W. M. THOMAS.

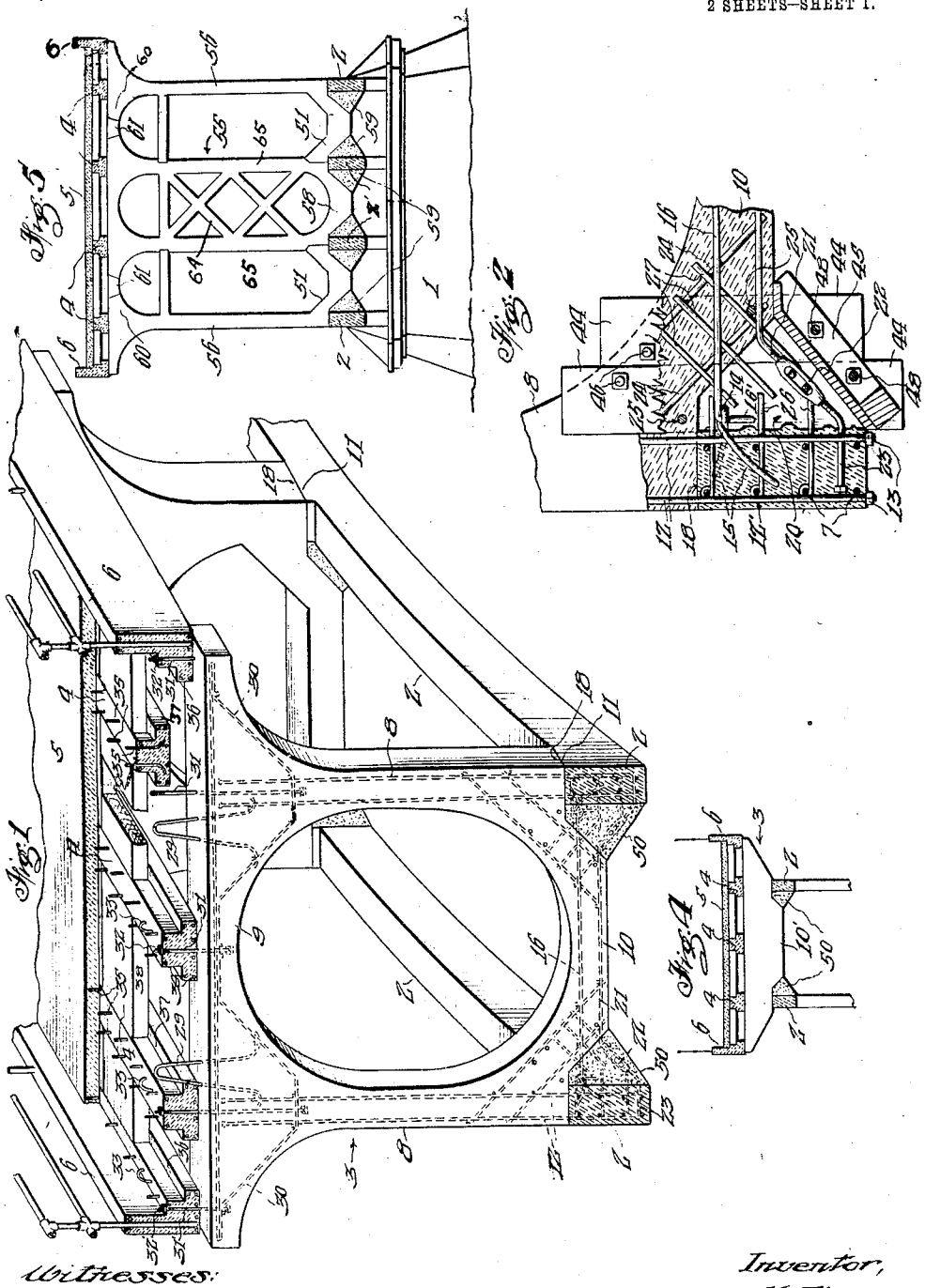
CONCRETE BRIDGE CONSTRUCTION.

APPLICATION FILED JAN. 24, 1911.

1,097,269.

Patented May 19, 1914.

2 SHEETS—SHEET 1.



Witnesses:
H. Mansfield
Lulu A. Otten

Inventor,
William M. Thomas;
by Townsend, Brown & Hackley
his attys.

W. M. THOMAS.

CONCRETE BRIDGE CONSTRUCTION.

APPLICATION FILED JAN. 24, 1911.

1,097,269.

Patented May 19, 1914.

2 SHEETS—SHEET 2.

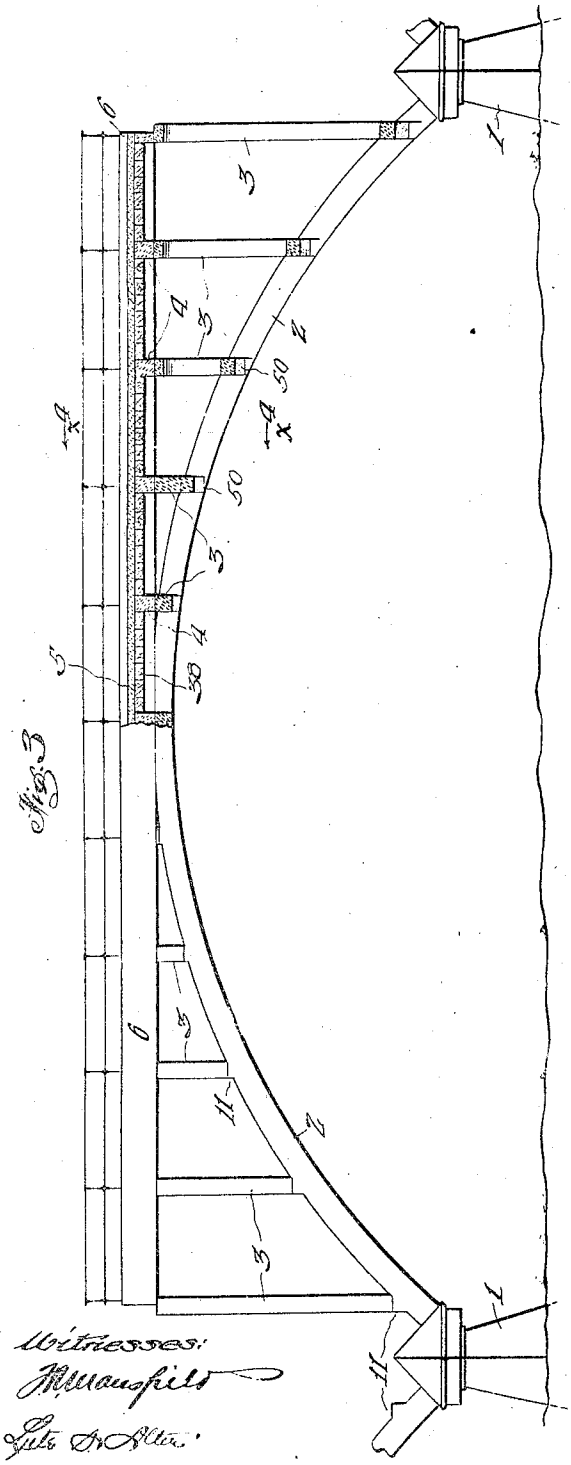


Fig. 3

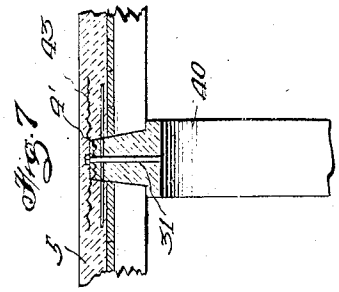


Fig. 7

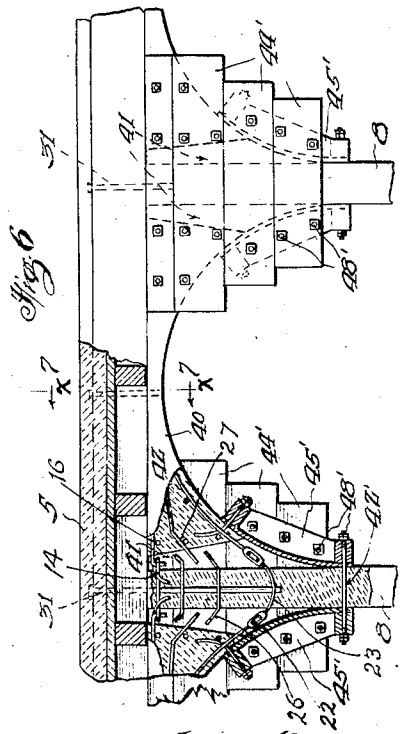


Fig. 6

Witnesses:

R. Mansfield

Geo. H. Miller

Inventor,

William M. Thomas,

by Dwinnell & Lauritzen

his attys

UNITED STATES PATENT OFFICE.

WILLIAM M. THOMAS, OF OCEANSIDE, CALIFORNIA.

CONCRETE BRIDGE CONSTRUCTION.

1,097,269. Specification of Letters Patent. Patented May 19, 1914.

Application filed January 24, 1911. Serial No. 604,434.

To all whom it may concern:

Be it known that I, WILLIAM M. THOMAS, a citizen of the United States, residing at Oceanside, in the county of San Diego and State of California, have invented a new and useful Concrete Bridge Construction, of which the following is a specification.

The main object of the present invention is to eliminate as much as possible the use of false work or centering required for monolithic construction of bridges. This I accomplish by forming the elements of the bridge, including the arch ribs, spandrel sections and floor beams, in positions other than that of final occupancy and then assembling such elements in their final positions and connecting them together by steel ties and molded joints so that they are held in rigid connection and in such manner as to resist both tensile and compressive strains. By such procedure, the cost of molding the parts is largely reduced for the reason that much of the expense of molding the concrete bridge constructions by the monolithic system is represented in the staging or false work required to support the molds in their proper positions and by molding the elements separately no such supports for the molds are required.

Another object of the invention is to provide a concrete bridge construction in which the several elements, namely, the arch beams, spandrel sections and ribs, are provided with means for temporary support of the molding devices for temporarily holding the cement for joining said elements together and completing the structure.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate the invention, and referring thereto:

Figure 1 is a perspective of a portion of the bridge construction, showing the floor in process of formation. Fig. 2 is a fragmentary section, showing the manner of attaching the spandrel section to the arch rib. Fig. 3 is a side elevation, partly in section, of one span of the bridge. Fig. 4 is a section on line x^4—x^4 in Fig. 3. Fig. 5 is a transverse section, showing a construction of spandrel section adapted for use where there are more than two arch ribs. Fig. 6 is a longitudinal section, showing the construction where the floor beams are of arched form. Fig. 7 is a section on line x^7—x^7 in Fig. 6.

Referring to Fig. 3, 1 designates the piers or supports for the spans of the bridge, 2 the arch ribs springing from said piers or supports, 3 the spandrel sections resting on said arch beams, 4 the longitudinal floor ribs, and 5 the floor. Curb beams 6 are provided at each side extending longitudinally of the bridge and resting on the spandrel sections. The arch ribs 2 are of reinforced concrete having longitudinal reinforcing members 7 and being provided at their ends with means for seating on the piers or abutments and being further provided at intervals along their length with horizontal ledges or seats 11 to receive the spandrel sections. In case the three-hinge arch construction is used, the said arch ribs will be formed in two members for each span, meeting and hinging together at their upper ends and resting at their lower ends on the piers by a hinge support, but it will be understood that my invention is not limited to such construction. The spandrel sections 3 are also of reinforced concrete and may be of the same general construction throughout the bridge, being adapted to rest on the arch ribs 2 and to support the floor beams 4 and where such spandrel sections are of any considerable height they are formed as open frames, as shown in Fig. 1, with a spandrel post 8 at each side connected at top and bottom by upper and lower transverse members 9 and 10. The lower ends of the spandrel posts 8 are formed as flat surfaces 18 adapted to rest on seats 11 on the arch ribs 2 and said spandrel posts may be provided with vertical metallic bolts 12 molded therein and extending through holes 12′ in the arch ribs 2, nuts 13 being screwed on the lower ends of said posts to hold the spandrel sections in position on the arch ribs. The arch ribs 2 are provided with eyes 14 having their shanks 15 molded into the arch ribs, said eyes being disposed in such manner as to receive the hook-shaped ends 16′ of reinforcing rods 16 molded in the lower members 10 of the spandrel sections. The lower transverse member 10 of the spandrel section preferably dips downward from its horizontal end portions 18 which rest on the seats 11 aforesaid, and the eyes 14 on the arch ribs 2 extend into the space 20 between said arch ribs and the depending portion of the spandrel section, the aforesaid rods 16 also extending at their ends into these spaces. Another reinforcing rod 21 in

the lower transverse member 10 extends at its ends into said spaces and is screw-threaded to receive turn buckles 22, whereby it is connected to threaded rods 23, molded into the arch beams 2. The spandrel section may be further provided with obliquely extending reinforcing rods 24 and with transverse perforations 25, said perforations serving to receive the bolts for temporarily supporting the molding members, as hereinafter set forth. Arch ribs 2 and the transverse members 10 of the spandrel sections are further provided with rods 26 and 27 projecting therefrom into the spaces 20 aforesaid, so as to be embedded in the cement and to tie the spandrel sections to the arch ribs 2. At their upper ends the spandrel sections may be provided with metallic loops 29 having their ends molded into the concrete sections, said loops being adapted to be engaged by the lifting devices for raising the spandrel sections into place. The upper spandrel sections near the top of the arch are of such small vertical dimensions that they may be formed as a single member, as shown in Fig. 4, the construction of this transverse member being similar to that of the lower transverse member for the open frame spandrel section as regards its means for support on the arch ribs, the two transverse members 9 and 10 being in effect coalesced into one transverse member 10′ in this form of the spandrel section. In each case the spandrel section may be provided with corbels 30 adapted to support the curbs and the overhanging part of the bridge floor.

The bridge flooring comprises longitudinal beams 4 resting on the top of the spandrel sections and perforated to receive bolts 31 extending up from the spandrel sections 3, nuts 32 being screwed on said bolts to hold the said longitudinal beams in position. The curb beams 6 are similarly held in position by bolts 31′ and nuts 32′, said bolts 31′ extending up from the spandrel sections 3. The floor beams 4 and curb beams 6 are further provided with loops 33 molded thereinto for engaging lifting devices for raising said beams into place and with upwardly projecting rods 35 to enter the molded floor for tying the floor and beams together. Said floor beams 4 and curb beams 6 are further provided with horizontally extending flanges 37 and 36 at their lower portions, adapted to receive and support temporary molding means, such as boards indicated at 38, for supporting the floor during the molding operation. Said floor beams 4 and curb beams 6 are of reinforced concrete construction, being provided with reinforcing members 39 and said beams are molded in any suitable position adjacent to the location of the bridge, but not *in situ*. The said floor beams 4 may be of uniform cross section, or, as shown in Fig. 6, they may be arched between the spandrel sections, such portion of the floor beams extending down to form spandrels 40 separated from the respective spandrel sections 3 by spaces 41 adapted to receive cement, as hereinafter set forth, and said spandrel portions of the floor beams and the spandrel posts being perforated, as at 42, for receiving the bolts for securing the molding members in place. The floor, indicated at 5, may be molded on top of said beams, as shown in Fig. 1, or, as shown in Figs. 6 and 7, the beams, indicated at 4′, may extend up part way through the floor. Reinforce rods or members 43 extend from the beam into the floor.

To facilitate holding the longitudinal beams 40 in place while they are being joined to the spandrel posts, said beams may be provided with hooked bars 16 engaging in eyes 14 on said spandrel posts and with bars 21 adapted to be connected by turn buckles 22 to bar 23 in the spandrel post, the beams being lowered into place and secured as above explained with reference to the joint at the lower end of the spandrel post. Metallic projections 26 and 27 are also provided on the spandrel post and on the beams extending into the space between said members and adapted to be embedded in the molded joint formed in said space to bind the parts together.

The bridge is constructed as follows: The several arch beams 2, spandrel sections 3 and longitudinal beams 4 and 6 are molded in suitable molds in any convenient location, for example, on the ground adjacent to the site of the bridge, but not *in situ*. By this procedure, the expense incident to supporting the molds in the position required for molding the bridge parts in their final position is eliminated and the expense of molding is also reduced by reason of the fact that the same mold elements may be used repeatedly for forming different elements of the bridge of the same form. For the purpose of transporting and raising the bridge elements into position, any devices, such as traveling cranes may be employed. The piers 1 of the bridge having been built or formed, the arch members 2 are raised into position on said piers and held in connection to form the arch spans during the completion of the span structure. The spandrel sections 3 are then raised into position over the arch beams and lowered so as to bring the lower ends of the spandrel posts 8 onto the horizontal seats 11 on the arch beams, the bolts 12 at the same time extending through the holes 12′ in the arch beams and the hooked members 16′ on the spandrel sections descending through the eyes 14 on the arch beams. By then applying and screwing up the nuts 13 and the turn buckles 22, the spandrel sections are held firmly in position on the arch beams 2

and serve to rigidly connect such beams. To complete the connection, however, and provide a construction which is substantially monolithic, cement is molded into the spaces 20 between the lower members 10 of the spandrel sections and the arch beams. For this purpose, mold boards or plates 44 are placed at each side of the spandrel sections, as shown in Fig. 2, and a bottom plate 45 is placed between said molding plates, said bottom plate extending obliquely from the bottom of the bower portion of the transverse member 10 to the inside of the arch beam 2.

The molding plates 44 are supported in position by bolts 46 passing through perforations 25 aforesaid in the spandrel section and the bottom mold member 45 is supported by bolts 48 engaging the said mold plates. Concrete is then poured into the space 20 between the arch beam 2, the bottom of the spandrel section, the molding plates 44 and the bottom molding member 45, and this concrete, indicated at 50, filling the said space, gives a rigid connection between the parts and embeds the projecting rods 26 and 27, so that the spandrel sections are rigidly connected to the arched ribs as regards both tension and compression strains. The spandrel sections having been secured in the manner above described on the arch beams, the floor beams 4 and curb beams 6 are placed on the top of the spandrel sections and secured thereto by the bolts 31 and 31′. In case arch floor beams are used, as indicated in Fig. 6, they will be joined to the spandrel sections by a molded joint, as indicated in said figure, mold boards 44′ and bottom plate 45′ being secured in place by bolts 48′ extending through holes 42 in the spandrel section posts and floor beam spandrels, and cement being poured into the space between these mold members, the beam and the spandrel sections.

It will be understood that in forming the molds for pouring the cement at the joints, as above stated, between the spandrel sections and the arch beams and between the floor beams and the spandrel sections, suitable openings will be provided for admitting the cement. When the floor beams have been secured, as above stated, mold boards or plates indicated at 38 in Figs 1, 3, may be placed on the projecting flanges 37 and 36 on the floor beams 4 and curb beams 6 and the floor indicated at 5 is then molded into position over the support or temporary floor formed by these mold boards, or, as indicated in Figs. 6 and 7, temporary joists 53 may be set on projections 54 of the floor beams and the mold boards 51 may be placed on said joists and the floor molded thereover. This completes the structure as regards the essential elements and when the cement, applied as above stated, has properly set, the various mold elements may be withdrawn, leaving the bridge as a substantially monolithic structure.

In case the bridge is of such width as to require more than two arch beams, for example, intermediate beams, as indicated at 2′, in Fig. 5, in addition to the outside beams 2, an intermediate spandrel section, as indicated at 55, may be provided seated on said intermediate beams in similar manner to that above described for the spandrel sections 3, and outside spandrel posts 56 are provided seated on the outside beams and having extensions 57 from their lower ends extending across to rest on the intermediate arch beams 2′. The intermediate spandrel section 55 may be braced by diagonal braces 64 extending between its vertical posts 65. The bottom member 58 of the central spandrel section 55 and the bottom member 51 of the spandrel post 56 are joined to the respective beams by cement joints or fillings 59 applied, as above described in the case of the fillings 50. The upper ends of the outside spandrel posts 56 and of the central spandrel member 55 may be provided with lateral extensions or arch portions 60 secured together by a keystone means 61 which may be molded into place, reinforcing means, indicated at 62, 63, being provided on the members thus joined and being embedded in the fillings 59 and 61 to give the requisite strength to the construction.

What I claim is:

1. In a reinforced concrete bridge, the combination of preformed arch ribs, preformed spandrel sections resting on said arch ribs and rigidly connected thereto, each spandrel section consisting of an integral section, the lower part of said spandrel section spanning a plurality of the arch ribs, and the upper part of said spandrel section constituting a transverse floor beam for the bridge, each spandrel section being provided with projecting metallic parts for connection with the respective floor beams and arch ribs, preformed longitudinal floor beams resting on said transverse spandrel sections, said spandrel sections having metallic projections extending through said floor beams, said projections being threaded, and nuts on said threaded projections engaging with the floor beams to secure the floor beams to the spandrel sections.

2. In a reinforced concrete bridge, the combination of preformed arch ribs, preformed transverse spandrel sections resting on said arch ribs, each spandrel section consisting of an integral section, the lower part of each spandrel section spanning a plurality of the arch ribs and the upper part of each spandrel section constituting a transverse floor beam for the bridge, said

spandrel sections formed to leave intervening spaces between portions thereof and said arch ribs, metallic members embedded in and projecting from said arch ribs and spandrel sections and extending into the said spaces, means for rigidly connecting said metallic members, and fillings molded into the said spaces and embedding the said metallic members.

3. In a reinforced concrete bridge, the combination of preformed arch ribs, preformed transverse spandrel sections resting on said arch ribs, each spandrel section consisting of an integral section, the lower part of each spandrel section spanning a plurality of the arch ribs and the upper part of each spandrel section constituting a transverse floor beam for the bridge, said spandrel sections being formed to leave intervening spaces between portions thereof and the adjacent portions of the arch ribs, metallic screw threaded members embedded in and projecting from said arch ribs and spandrel sections and extending into said spaces, and turn-buckles screwing on said screw threaded members to connect the same, and fillings molded into the said recesses and embedding the said metallic screw threaded members.

4. In a concrete bridge construction, the combination of preformed arch ribs formed with horizontal seats, preformed transverse spandrel sections, each consisting of an integral section, the lower part of each spandrel section spanning a plurality of the arch ribs and the upper part of each spandrel section constituting a transverse floor beam for the bridge, and each spandrel section having horizontal faces resting on said seats and having a transverse portion extending downwardly into the space between said arch ribs and formed to leave intervening spaces between the said downwardly extending portion and the adjacent portions of the arch ribs, metallic reinforcing means embedded in said arch ribs and spandrel sections, and projecting therefrom into said spaces, means screwing on said metallic reinforcing means to rigidly connect the spandrel sections to said arch ribs, and fillings molded into said spaces for connecting the spandrel sections to the arch ribs.

5. In a concrete bridge, the combination of preformed arch ribs and preformed spandrel sections resting thereon, each spandrel section consisting of an integral section whose lower portion spans a plurality of arch ribs and whose upper portion forms a transverse floor beam for the bridge, preformed reinforced concrete floor beams resting on said spandrel sections, reinforcing rods of metal running through said spandrel sections and floor beams and connected together, forming an articulate framework of metal, said spandrel sections being formed to leave intervening spaces between portions thereof and adjacent portions of the arch ribs, and cement molded into said recesses to connect the arch ribs and the spandrel sections together.

In testimony whereof, I have hereunto set my hand at Oceanside, California, this 18th day of January, 1911.

WILLIAM M. THOMAS.

In presence of—
FRED HAYES,
JOHN GRIFFIN HAYES.