbage is first shredded and then fed to the dehydrators, both operations being mechanical. The dehydrators are of indirect-direct heat type. They reduce the free moisture content to about 30 per cent. In the dehydrators the remaining moisture is eliminated, the material is broken down under low temperature and the grease extracted, all this work being done as a continuous process within the closed receptacle. After the process thus outlined is completed, the remaining solid material is screened and then conveyed to storage.