W. M. THOMAS.

CONCRETE BRIDGE CONSTRUCTION.

APPLICATION FILED JAN. 30, 1908.

915,316.

Patented Mar. 16, 1909.

4 SHEETS—SHEET 1.

Fig. I.

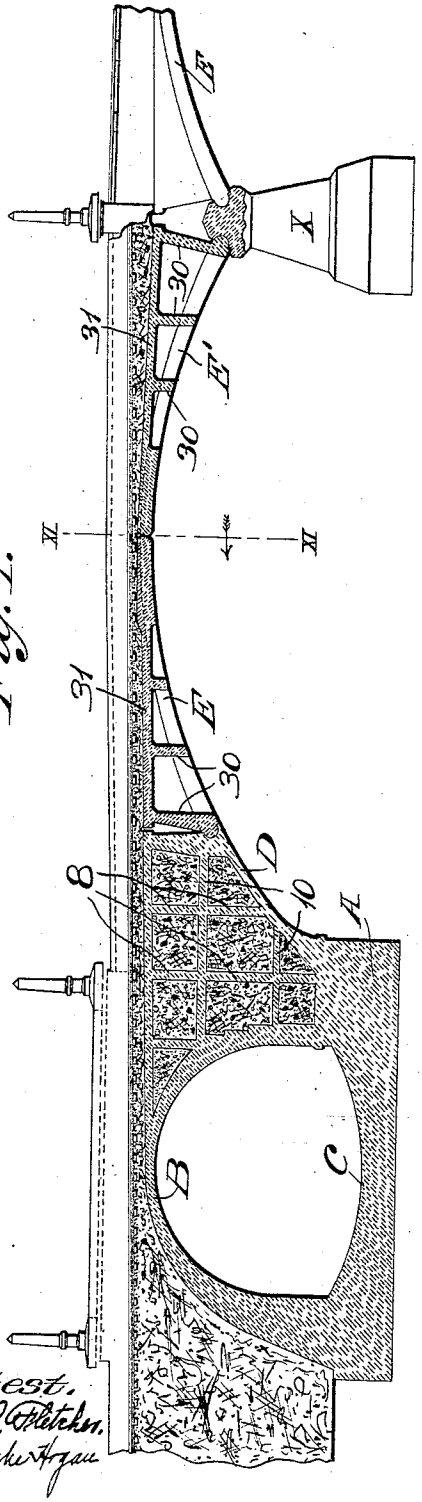
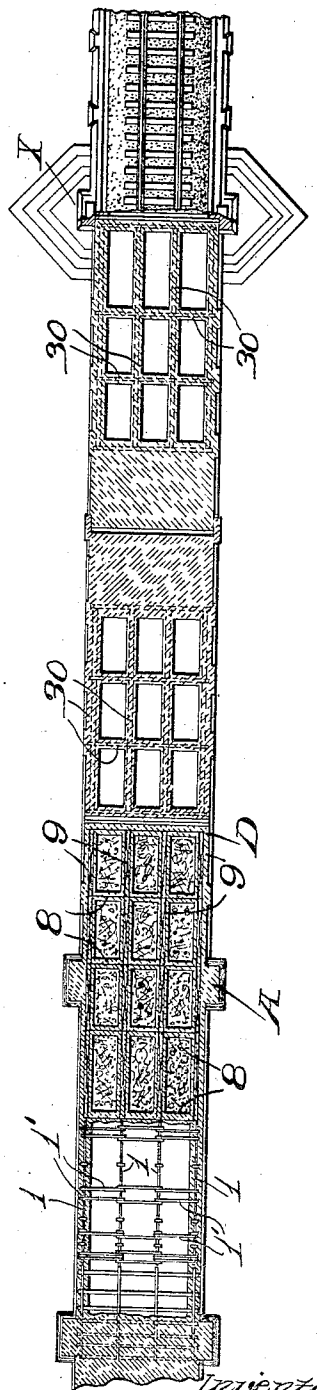


Fig. II.



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4 SHEETS—SHEET 2.

Fig. III.

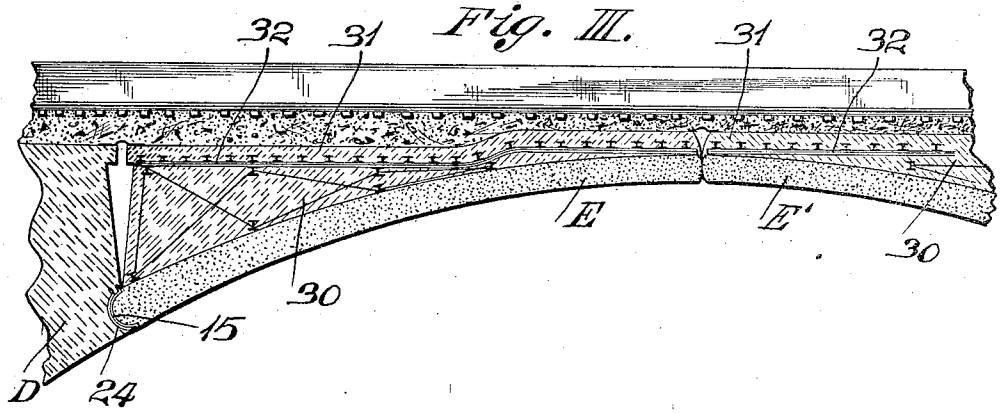
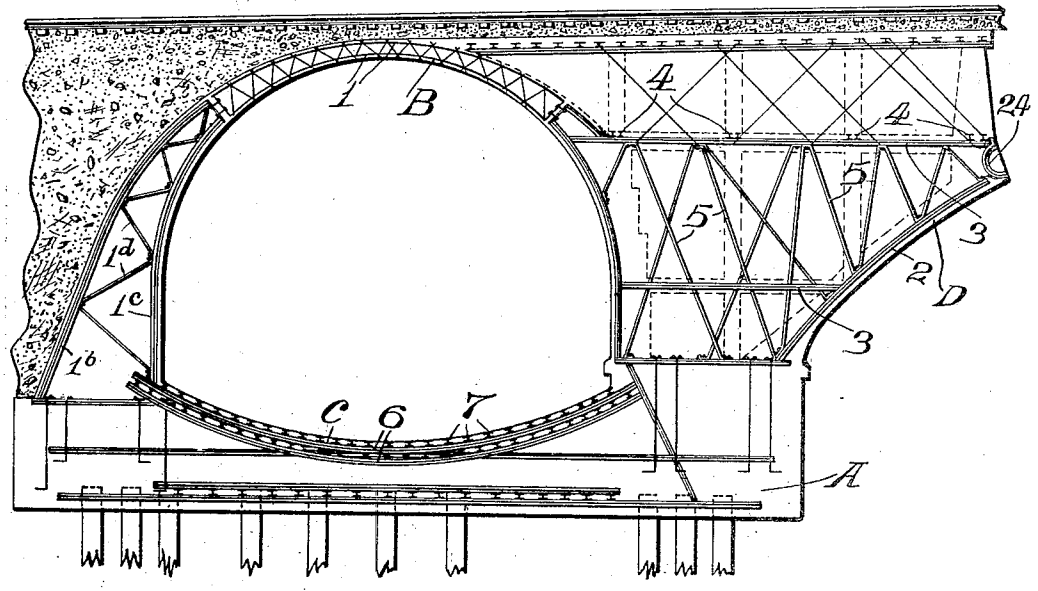


Fig. IV.



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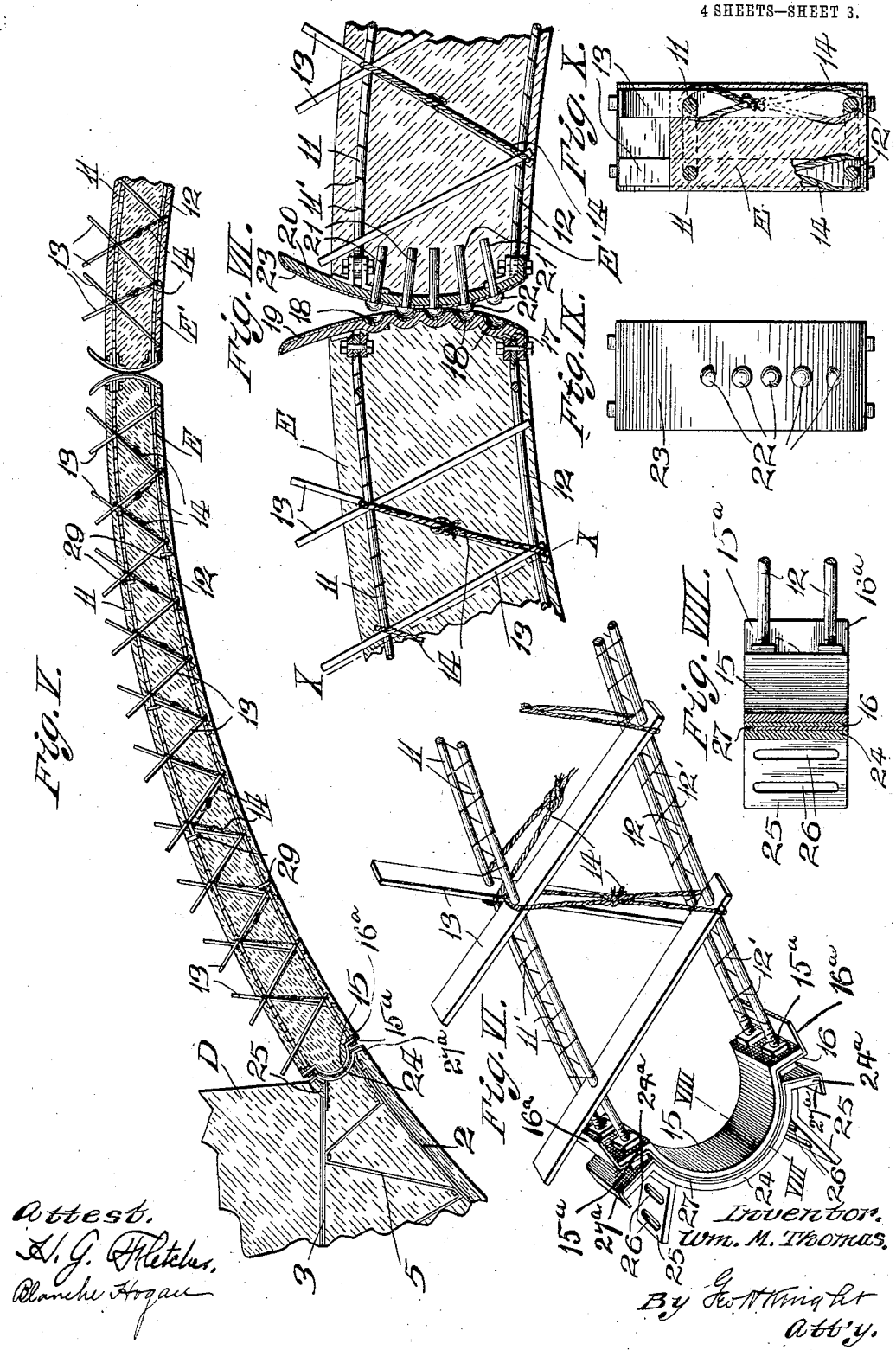
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4 SHEETS—SHEET 3.



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4 SHEETS—SHEET 4.

Fig. XIII.

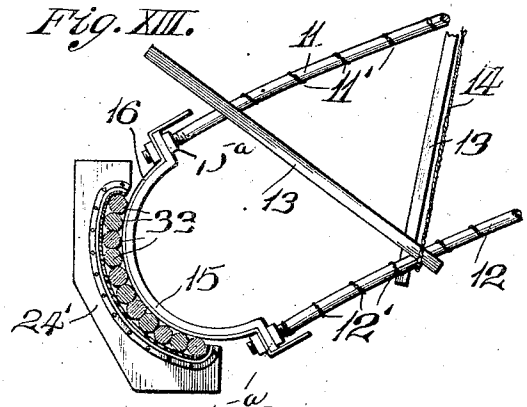


Fig. XIV.

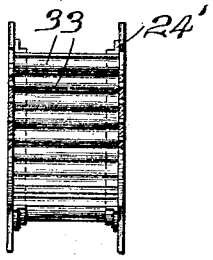


Fig. XI.

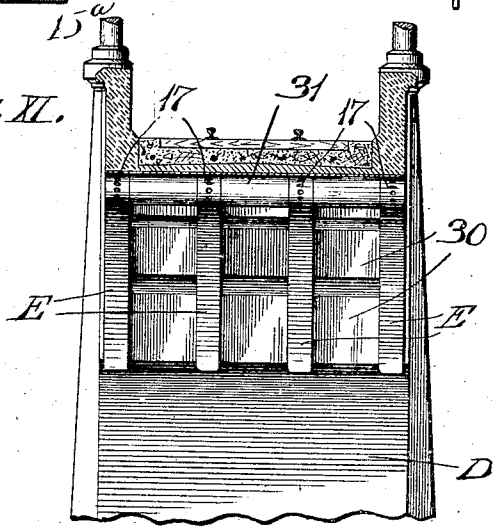
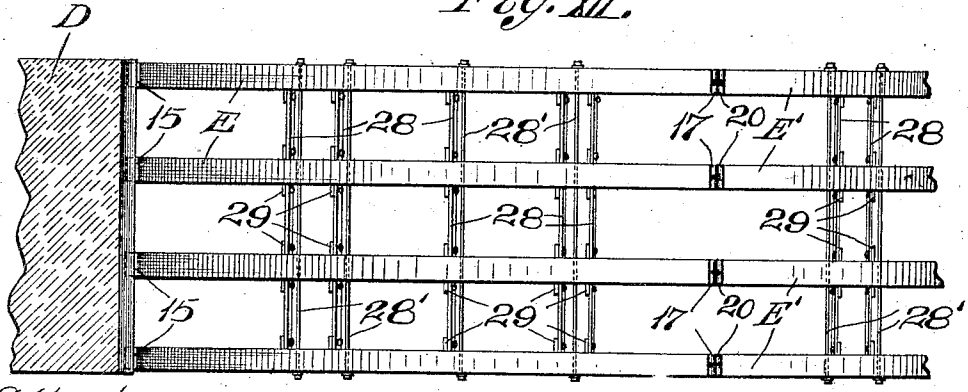


Fig. XII.



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UNITED STATES PATENT OFFICE.

WILLIAM M. THOMAS, OF SANTA CRUZ, CALIFORNIA.

CONCRETE-BRIDGE CONSTRUCTION.

No. 915,316. Specification of Letters Patent. Patented March 16, 1909.

Application filed January 30, 1908. Serial No. 413,365.

To all whom it may concern:

Be it known that I, WILLIAM M. THOMAS, a citizen of the United States of America, residing at Santa Cruz, in the county of Santa Cruz and State of California, have invented certain new and useful Improvements in Concrete-Bridge Constructions, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to the construction of concrete bridges and it has for its object the production of a structure of this character in which the abutments are reinforced both longitudinally and transversely and which include reinforced cantaliver arms.

A further object of my invention is to provide reinforced segmental arch sections which may be produced prior to mounting them in the bridge structure and provide these arch sections with means whereby they are adjustably mounted in the bridge structure.

A further object of my invention is to provide for an efficient reinforced connection between various arch sections employed in the bridge structure.

Figure I is a vertical longitudinal section taken through a portion of a bridge constructed in accordance with my improvement. Fig. II is a horizontal section taken through the structural parts shown in Fig. I. Fig. III is an enlarged vertical section taken through the arch sections of the bridge structure shown in Figs. I and II and the structural elements of the bridge above these arch sections. Fig. IV is a longitudinal section taken through the framework of one of the abutments of the bridge structure. Fig. V is a longitudinal section taken through one of the arch sections a part of a mating arch section and a part of one of the abutments and showing the reinforcing framework within said members. Fig. VI is an enlarged perspective view of the reinforcing framework in one of the arch sections and one of the hinge members carried by said framework, a socket hinge member of the description employed in the abutments being shown associated with the hinge member of the arch section. Fig. VII is an enlarged vertical longitudinal section through the crown ends of a pair of mating arch sections and illustrating the hinge by which these sections are movably fitted to each other. Fig. VIII is a cross section taken on line VIII—VIII, Fig. VI. Fig. IX is an elevation of one of the crown hinge members of the arch sections. Fig. X is a cross section taken on line X—X, Fig. VII through one of the arch sections. Fig. XI is a vertical cross section taken on line XI—XI, Fig. I. Fig. XII is a top or plan view of the arch sections illustrated as they appear when mounted in a bridge structure and connected to each other before concrete webs are molded between the arch sections to inclose the tie members. Fig. XIII is a view partly in elevation and partly in vertical section illustrating a modified form of hinge that may be used at the junction of the arch sections with the abutments of a bridge to furnish antifriction bearings in the hinges. Fig. XIV is a view partly in elevation and partly in section of the antifriction bearing device shown in Fig. XIII.

Referring to the accompanying drawings: A designates one of the abutments of a concrete bridge and X is a second abutment located at a distance from the abutment A and between which and said abutment A the arch constructed in accordance with my invention is located. The abutment A comprises an arch B, an invert C and a cantaliver arm D, and said abutment is mainly constructed of concrete but has reinforcing elements therein which I will proceed to describe.

1 designates reinforcing ribs, see Figs. II and IV, of the abutment A which include trussing and tie members that may be arranged in any suitable manner for the purpose of resisting the strain that is imposed upon said ribs. The several ribs are united by ties 1′, see Fig. II. Each reinforcing rib 1 in my bridge structure has associated with it on one side a stay frame having upwardly extending reinforcing members 1^b and 1^c, and trussing member 1^d and, on the other side, a cantaliver arm 2 that extends outwardly from the arch of the abutment A and in which are horizontal reinforcing tie members 3 that extend longitudinally of the cantaliver arm, horizontal reinforcing tie members 4 that extend transversely of the cantaliver arm and vertical reinforcing trussing members 5 by which the other reinforcing members of the cantaliver arm are reinforced. The invert C of the abutment A contains longitudinal reinforcing members 6 and transverse reinforcing members 7 which are united

to each other. The reinforcing members in the invert are united to the sides of the abutment rib 1 and act to take up the thrust of the abutment arch and distribute the weight of the structure and the thrust in the entire bearing area of the abutment.

The series of abutment ribs 1 are connected by a plurality of concrete cross webs 8, see Figs. I and II, in which the transverse reinforcing tie members are situated and the longitudinal reinforcing members of the ribs are incased within longitudinal concrete webs 9. The webs 8 and 9 are united by horizontal or floor webs 10 and as a consequence the reinforcing members of the abutment ribs are entirely protected by being surrounded by concrete. The cells produced by the production of the webs mentioned may be, if desired, filled with sand, loam, or other suitable material.

E and E′ are the concrete segmental arch sections in my bridge structure that are adapted to be mounted between the abutments A and X, or between additional abutments of the bridge structure. These segmental arch sections, which constitute the haunches of the arch, have incorporated therein reinforcing ribs that are embedded in the concrete. These reinforcing ribs are patterned somewhat after the reinforcing framework shown and described in U. S. Letters Patent No. 805,762, issued November 28, 1905, to John S. Thomas and myself. The reinforcing ribs comprise upper pairs of longitudinal rods 11, preferably of rolled metal, that are bent to radius of the circle of the arch that is to be produced and lower pairs of longitudinal rods 12 parallel with the upper pairs of rods 11. The upper pairs of rods 11 are nearest to the extrados of the arch and the lower pairs of rods 12 are nearest to the intrados of the arch when the arch sections are assembled in the bridge structure and I will hereinafter refer to the rods 11 as longitudinal extrado rods and the rods 12 as longitudinal intrado rods for the purpose of distinguishing them from each other. There is preferably one pair of extrado rods and one pair of intrado rods in each arch section.

13 are crossed strut plates that are disposed diagonally across the longitudinal extrado rods 11 and longitudinal intrado rods 12 and which are preferably threaded onto these rods.

14 are wire stays and by which the strut plates 13 are held in position in the ribs of the segmental arch sections. In making the stays 14 of wire, I pass the wires over the rods 11 and under the rods 12 and across the upper ends of the strut plates 13 and lower ends of the next strut plates 13 to produce loops extending around these parts and then unite the ends of the wires by twisting said ends together across the bodies of the stays, thereby causing the stays to exert a tightening action upon the strut plates to hold them firmly. The strut plates and stays connecting the extrado and intrado rods at one side of each segmental arch rib are placed diagonally in one general direction while the strut plates and stays connecting the other pair of said rods in the same rib are disposed diagonally in the opposite general direction thereby affording greater resistance in the ribs than would be afforded if the strut plates and stays were all arranged in one general direction. The strut plates 13 are extended beyond the longitudinal extrado rods 11 and project through the extrados of the segmental arch sections, as seen in Figs. V and VII when said sections are produced. The extensions thus provided serve as ties when the spandrel wall is built up above the arch in my bridge structure.

The upper pairs of rods 11 and lower pairs of rods 12 of the reinforcing ribs are reinforced horizontally by wires 11′ and 12′ respectively that are twisted around and over and under the rods (see Fig. VI). These wires serve to provide braces for lateral reinforcement of the rods to which they are applied.

At the abutment end of each segmental arch section is a semi-circular hinge member 15 having radial flanges 15^a and which is secured by its radial flanges 15^a in a suitable manner to the longitudinal extrado and intrado rods of the arch section ribs and which has fitted to its outer face a correspondingly shaped protective sheet 16 of non-corrosive material, such as copper having flanges 16^a lapping the edges of the radial flanges 15^a of the hinge member 15. At the crown end of each segmental arch section E and suitably secured to the longitudinal extrado and intrado rods is a crown hinge plate 17 that is provided with pockets 18 that receive members to be presently mentioned. The hinge plate 17 has applied to its face a protective sheet 19 of copper or other suitable non-corrosive material.

20 is a hinge plate suitably secured to the longitudinal extrado and intrado rods of the segmental arch section E′. This plate has mounted in it a plurality of bolts or pins 21 that are provided with round heads 22 located at the face of said hinge plate 20. The bolts or pins 21 are of non-corrosive material and they are adapted, when the arch sections E and E′ are assembled, to enter the pockets 18 in the hinge plate 17 to act as cogs and permit movement of the crown of the arch in which the arch sections E and E′ are incorporated. By this construction I provide an arch that is susceptible of rising and falling when subjected to excessive strains or when expansion and contraction take place in the bridge structure. The hinge plate 20 is similarly, to the hinge plate 17, protected at its face by a protective

sheet 23 of copper or other non-corrosive material.

After the segmental section arch ribs have been constructed in the manner described and previous to the mounting of the arch sections in a bridge structure I lay said ribs in a suitable mold properly shaped to produce the extrados and intrados of an arch and fill the mold with concrete with the result of wholly embedding the ribs in concrete with the exception of their hinge members located at the abutment and crown ends of the arch sections. By this plan of making the arch sections I am enabled to produce them in a condition ready to be put in place in a concrete bridge and dispense with the erection of false work and the building of molds upon the false work during the progress of erecting the bridge structure to produce the arch of such structure.

To provide for the reception of the segmental arch sections E and E', by the abutments of the bridge I utilize segment shaped socket plates 24 that are provided with radial flanges 24ª attached to the reinforcing framework or ribs of the abutments of the bridge structure and at the ends of the cantaliver arms of the abutment in the instance of the abutment A. These socket plates are preferably provided with wings 25, see Figs. V, VI and VIII, that extend rearwardly from the plates and contain slots 26 through which bolts may be passed to connect the socket plates to the reinforcing framework of the abutments, the slots providing for any desired lateral adjustment of the socket plates in mounting them.

27 are protective sheets of non-corrosive material having flanges 27ª lapping the edges of the socket plates 24 and that are applied to the faces of the socket plates 24 and which, in connection with the socket plates, are embedded within the concrete of the abutments so that the socket plate is sealed from the air, thereby preventing corrosion or rusting of the plates.

The series of arch sections E and the series of arch sections E' in the bridge structure are individually united by brace and tie rods 28, see Fig. XII, which are preferably secured to the ribs of the arch sections through the medium of cross rods 29 fitted to the extrado and intrado rods of the arch sections and to which the brace and tie rods are riveted or otherwise secured. The arch sections in sets are bound together by tie bolts 28' extending transversely through the sections. After the segmental arch sections have been tied together in the manner just explained, cross walls 30, see Figs. I and II, of concrete are molded between the arch sections to stiffen the arch and these cross walls are extended upwardly as seen in Fig. I, to points above the arch sections and united by a superstructure 31 of concrete that contains longitudinal and transverse reinforcing framework 32, see Fig. III.

In Figs. XIII and XIV I have shown a modification of the abutment socket bearing for the segmental arch sections of my bridge structure in which a socket plate or frame 24' is utilized and anti-friction rollers 33 are mounted in said plate or frame to receive the hinge plates 15 at the abutment ends of the segmental arch sections.

It will be seen that in the construction of the abutment of my bridge structure the invert acts as a compression member while the arch of the abutment follows the line of thrust of the span arch and is in compression. The cantaliver arm is in tension until the pair of ribs are inserted into sockets at ends of cantaliver arm, then cantaliver arm becomes part of large or span arch cantaliver arm is in compression also that said invert is strong enough to receive the thrust from the large arch that depends for its support upon the cantaliver arm.

I claim:—

1. In a bridge construction, a reinforced concrete abutment comprising a large, thick reinforced concrete slab extending under entire abutment, a portion of which slab forms an invert of an arch that is taken out of the abutment, leaving an arch with two piers resting on invert slab; the outside pier having a cantaliver arm extending outwardly from it and which forms a portion of a large arch, and the soffit of which forms the intrados of portions of large arch; said cantaliver arm having at its extremity a semi-circular skewback or portion of hinge securely bolted to longitudinal reinforcing; said abutment being built in longitudinal reinforced concrete ribs, reinforced with cross walls and horizontal reinforced floors which form compartments in abutment which may be filled with sand or rock to save concrete material.

2. In a bridge construction, a concrete arch section having lower and upper longitudinal ribs each consisting of a pair of rods, crossed strut plates extending across the lower and upper ribs, and stays extending around the lower and upper ribs at the crossing of the strut plates.

3. In a bridge construction, an arch comprising segmental concrete arch sections having reinforcing ribs therein comprising longitudinal lower and upper rods arranged in pairs, strut plates interposed between the lower and upper rods in said pairs, and stays connecting said lower and upper rods; said strut plates having extensions projecting through the extrados of said section, substantially as set forth.

4. In a bridge construction, an arch comprising segmental concrete arch sections

having reinforcing ribs therein comprising longitudinal lower and upper rods arranged in pairs, and crossed strut plates interposed between the lower and upper rods in said pairs; said strut plates being disposed diagonally between the lower and upper rods at one side of each rib and being disposed diagonally but in a reverse direction between the lower and upper rods at the opposite side of each rib, substantially as set forth.

5. In a bridge construction, an arch comprising segmental concrete arch sections having reinforcing ribs therein comprising longitudinal lower and upper rods arranged in pairs, crossed strut plates interposed between the lower and upper rods of said pairs, stays extending around and connecting said lower and upper rods at the crossing of the strut plates and wires by which said lower and upper rods are bound together in pairs, substantially as set forth.

6. In a bridge construction, an arch comprising an abutment having a cantaliver arm containing reinforcing members, hinge socket plates provided with slotted wings adapted to be adjustably secured to the reinforcing members of said cantaliver arm and adapted to receive an arch member of the bridge structure, substantially as set forth.

7. In a bridge construction, a pair of mating concrete arch sections having hinge plates at their crown ends the hinge plate of one of the sections being provided with pockets and the hinge plate of the other section being provided with pins having heads adapted to enter the pockets in the mating hinge plate, substantially as set forth.

8. A concrete abutment formed with an arch having reinforcing ribs and cross ties, a stay frame having upwardly extending reinforcing members and trussing members, a cantaliver arm having longitudinal reinforcing tie members, transverse reinforcing tie members, and vertical reinforcing trussing members, and an invert having longitudinal reinforcing members and transverse reinforcing members.

9. A concrete abutment formed with an arch having reinforcing ribs and cross ties, a stay frame having upwardly extending reinforcing members and trussing members, a cantaliver arm having longitudinal reinforcing tie members, transverse reinforcing tie members, vertical reinforcing trussing members, concrete cross webs, concrete longitudinal webs and concrete floor webs and an invert having longitudinal reinforcing members and transverse reinforcing members.

10. A concrete abutment formed with an arch having reinforcing ribs and cross ties, a stay frame having upwardly extending reinforcing and trussing members, a cantaliver arm having longitudinal reinforcing tie members, transverse reinforcing tie members, vertical reinforcing trussing members, segment shaped socket plates, having wings connected to the frame work of the cantaliver arm, and an invert having longitudinal reinforcing members and transverse reinforcing members.

11. A bridge construction comprising a concrete abutment formed with a cantaliver arm having reinforcing framework, segmental shaped socket plates having wings connected to the framework of the cantaliver arm, and an arch section having semi-circular hinge members fitted to the socket plates.

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In the presence of—
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