965,357.

P. AYLETT.

CONCRETE CONSTRUCTION.

APPLICATION FILED SEPT. 26, 1906.

Patented July 26, 1910.

3 SHEETS—SHEET 1.

Fig. 1

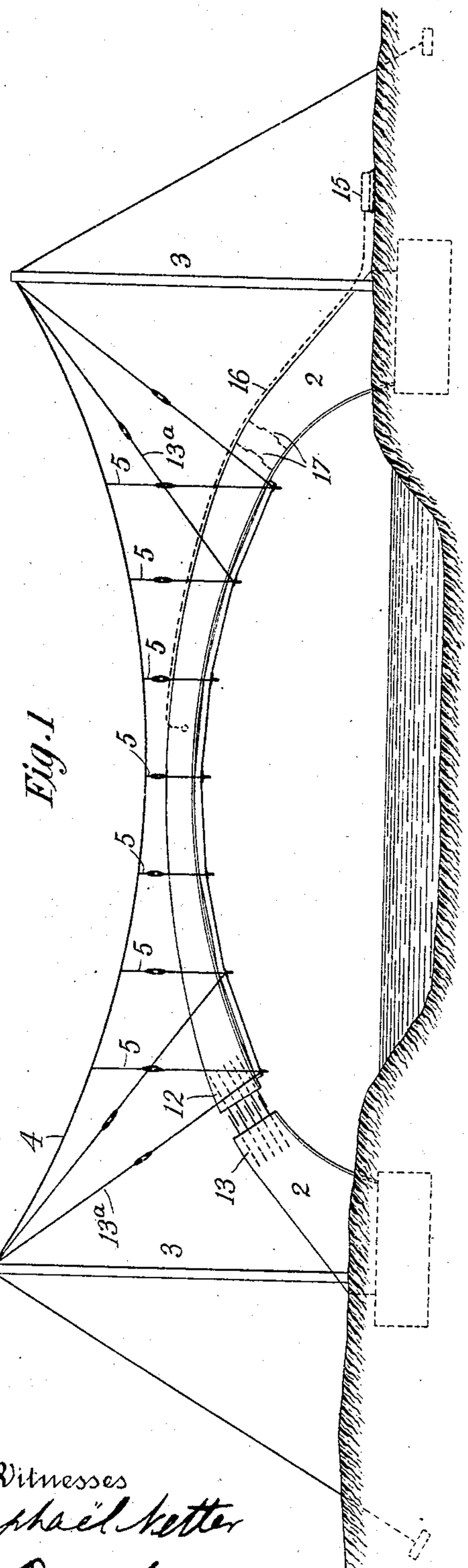


Fig. 11

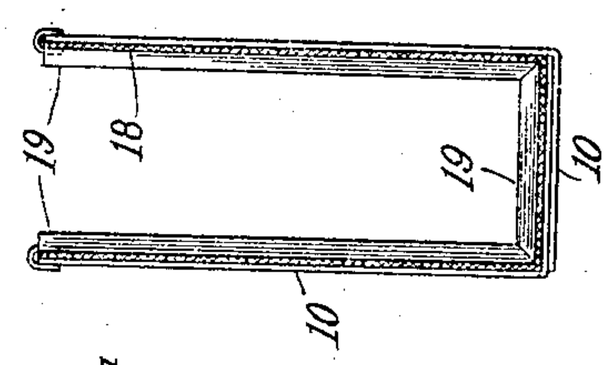


Fig. 10

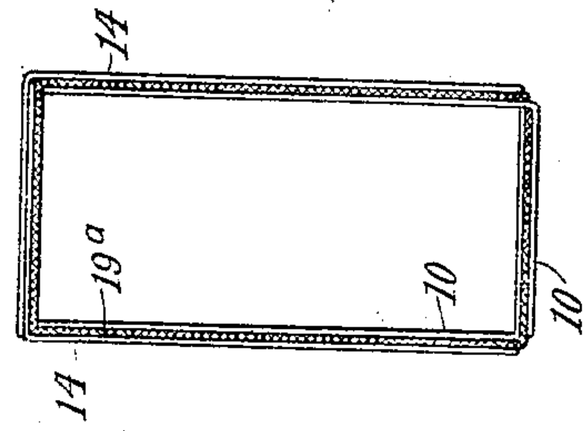
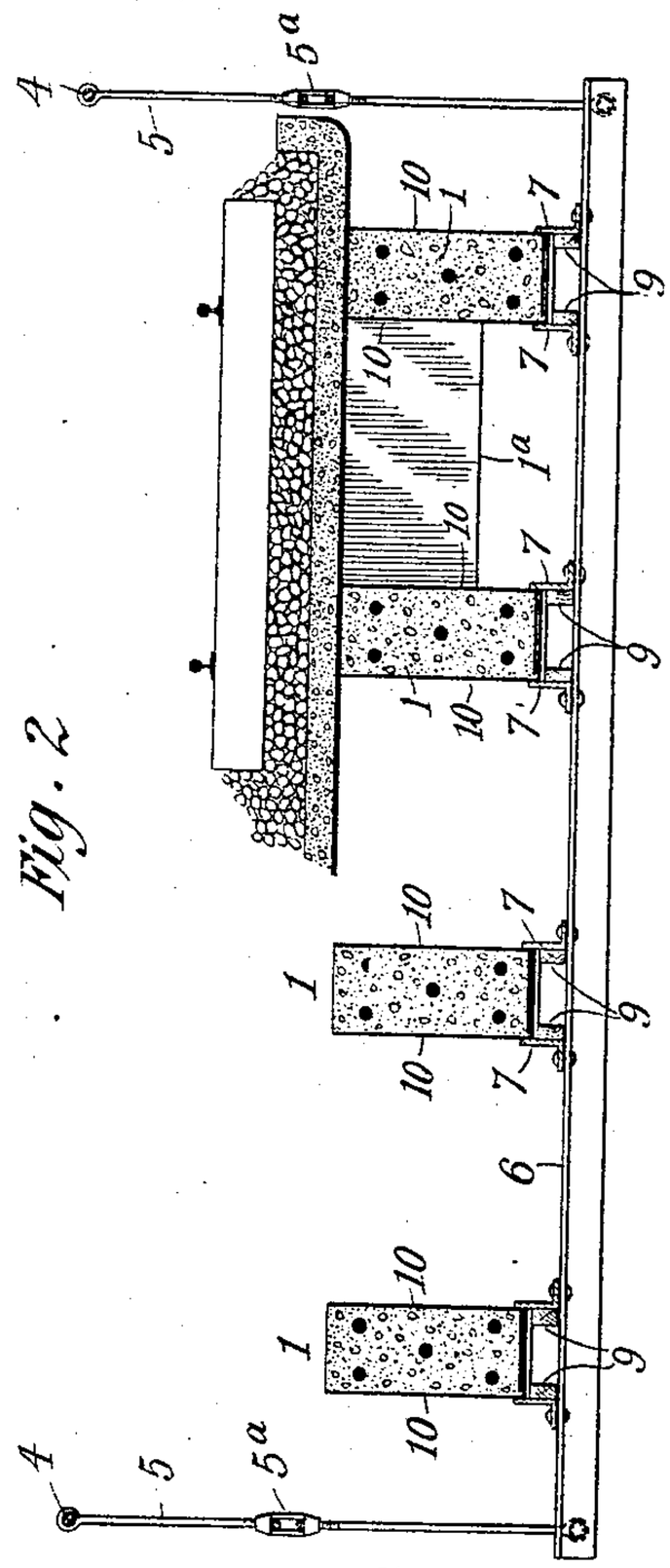


Fig. 2



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3 SHEETS—SHEET 2.

Fig. 3

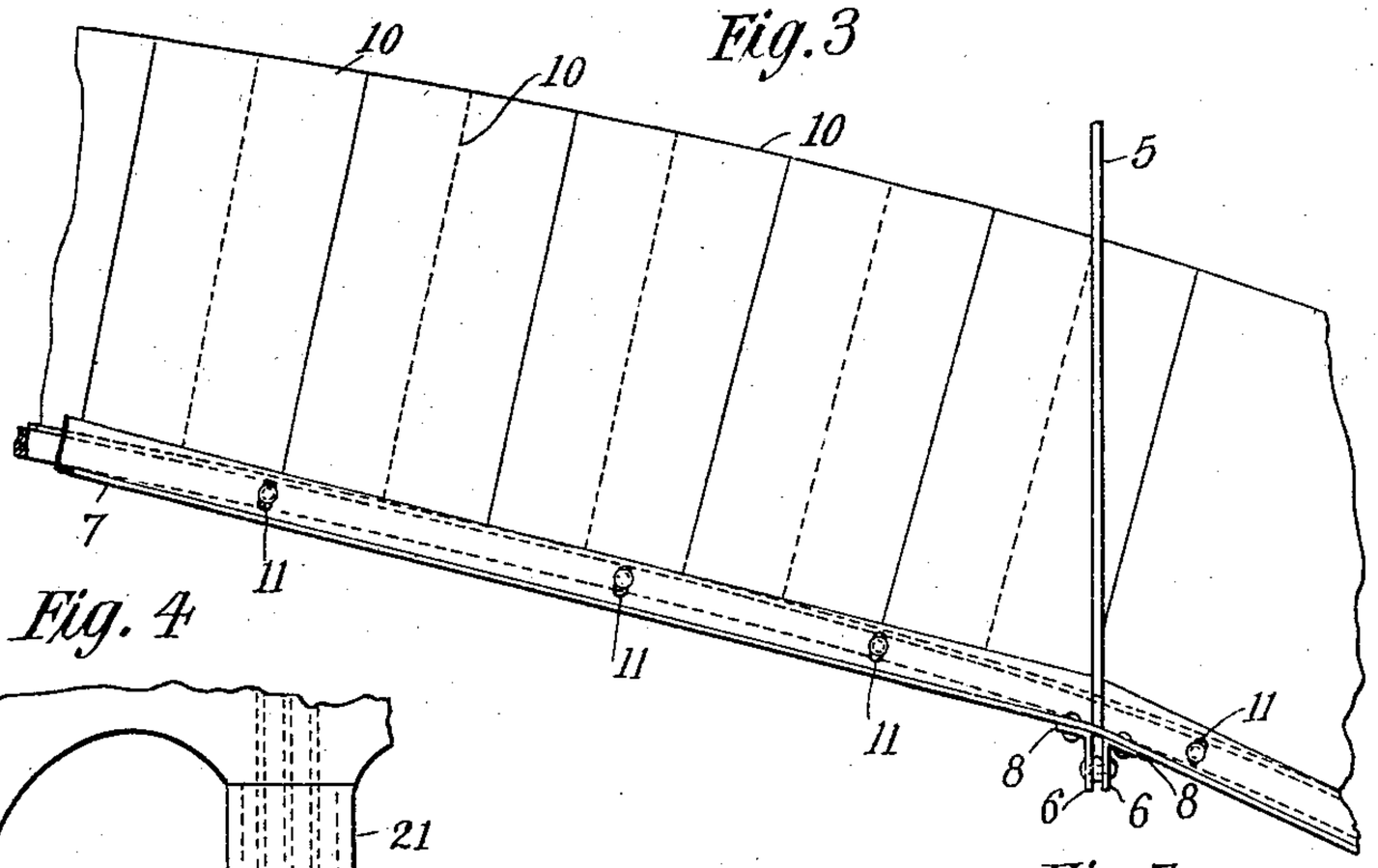


Fig. 4

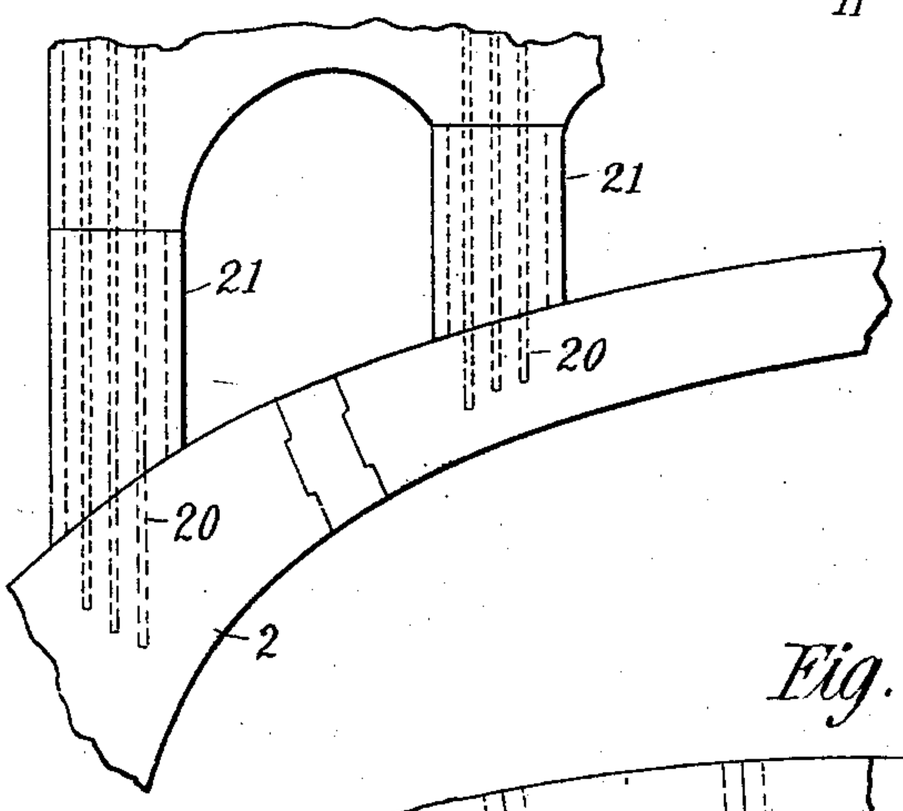


Fig. 5

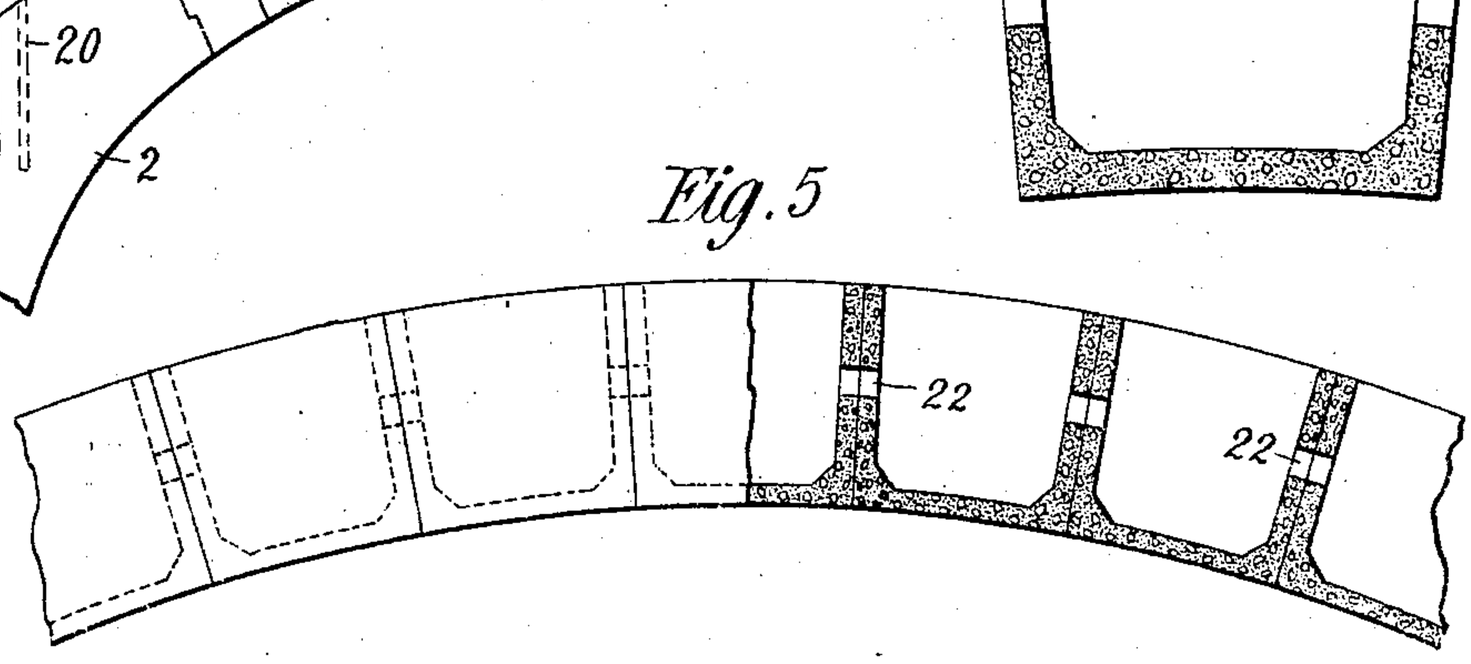


Fig. 6

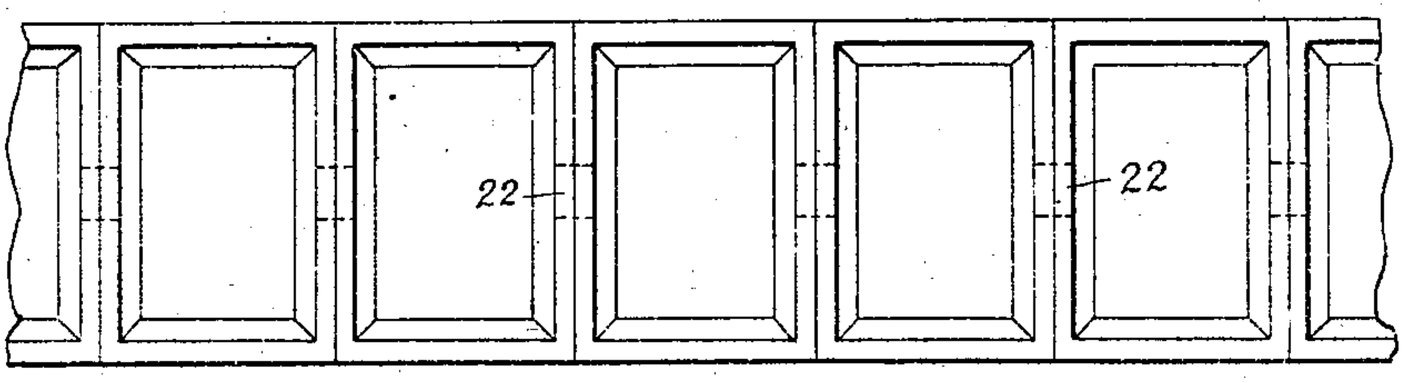
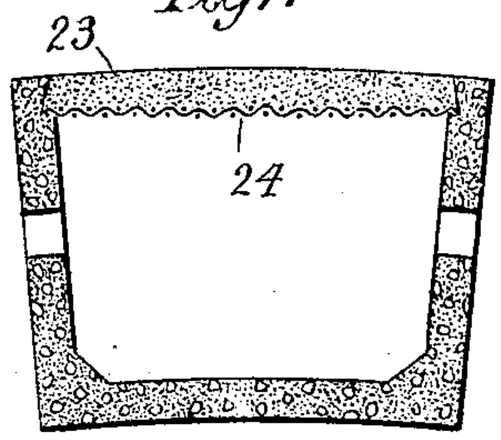


Fig. 7



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3 SHEETS—SHEET 3.

Fig. 8

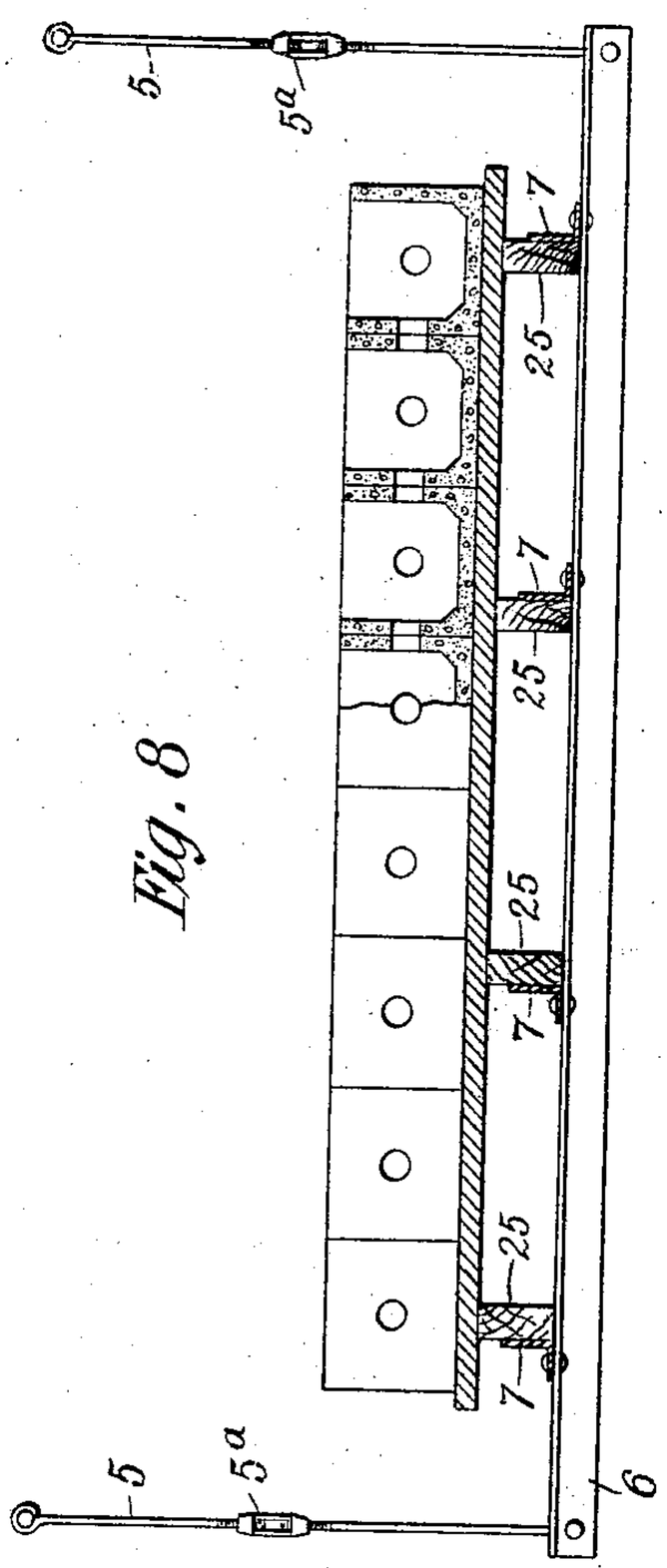
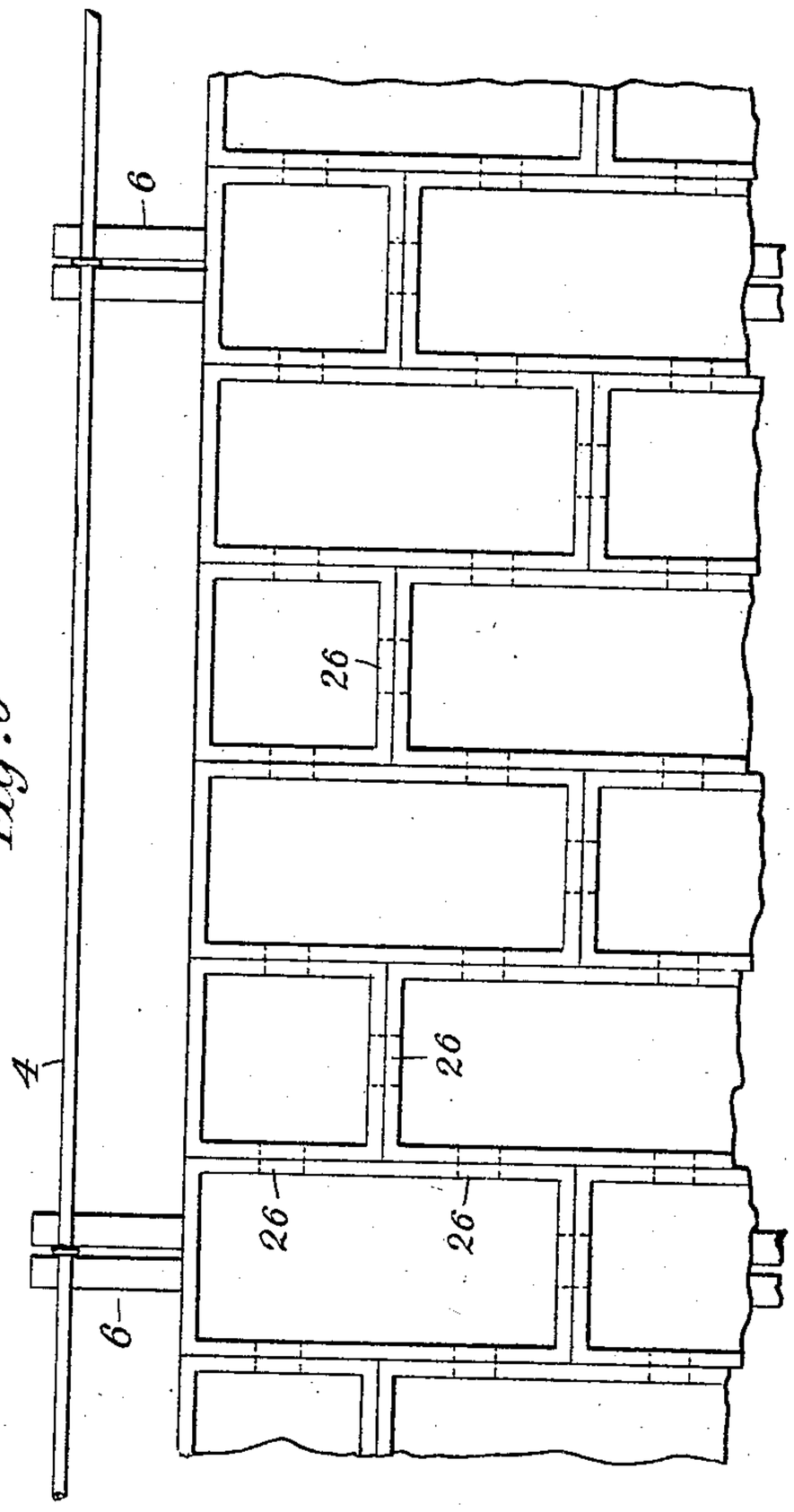


Fig. 9



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CONCRETE CONSTRUCTION.

965,357. Specification of Letters Patent. **Patented July 26, 1910.**

Application filed September 26, 1906. Serial No. 336,315.

To all whom it may concern:

Be it known that I, PHILIP AYLETT, a citizen of the United States, residing at Portsmouth, in the county of Norfolk and State of Virginia, have invented certain new and useful Improvements in Concrete Construction, of which the following is the specification, reference being had to the drawing accompanying and forming part of the same.

My invention relates to concrete structures, and is herein illustrated and described as applied to the erection of bridges. It will, however, be understood by those skilled in the art that the invention is not limited to bridges and the like, but may be employed to advantage in numerous other structures also.

Referring now to the annexed drawings, Figure 1 shows in side elevation an arch bridge in process of construction according to my invention, the supports for the floor or roadway of the bridge being formed by longitudinal ribs or beams. Fig. 2 is a cross-section of the bridge, showing beam molds composed of L-shaped metal members, arranged with their flanges disposed inwardly and overlapping. Fig. 3 is a detail side-elevational view, showing the preferred manner of arranging and supporting the arch molds. Fig. 4 is a detail side-elevational view, showing a convenient way of erecting columns on the arch beams, to support the floor or roadway of the bridge. Fig. 5 is a detail side-elevational view, partly in longitudinal section, showing a different type of beam mold, composed of hollow blocks or shells, which may be supported in the proper position in the same way as the metal molds are supported in Figs. 1, 2 and 3. Fig. 6 is a plan view of a portion of a beam mold composed of hollow blocks or boxes. Fig. 7 is a view of a single block or shell in vertical section, showing the block closed at the top. Fig. 8 is a cross section showing an arch-mold composed of hollow blocks arranged in a layer extending across the width of the bridge. Fig. 9 is a plan view of a portion of an arch-mold of the kind illustrated in Fig. 8. Fig. 10 is a detail end view of a tubular beam mold composed of L-shaped plates, with canvas or other suitable material disposed between the outer and inner plates, to make the joints liquid-tight. Fig. 11 is a similar view of an open-top or trough-shaped mold composed of L-shaped plates, with a lining of canvas or other suitable material to make the joints liquid-tight and provided with mold-strips for producing in the cast beam the appearance of joints in masonry.

The fundamental feature of the bridge shown in Fig. 1 is, as will be seen, an arch. The arch preferably consists of a plurality of longitudinal beams or ribs, two or more, as 1, shown in the cross sectional view Fig. 2, on which is supported the floor of the bridge.

In constructing the bridge, abutments 2 are first provided at the proper positions for the ends of the bridge, the abutments being of any suitable character and form, but preferably composed of concrete. At convenient points suitable supports, as the towers 3, are erected, and over these towers pass supporting cables, 4, for supporting the forms or molds in which the concrete structural element is to be cast, the ends of the cables being securely anchored in any convenient and suitable way.

Depending from the cables at suitable points are rods or cables 5, constituting hangers, and carrying cross bars or transverse supports consisting preferably of angle irons, as 6. These cross bars or supports are located on their respective hangers so as to lie in the curve of the arch, as clearly shown in Fig. 1. The hangers preferably include devices, for example turnbuckles 5^a, by which they may easily be shortened or lengthened, to bring the cross bars to the proper positions, as will be readily understood.

Extending from bar to bar, longitudinally of the bridge, are mold carriers 7, by preference angle irons, resting on and secured to the flanges of the cross supports, which flanges are preferably arranged to lie in the curve of the arch, as shown at 8, Fig. 3, so as to furnish good bearing surface for the mold carriers.

Secured to the inner faces of the vertical webs of the carriers 7 are strips 9, of suitable material, for example of wood. On these strips rest the molds for the concrete structural element which is to span the space between the abutments, for example one or more longitudinal beams. The molds consist preferably of L-shaped sections, 10, ar-

ranged with their horizontal members overlapping as shown in Figs. 2, 10 and 11. These L-shaped sections are preferably made in short lengths, as shown in Fig. 3, so that when assembled end to end they will conform to the curvature of the arch. In order to make the mold conform as closely as possible to the arch curvature the bolts which secure the longitudinal strips 9 to the carriers 7 pass through slots in the latter, as shown at 11, Fig. 3, so that the strips may be bent to the proper curve and the bolts then tightened, securing the strips firmly. The mold-sections on opposite sides of the mold are preferably arranged so as to break joints, as shown in Fig. 3.

Molds for as many ribs or beams as desired are erected in the manner described, but by preference terminate short of the abutments. Reinforcing bars are placed in the molds, with the ends of the bars projecting from the molds, as shown at 12, Fig. 1, and lying between bars 13 projecting from the adjacent end or face of the abutment. The ends of the molds are now closed in any convenient and suitable way, as by packing plastic concrete therein, embedding the reinforcing bars.

It will be observed that the structure described, being suspended from cables, is free to sway or yield under the pressure of wind, such movement being permitted by the fact that the molds are not connected to the abutments, while the projecting reinforcing bars, by reason of their staggered arrangement, do not interfere with such movement. This yielding of the structure under wind pressure avoids breakage or disarrangement of the parts, as will be readily understood. If desired, however, the structure may be held against movement under wind pressure by suitable guys, not shown.

In order to prevent disarrangement of the structure should one end be loaded more heavily than the other, which would distort the cables from their normal curvature, tie rods, as 13[a] may be provided, extending from the towers, preferably from the tops of the same, to the transverse supports 6. These tie rods will prevent the cables from sagging, and may be provided with turnbuckles, as shown, by which they may be shortened or lengthened as desired. Of course as many tie rods as necessary may be employed.

The molds having been prepared as above described, they are closed at the top, for example by inverted mold sections 14, Fig. 10, secured in any suitable and convenient way, thus making the molds substantially tubular. The molds may now be filled with water, the weight of which causes the molds to conform closely to the curvature of the arch, as determined by the supporting devices previously described, after which the water is drawn off and the molds filled with concrete, which is of course allowed to harden or set. I prefer to pump liquid concrete into the molds, under pressure, using for this purpose one or more pumps, as 15, conveniently located, the pipe or pipes 16 therefrom extending to suitable apertures in the molds. I prefer to discharge the liquid concrete at the top of the arch, so that the liquid will flow equally to both ends of the mold and so keep the same in equilibrium. Of course where concrete of a consistency too stiff to flow is used to fill the molds the latter need not, in general, be closed at the top. This method of filling the molds, namely, with liquid concrete, preferably forced into the molds under pressure, is a highly important feature of my invention. It secures a solidity and homogeneity which cannot be secured by packing or tamping, since the liquid concrete penetrates all parts of the mold and is necessarily of substantially the same consistency and density throughout; whereas the tamping or packing method, in which a batch of concrete is deposited in the mold and tamped, another batch deposited on the first and tamped, and so on, results in a more or less layer-like formation. It is also difficult, if not practically impossible, to have all parts of the structure packed or tamped to the same degree, and the result is that the structure does not have the same density and solidity throughout, one part being less dense than another. To connect the beams, thus formed, and the abutments, a centering (not shown) which may be either permanent or temporary, is placed around the gaps at the ends of the beam and the gaps filled with concrete, embedding the projecting reinforcing bars and binding the parts securely together. I prefer to groove the adjacent faces of the beam and abutment, as shown at 17, Fig. 1, or otherwise shape these faces so that the connecting blocks will positively engage the contiguous parts, and as will be readily understood. The beams having been completed, the cables and other supporting devices may be removed and the shells or mold sections 10 stripped off.

The joints between the mold-sections may be made liquid tight, to prevent escape of the water used to conform the mold to the curvature of the arch, or to prevent leakage of the liquid concrete. Any suitable and convenient means may be employed to render the joints tight, but I prefer to do so by lining the mold, as at 18, Fig. 11, with canvas or other suitable material. This lining can be readily stripped off the beam, and leaves the surface thereof smooth and uniform. Advantage can be taken of the lining to produce a jointed effect on the beam, to simulate masonry. For this purpose the lining may carry strips 19, of suitable cross section, say, triangular, arranged radially or normally to the curve of the beam. These

strips produce grooves in the beam, as will be readily understood, closely resembling the joints between the members of an arch. Where this feature is not desired the lining may be located between the outer mold sections 14, and the inner mold sections 10, as shown at 19ª, Fig. 10.

The superstructure of the bridge, supported by the arches or beams just described, may be of any desired kind. For example, to support the floor or roadway at points where it does not rest directly on the beams or ribs themselves, as at the ends of the bridge, columns may be erected on the beams, extending to the proper height. Where this plan is pursued, dowels, as 20, reinforcing bars, or other suitable devices are employed, projecting from the upper faces of the beams, (and, if desired, from the abutments also), as in Fig. 4, preferably arranged in position before these elements are cast, so as to be firmly embedded at their lower ends in the elements mentioned. Over the dowels or other devices employed for the purpose are arranged suitable column molds, for example in the form of concrete tile, as 21. These column molds are filled with concrete, embedding the dowels and forming rigid columns. The floor or roadway may now be formed on a suitable centering, not shown. The floor and columns may of course be made integral with each other, if desired. Before the floor is formed, cross beams as 1ª may be formed between the longitudinal beams or ribs, if deemed necessary or desirable. These cross beams may be molded in any suitable manner, as by means of molds similar to those employed for the longitudinal ribs, and may of course be integral with the floor if desired. When cross beams are to be used, reinforcing bars may be embedded transversely in the longitudinal ribs. These bars, projecting laterally from the ribs into the cross beam molds, are also embedded in the latter, thus binding the longitudinal and transverse beams securely together.

The above is the preferred form of my invention, but it will be clear to those skilled in the art that various modifications may be employed without departing from the proper scope of the invention. For example, instead of metal beam-molds I may use molds composed of concrete, as described and claimed in my co-pending application filed of even date herewith, Serial No. 336,316. Or I may use hollow concrete boxes or blocks, as shown in Figs. 5 to 9, to form the beam molds. These blocks are arranged in arch form on the arched supports and are provided with registering apertures, as 22, in their adjoining sides, through which reinforcing bars may pass and through which the liquid concrete may flow from one to the other. Near the abutments or at the haunches of the arch the blocks may be provided with covers, as 23, Fig. 7, so that they may be entirelv filled with liquid concrete. These covers may be formed by a layer of concrete, supported and reinforced by a layer 24 of wire netting, or expanded metal, or bars, etc. Or I may do away with longitudinal ribs or beams entirely, as such, and form the bridge arch by a layer of the hollow blocks above described, as shown in Fig. 8. In this case the wood strips 25, corresponding to the strips 9, Figs. 2 and 3, project above the carriers 7, but are secured thereto preferably in the way illustrated in Fig. 3. On these strips is laid a support, for example transverse planks laid edge to edge, and on the support thus formed are placed the hollow concrete blocks, extending over the entire arch. The blocks or forms used for this purpose are preferably somewhat longer relative to their width than are the blocks shown in Fig. 6, for example, and are arranged like brick work or paving, to break joints, as shown in Fig. 9. In the sides and ends of the blocks are apertures 26 through which reinforcing bars may extend, if desired, and through which the liquid concrete may flow from one block to the other. Of course the blocks are closed at their tops wherever necessary, as previously explained.

Other modifications will suggest themselves to the engineer who undertakes to practice my invention, but the above is sufficient to make it clear that the invention is not limited to the precise forms and arrangements herein specifically described but may be variously embodied without departure from its proper scope.

What I claim is:

1. In a system of concrete construction, the combination with a mold for a concrete structural element, of supporting cables extending longitudinally of the said mold, hangers on the cables, and transverse supports carried by the hangers and supporting the said mold, as set forth.

2. In a system of concrete construction, the combination with supporting cables, of hangers thereon, transverse supports carried by the hangers, longitudinal supports or carriers on the transverse supports, and a mold for a concrete structural element supported by the said longitudinal supports, as set forth.

3. In a system of concrete construction, the combination with a mold for a concrete structural element, of supporting cables therefor, extending longitudinally thereof, as set forth.

4. In a system of concrete construction, the combination with supporting cables, of a mold for a concrete structural element supported by the cables, said mold being com-

posed of a plurality of separable sectional units arranged in a longitudinal series, as set forth.

5. In a system of concrete construction, the combination with supporting cables, of transverse supports suspended from the cables at various distances therefrom so as to lie in the curve of an arch, and an arch-shaped mold for a concrete structural element supported by said supports, as set forth.

6. In a system of concrete construction, the combination with supporting cables, of hangers depending therefrom, transverse supports on the hangers at various distances from the cables, so as to lie in the curve of an arch, and an arch-shaped mold for a concrete structural element supported by said supports, as set forth.

7. In a system of concrete construction, the combination with supporting cables, of transverse supports suspended therefrom, and an arch-shaped mold for a concrete structural element supported by said supports.

8. In a system of concrete construction, the combination with supporting cables, of an arch-shaped mold for a concrete structural element supported by the cables, as set forth.

9. In a system of concrete construction, the combination with abutments, and supporting cables extending over the space between the abutments, of a mold for a concrete structural element supported by the cables and spanning the space between said abutments, as set forth.

10. In a system of concrete construction, the combination with abutments, and supporting cables extending over the space between the abutments, of an arch-shaped mold for a concrete structural element supported by the cables and spanning the space between said abutments, as set forth.

11. In a system of concrete construction, the combination with abutments, and supporting cables extending over the space between the abutments, of a mold for a concrete structural element spanning the space between the abutments, supported by the cables and occupying the position which the said element is to occupy in the finished structure but terminating short of the said abutments, as set forth.

12. In a system of concrete construction the combination with abutments, and supporting cables extending over the space between the abutments, of a mold for a concrete structural element spanning the space between the abutments, supported by the cables and occupying the position which the said element is to occupy in the finished structure but terminating short of the abutments, and reinforcing bars extending from the abutments and from the said mold into the spaces between the mold and the abutments, as set forth.

13. In a system of concrete construction, the combination with supporting cables, and a mold for a concrete structural element supported by the cables, of means for supporting the ends of the mold to prevent distortion of the mold by greater weight on one end of the same than on the other during the casting of the element, as set forth.

14. In a system of concrete construction, the combination with elevated cable supports, and cables extending between the same, of transverse supports suspended from the cables, a mold for a concrete structural element supported by the said supports, and tie rods extending from the said cable supports to transverse supports, as set forth.

15. In a system of concrete construction, the combination with one or more beam-molds, of supporting cables for the molds, arranged longitudinally thereof, as set forth.

16. In a system of concrete construction, the combination with two or more beam-molds of arch-shaped form, of supporting cables for the molds, arranged longitudinally thereof, as set forth.

17. In a system of concrete construction, the combination with supporting cables, of transverse supports carried thereby, longitudinal carriers on the supports, and a longitudinal beam-mold supported by the carriers, as set forth.

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