Sept. 21, 1943. C. E. INGLIS 2,329,906

TRIANGULATED FRAMEWORK

Filed March 26, 1941 4 Sheets-Sheet 1

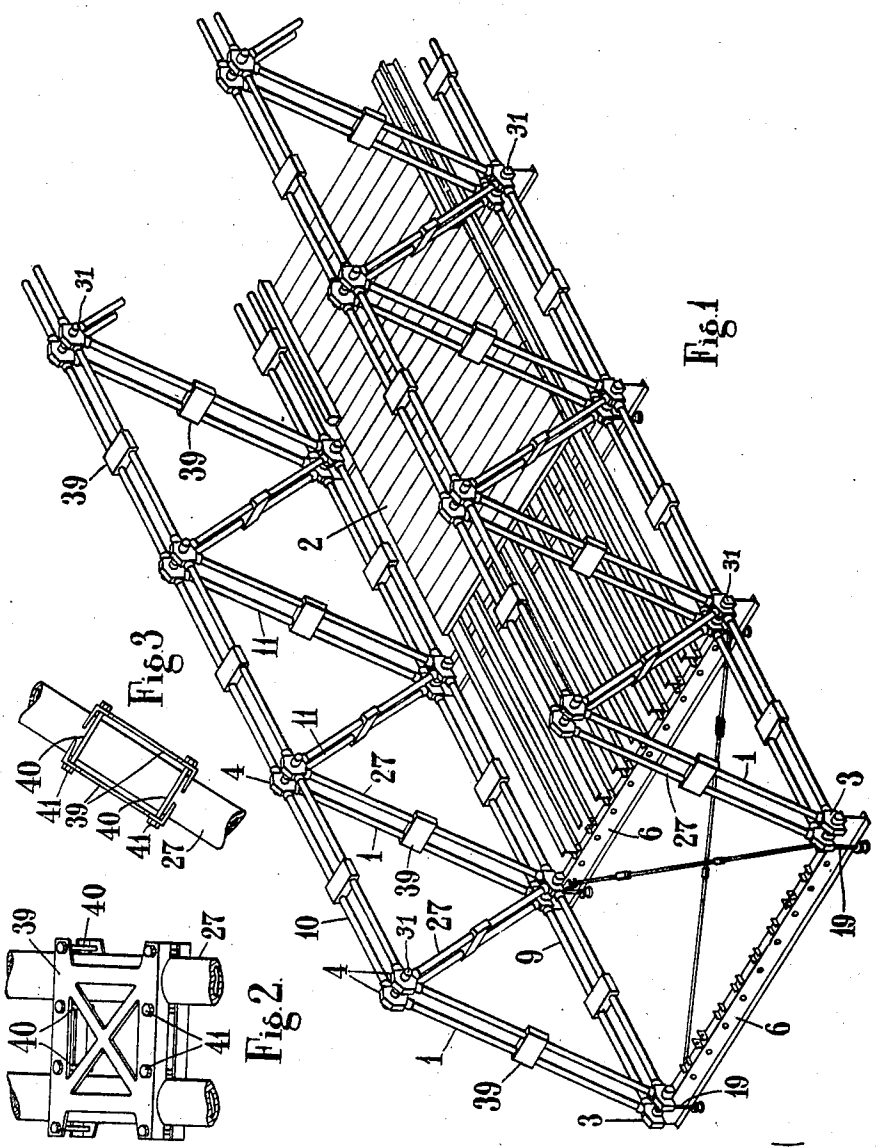

Fig. 1

Fig. 3

Fig. 2

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TRIANGULATED FRAMEWORK

Filed March 26, 1941 4 Sheets-Sheet 2

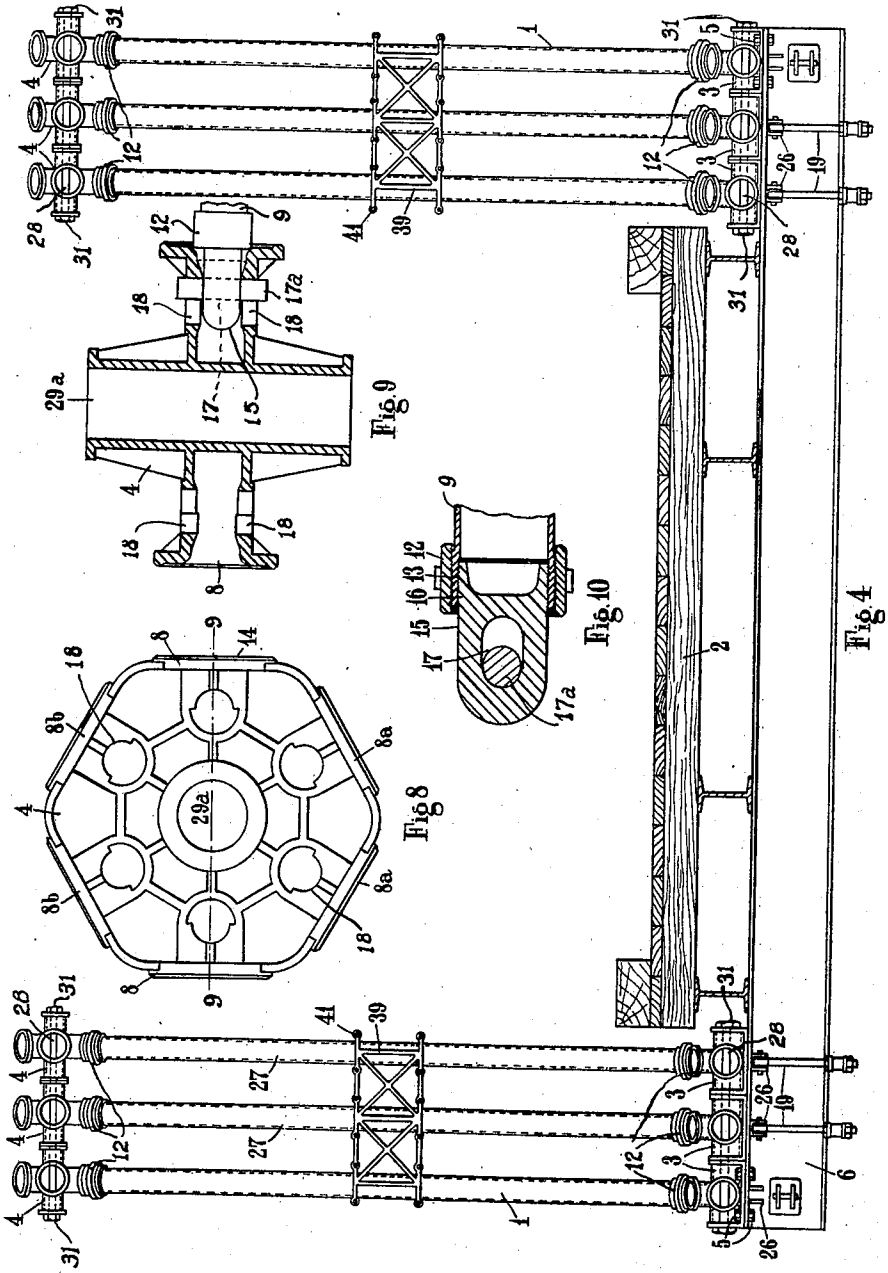

Fig. 4

Fig. 8

Fig. 9

Fig. 10

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TRIANGULATED FRAMEWORK

Filed March 26, 1941 4 Sheets-Sheet 3

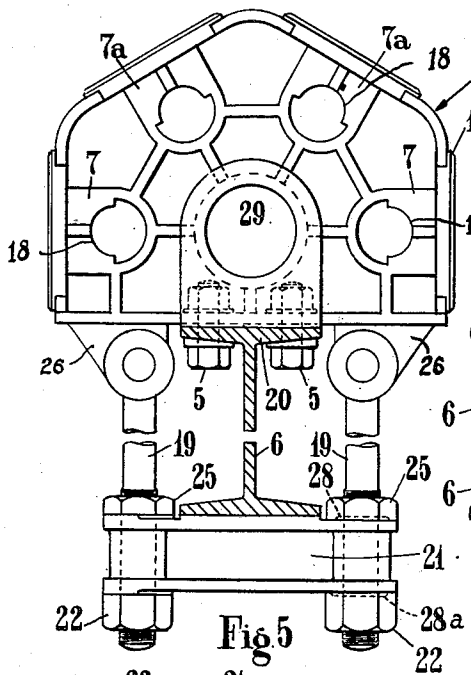

Fig. 5

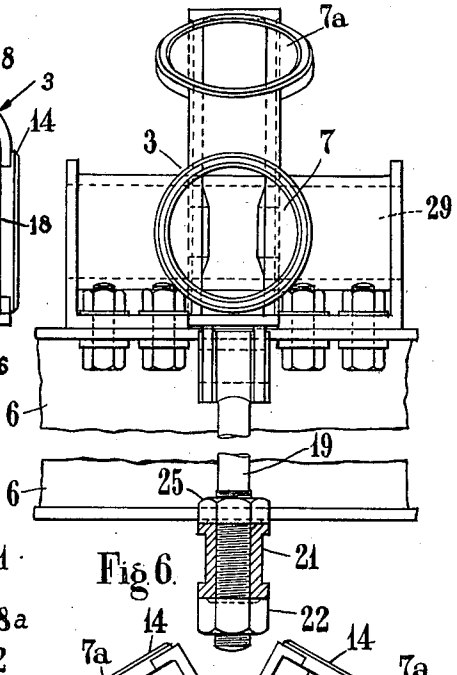

Fig. 6

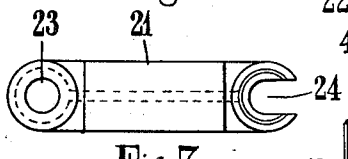

Fig. 7

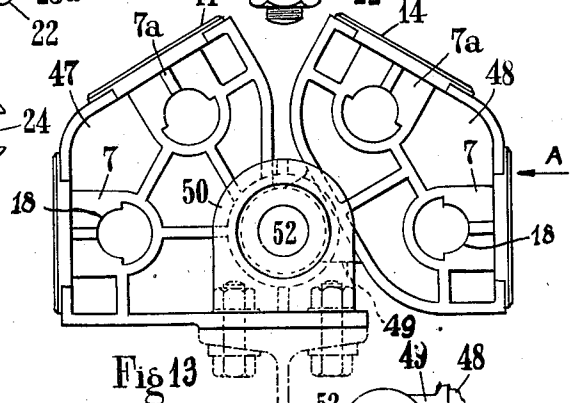

Fig. 13

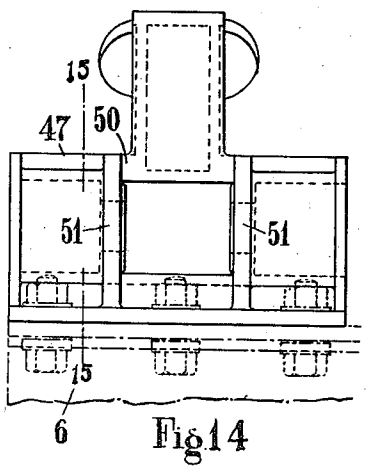

Fig. 14

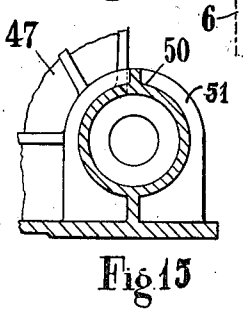

Fig. 15

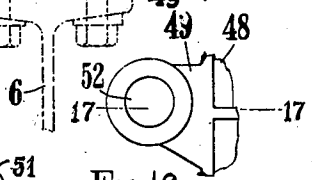

Fig. 16

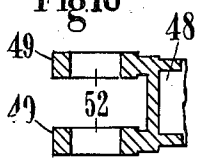

Fig. 17

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TRIANGULATED FRAMEWORK

Filed March 26, 1941 4 Sheets-Sheet 4

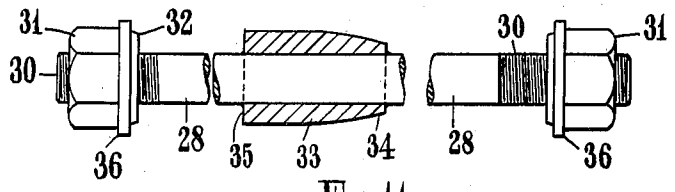

Fig. 11

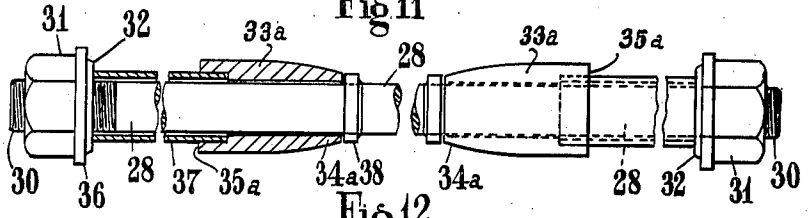

Fig. 12

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Patented Sept. 21, 1943 2,329,906

UNITED STATES PATENT OFFICE

2,329,906

TRIANGULATED FRAMEWORK

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Application March 26, 1941, Serial No. 385,354
In Great Britain April 30, 1940

4 Claims. (Cl. 14—13)

This invention relates to triangulated frameworks which are capable of general application to the supporting of loads but which are particularly suited to the construction of bridges.

The invention has for its object to provide a triangulated framework which can be quickly and easily erected and which is readily adaptable to the supporting of varying loads.

A girder in accordance with the invention is constructed from similar metal tubes joined together by junction-boxes to form the upper and lower booms and the web braces and to provide additional load carrying capacity additional tubes and junction-boxes are provided so that a similar supplementary girder, or girders, may be built up in situ alongside the main girder and be connected therewith.

Thus in building a bridge in accordance with the invention a pair of triangulated girders are formed from similar lengths of metal tubes jointed to junction-boxes and are connected to the transverse joists or transoms for receiving the bridgeway or decking. The bridge thus far constructed is then launched across the span to be bridged and subsequently one or more additional girders are built up in situ alongside the constructed girders and connected thereto in order that the carrying capacity of the bridge may be increased.

The invention also extends to the provision of improved junction-boxes for the girder tubes and to the other features of construction hereafter described or indicated.

In the accompanying drawings:

Figure 1 is an isometric view of a portion of a bridge constructed in accordance with the invention,

Figure 2 is a fragmentary view showing in front elevation the plates provided for tying together the laterally adjacent tubes,

Figure 3 is an end view of Figure 2,

Figure 4 is an end view of a bridge construction according to the invention involving a triple-tube assembly,

Figure 5 is a front elevational view of a lower junction-box, shown secured to its transom, the latter being in section,

Figure 6 is an end view of Figure 5, partly in section,

Figure 7 is a plan view of the stirrup plate employed for securing to the transom such additional lower junction-boxes as may be required to complete the bridge after the main girders have been erected,

Figure 8 is a front elevational view of an upper junction-box,

Figure 9 is a section on the line 9—9 of Figure 8,

Figure 10 is a fragmentary view partly in section of a tube end joint,

Figure 11 shows one of the through bolts employed for securing the adjacent junction-boxes together and provided with a single tapered locating plug whereby the bolt is applicable to a two-tube girder as illustrated in Figure 1, the plug being shown in section and the bolt being broken away for ease of illustration,

Figure 12 is a similar view to Figure 11 but equipped with two locating plugs so that the bolt is applicable to a three-tube girder as illustrated in Figure 4,

Figure 13 is a front elevational view of a modified form of base junction-box suitable for use when it is desired that in the case of a bridge construction, for example, there should be an inclined trackway leading to the bridge proper,

Figure 14 is a view looking in the direction of the arrow A of Figure 13 with the male part of the junction box removed.

Figure 15 is a section on the line 15—15 of Figure 14,

Figure 16 is a fragmentary view showing the fork end of the male junction-box element,

Figure 17 is a fragmentary sectional view on the line 17—17 of Figure 14.

In carrying the invention into effect in one convenient manner as illustrated in the drawings and in the construction of a bridge as illustrated in Figures 1 to 4 in particular, the bridge is composed of two main girders 1 disposed parallel to each other and spaced apart so as to span the space to be bridged and between which the bridgeway 2 is carried so as to be supported by the girders, each of which is built up from similar steel tubes united together in the form of a Warren girder having the tube elements thereof disposed in a vertical plane.

The individual tube elements are connected at their junctions with one another to lower junction-boxes 3 (Figures 5, 6 and 7) and upper junction-boxes 4 (Figures 8 and 9) conveniently in the form of steel box-castings and of which the lower junction-boxes are adapted to be secured, as by bolts 5, to transverse joists or transoms 6 and have four tubular sockets 7, 7, 7a, 7a, while the upper junction-boxes may have six tubular sockets 8, 8, 8a, 8a, 8b, 8b, inclined to each other at an angle of 60°. The tubular sockets 7 of each base box-casting are in line with

one another and receive the adjacent horizontal tubes forming the bottom boom 9 (Figure 1) of the girder while the tubular sockets 8 of each upper box-casting are also in line with one another to receive the adjacent horizontal tubes forming the top boom 10 of the girders.

The two sockets 7a in each base junction-box and the two sockets 8a in each upper junction-box serve to receive the ends of those tubes which form the web braces 11 (Figure 1) of the girders while the two additional sockets 8b in the upper boxes may serve to receive the lower ends of a further series of tubes forming upwardly extended web braces, when for long spans it is desired that the girders should be of double depth to give the desired strength in the most economical manner.

The individual tubes are connected to their respective junction-boxes by means of a loose pin joint which includes a nut 12 (Figure 10) threaded on to the tube end and adapted to press against a bearing surface 14 (Figures 5 and 8) on the junction-box to take up the back-lash when the nut is tightened. For this purpose there is fitted to each end of each tube a tongue element 15 having an externally screw-threaded end portion 16 which is secured within the end of the tube by being engaged with an internally screw-threaded portion 13 thereof and which tongue is provided with a transverse slot 17 elongated in the direction of the longitudinal axis of the tube. Each end portion of the tube containing the interior screw-threaded portion is also screw-threaded on the outside to receive thereon the nut 12 and a loose pin 17a is provided for use in association with each joint. Each socket in the junction-boxes is larger than the tongue so that the latter can readily be positioned therein and when this has been accomplished such that the slot in the tongue is disposed opposite openings 18 in the walls of the socket (which openings are also larger than the pin) the joint pin 17a is placed in position so as to extend transversely through the slot. The final joint is made by tightening the nut so that the slackness of the pin, due to the elongated slot in the tongue and the enlarged openings in the junction-box, is taken up and the tube is fixed in position as well as being fixed rigidly in its correct direction relatively to the junction-box as shown in detail at the right of Fig. 9.

The mode of connecting the tongue element 15 to the tube end as illustrated in Figure 10 involves a screw-threading of the tube end on the interior thereof as well as on its exterior but alternatively the tongue element may be welded to the tube.

It is intended that the bridge should be constructed on land in skeleton form by a pair of tubular girders as above described being assembled and secured to the transverse joists or transoms which serve to receive the floor of the bridge and that when this skeleton bridge, that is the bridge consisting of the main or outside girders 1 and the transoms 6 as illustrated in Figures 1 and 4, has been launched across the span to be bridged if further strength is required it shall be provided by one or more additional girders 27 being built up in situ alongside the preformed girders of the skeleton bridge, each additional girder being also composed of similar tubes and junction-boxes similar to those already described. In this way the important advantage is obtained that the final bridge may be made to withstand heavy loads without, however, the need for increasing the launching weight. The bridge as illustrated in Figure 1 is of double-tube formation whereas the bridge according to Figure 4 is triple-tubed and as the upper and lower junction-boxes are similar throughout these have been given the same references.

The junction-boxes provided to form the base junction-boxes of the tubes of the girders to be built up in situ alongside the main girders are, however, of modified construction and permit of these boxes being placed loosely upon their supporting joists or transoms 6 and secured thereto during the construction of the supplementary girder or after the same has been completed. This is achieved by each such box being provided with a pair of laterally spaced bolts 19 pivoted to the base of the box so as to depend therefrom and adapted to pass through openings at the ends of a transverse stirrup plate 21 passed beneath the base of the joist or transom so that the bolts lie upon opposite sides of the latter, the free ends of the bolts being screw-threaded to receive securing nuts 22 for pulling the box hard down against the top flange 20 of the joist. Conveniently the said openings may consist of a bore 23 through which the corresponding bolt is introduced as the box is lowered into position upon the joist and an open-ended slot 24 into which the other bolt can be moved by angular movement thereof, the arrangement permitting of a fastening of the box by the securing of the nuts on the bolt which is passed through the said bore (there being two nuts consisting of the one 22 secured upon the bolt beneath the said stirrup plate and a lock nut 25 secured upon the bolt above the stirrup plate, the latter being drawn into close contact with the base of the joist when the nuts are tightened) and of a final securing of the box in position by the other bolt being secured within the slot in the plate. The arrangement enables two, three or even more girders to be built up in situ alongside each main girder to provide such increased carrying capacity as may be required while the complete elasticity of the system permits of the strengthening of the main girders to be carried out to a varying extent lengthwise thereof by, for example, each girder being made of double-tube form in the end portions thereof and of triple-tube form in the centre portion.

The base junction-boxes employed for the main and the supplementary girders are identical except for the provision of the bolts 19 and associated parts for the junction-boxes of the supplementary girders, and accordingly Figure 5 is relied upon as illustrating both the base junction-box employed for the main girders and also for the supplementary girders. This enables a uniform construction of all the base junction-boxes to be adopted since, when required for use to form a supplementary girder, it is only necessary to apply the bolts 19 to the lugs 26 (Figure 4) which depend from the base of each junction-box.

Conical bosses 28a may be provided on the stirrup plates at the slotted ends thereof for engagement with conical recesses in the nuts to prevent the bolts engaged with the slots from escaping therefrom when the nuts are tightened.

Since the added girders are identical in form to the girders originally erected, when the lower junction-boxes are pulled down by the bolts and stirrup plates to make close contact with the transoms, the deflections of the girders thus

united together will be identical and consequently the load on the adjacent girders will be distributed equally among the girders.

Besides the connection of the base junction-boxes carrying the tubes forming the supplementary girders 27 to the transverse joists or transoms 6 by the bolts 19 above described it is also proposed to connect the transversely adjacent junction-boxes by through bolts which may be employed in association with both the base and the upper junction-boxes to ensure that the axes of the tubes at their ends are constrained to lie at right angles to the axes of the bolts coupling together adjacent upper and lower junction-boxes and has the effect of greatly increasing the lateral stiffness of the girder when double- or triple-tubed.

A suitable form of through bolt is illustrated in Figures 11 and 12 wherein the bolt 28 is formed to pass through the central openings 29 in the base junction-boxes and through openings 29*a* in the upper boxes 4 and has screw-threaded ends 30 which project beyond the outer faces of the junction-boxes and serve to receive the nuts 31 which are tightened upon these faces and to force adjacent junction boxes to register coaxially tapered bosses 32 are provided.

The through bolt illustrated in Figure 11 is suitable for application to a two-tube girder as illustrated in Figure 1 and has secured thereto a plug 33 having a tapered end 34 and opposite end portion 35 which is adapted to enter openings 29 or 29*a* of the junction boxes to align said boxes as the nuts 31 are tightened.

The through bolt illustrated in Figure 12 is suitable for application to a three-tube girder as illustrated in Figure 4 and the through bolt in this case is provided with two plugs 33*a* slidable upon the bolt and provided with coaxial sleeves 37 which, at their outer end, are engaged by the nuts 31 when the latter are tightened upon the bolt and the correct location of which upon the bolt is ensured by the presence of the flanges 38 upon the latter whereby as the nuts are tightened, the tapered ends 34*a* of the plugs will firmly engage within the central opening 29 or 29*a* of the central junction-box while the outer junction-boxes will be aligned by the base portions 35*a* of the plugs fitting in openings 29 or 29*a*.

The overall diameter of the plugs is such as will permit the bolt and the plugs to be passed freely through the openings 29 of the junction-boxes to be tied thereby after which the nuts 31 are secured in position upon the bolt and tightened to complete the tie.

To provide additional lateral rigidity or strength the transversely adjacent tubes of the main and supplementary girders may be connected together by plates 39 (Figures 2 and 3) secured transversely across the tubes intermediate the ends thereof. These plates are conveniently of skeleton and channel form and are secured one upon opposite sides of the tubes so that the channels thereof face inwards and partly embrace the tubes of the flanges by forming the channels with recesses to receive the tubes, the attachment of the pairs of plates to the various tubes being effected by bolts 40 passed through openings in the plates so as to extend in the direction of the girders and to which bolts securing nuts 41 are applied at the end portions thereof.

Figures 13 to 17 illustrate a modified form of base junction-box suitable for use when an inclined approach to a bridge is required in which case the end base junction-boxes of each girder are of this modified form and each comprise a fixed female part 47 and a male part 48 which is pivotally mounted upon the fixed part so as to be capable of being swung outwards with respect to the latter according to the inclination required. In such case the upper booms of the girders will be discontinued between the bridge proper and the inclined gangway. The male junction part is formed with a fork in the form of a pair of spaced lugs 49 adapted to be introduced into a bearing block 50 on the female part so as to be positioned between two axially spaced ring plates 51 therein and formed with central openings 52 for receiving a pivot pin or plug.

I claim:

1. A triangulated framework structure comprising in combination a main girder composed of similar tubes forming the upper and lower booms and the web braces, junction-boxes connecting the tubes with each other, a supplementary girder composed also of similar tubes and junction-boxes disposed to lie alongside the main girder, transverse transoms spaced longitudinally of the girders and common to and connected with the base junction-boxes of both girders, and means independent of said transoms connecting the adjacent junction-boxes of both girders.

2. A triangulated framework structure as claimed in claim 1, wherein the junction-boxes are formed with central openings and through bolts are provided adapted to be passed one through each aligned series of openings of the laterally adjacent junction-boxes of the several girders to connect the same together.

3. A triangulated framework structure as claimed in claim 1, wherein bolts passing through the junction-boxes are provided for securing the adjacent junction-boxes together, drift plugs on said bolts serving to obtain the proper coaxial registration of the junction-boxes and equal distribution of the stresses throughout the adjoining tube members, the drift plugs being spaced axially along the bolt and having tapered ends engageable within the central opening of the junction-boxes.

4. A triangulated framework structure comprising in combination a main girder composed of similar tubes forming the upper and lower booms and the web braces, junction-boxes connecting the tubes with each other, a supplementary girder composed also of similar tubes and junction-boxes disposed to lie alongside the main girder, transverse transoms spaced longitudinally of the girders and common to and connected with the base junction-boxes of both girders, the base junction boxes at the ends of the structure including pivotally mounted tube-carrying sockets whereby the structure is adapted for the formation of an inclined approach thereto.

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