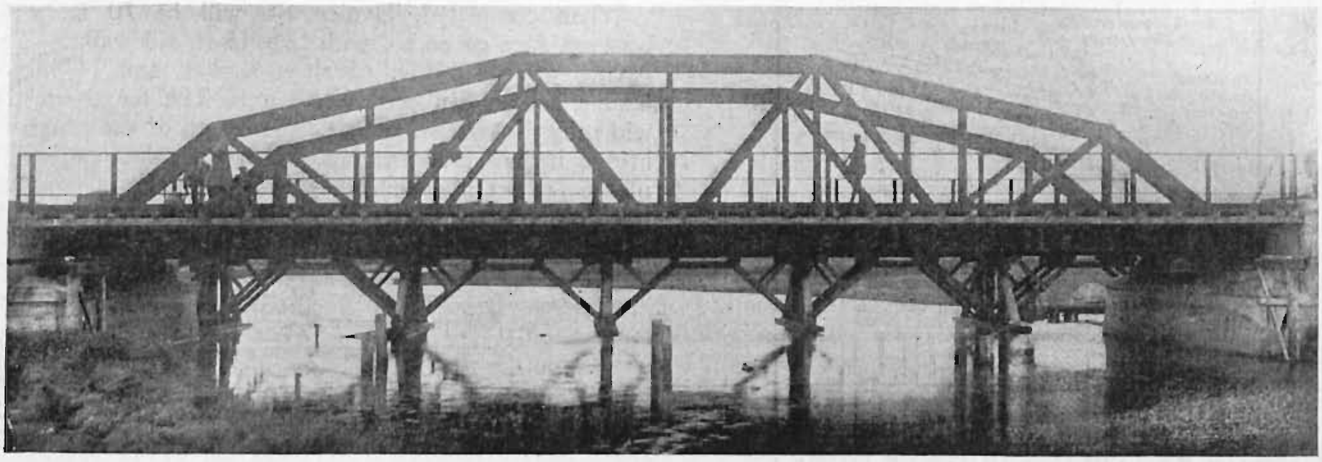

FIG. 1—ARC-WELDED HIGHWAY BRIDGE IN EUROPE
Falsework is still in place.

The First Arc-Welded Bridge in Europe

Through-Truss Highway Structure of 88½-Ft. Span Built for Polish Government—All Members Built Up of Plates, Channels and Angles, Using Flux-Covered Electrodes With 180-Amp. and 30-Volt Current

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THE first arc-welded steel bridge in Europe has been erected for the Polish government in Lowicz, Poland, and crosses the Sludwia River in a single span 88½ ft. between supports. It is located on the principal state highway between Warsaw, Poznan and Berlin. The total width of the bridge is about 32 ft. 9 in. and the distance between the trusses is 20 ft. 4 in. Sidewalks 6 ft. wide are cantilevered out on either side.

The design calculations were made in compliance with the specification of the Polish Ministry of Public Works, issued in 1925. The material used in the bridge is mild steel with an ultimate strength of 55,000/60,000 lb. per sq.in. and with a minimum elongation of 20 per cent. The allowable unit stresses were 16,000 lb. per sq.in. for the trusses and about 12,000 lb. per sq.in. for the floorbeams and stringers. Mild steel electrodes with an ultimate strength of 55,000/60,000 lb. per sq.in., containing a minimum of 0.1 per cent carbon and 0.25 per cent manganese, were used. Elongation, bend and shearing tests were required of all welders.

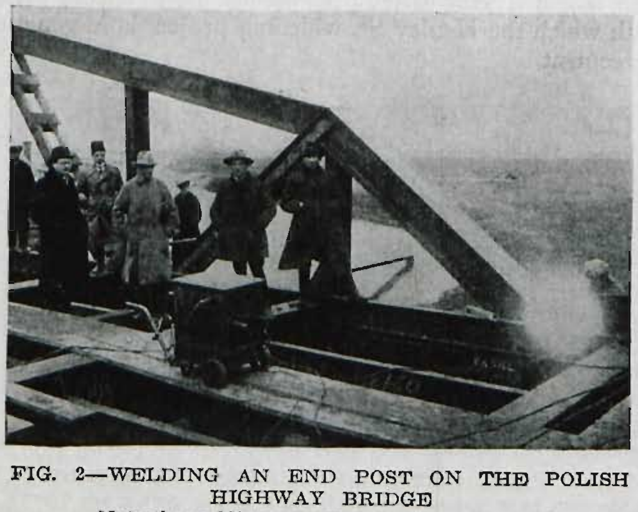

FIG. 2—WELDING AN END POST ON THE POLISH HIGHWAY BRIDGE
Note the welding generator in the foreground.

FIG. 3—WELDED CONNECTION BETWEEN STRINGER AND FLOORBEAM
Adoption of this type of connection permitted calculation of the stringers as continuous beams and resulted in a saving of about 12 per cent of steel in the crossbeams.

Details of the Bridge—The trusses of the bridge are of camel-back outline, having a span of 88½ ft. and a height in the middle of 14 ft. All members of the trusses are built up of plates, channels and angles, as shown in the accompanying drawings. The chords are built up entirely of plates. The diagonals consist of two channels turned to the outside and joined with coverplates top and bottom, while the vertical members are made up of a single plate and four flange angles. The crossbeams are plate girders constructed entirely of flat plates with no flange angles.

I-beams are used as longitudinal stringers and are welded to the cross-girders by trapezoidal plates, not only for the purpose of connection but also to stiffen the web of the cross-girders. This detail, shown in Fig. 3, permitted the calculation of the stringers as continuous beams on elastic supports. While the elasticity of the supports diminishes the advantage of continuity, it draws the crossbeams into co-operation and allowed a saving of 12 per cent in the material of the crossbeams. However, this saving is possible only if there are one or two concentrated loads sufficiently large in comparison with the other loads, a contingency foreseen by the Polish specifications.

All the welds of the plates are butt welds. In the calculations it was assumed that these welds had only 75 per cent of the resistance of the base material. The wind bracing consists of angles welded to horizontal gussets which are attached to the lower chords of the main trusses and to the crossbeams.

Building the Bridge—Pieces up to 23 ft. long were welded in the shop. Special jigs (Fig. 6) were used at about 3-ft. intervals to hold the pieces firmly together. In one instance these jigs consisted of $\frac{3}{4}$-in. round bars bent according to the cross-section of the pieces to be welded. Two gussets were welded to the inside of these bars with a crack of about 2 in. left between the gussets. The width of this crack was regulated by means of two angles in such a way as to admit the vertical plates of the bridge member with close clearance.

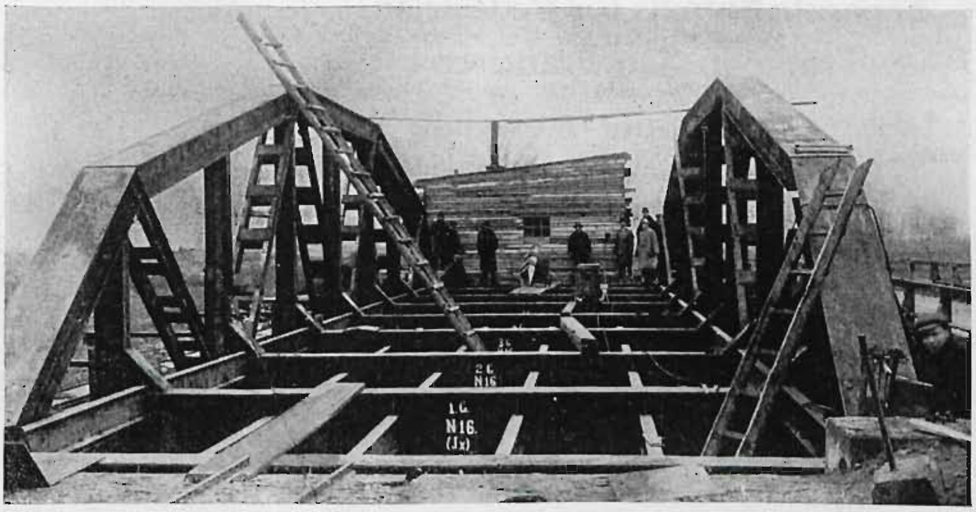

FIG. 4—WELDED HIGHWAY BRIDGE IN POLAND NEARING COMPLETION

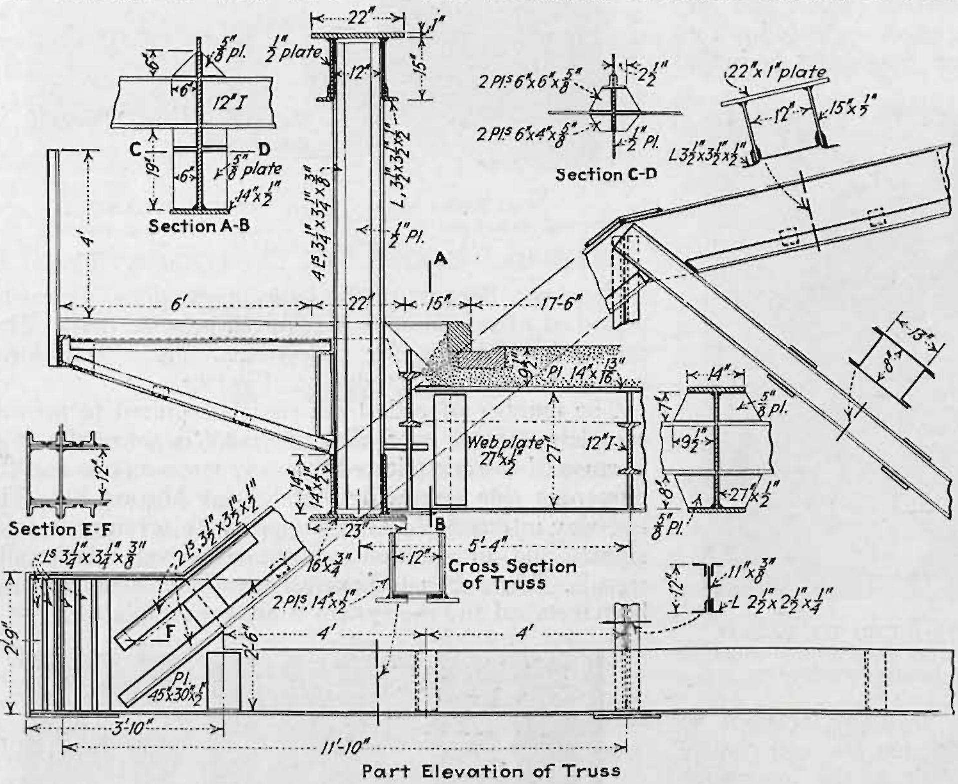

FIG. 5—STRUCTURAL DETAILS OF WELDED HIGHWAY BRIDGE IN POLAND

In the jig for the upper chord, which has a double-T section, channel spacers were placed between the vertical plates of the chord. Between the gussets and the flanges of these channels a crack about 1 in. wide was left to permit free access of the electrode.

The vertical members, consisting of a plate and four angles, were assembled by the aid of two screws on both ends and some short welds along each vertical. The two channels of the diagonal members were assembled by means of plates cut as shown in Fig. 6D. The cross-girders were constructed by the aid of the jigs shown in Fig. 6C and similar to those employed for the chords.

Current of 180 amp. and 30 volts was used in the field. Hand welding was resorted to, utilizing flux-covered electrodes. Assembling in the field was done on a temporary wooden trestle, all of the steel being erected by means of a wooden crane. The work began by placing the floor of the bridge and later the main trusses. Three welders were employed in the field.

The design of the bridge was executed by the writer, who also had supervision of the construction and erection. The total weight of the bridge is 55 tons, while the riveted design would have weighed 70 tons. Unfortunately there was not an equal saving in the cost of the bridge, because the amortization of the cost of the necessary arc-welding machines had to be included in the cost of the bridge. As a consequence the arc-welded bridge cost approximately as much as a riveted bridge. Nevertheless, the writer is firmly convinced that in the course of time the proportion of costs of the two types of bridges will be changed in favor of the arc-welded design.

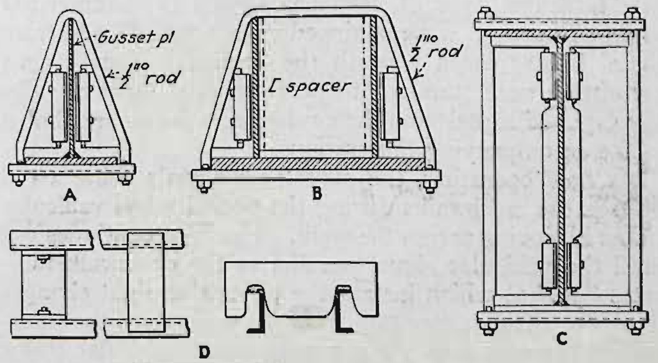

FIG. 6—JIGS USED IN FABRICATING MEMBERS FOR WELDED BRIDGE IN POLAND