O. HOFF.

SUBAQUEOUS TUNNEL STRUCTURE.

APPLICATION FILED OCT. 8, 1913.

1,085,338.

Patented Jan. 27, 1914.

2 SHEETS—SHEET 1

Fig. 1.

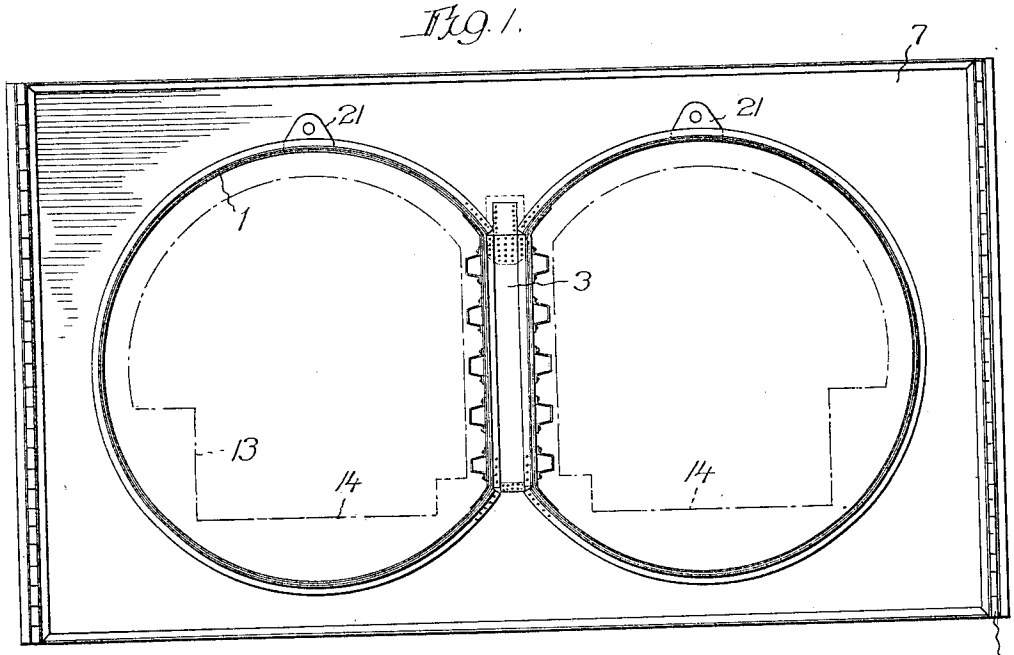
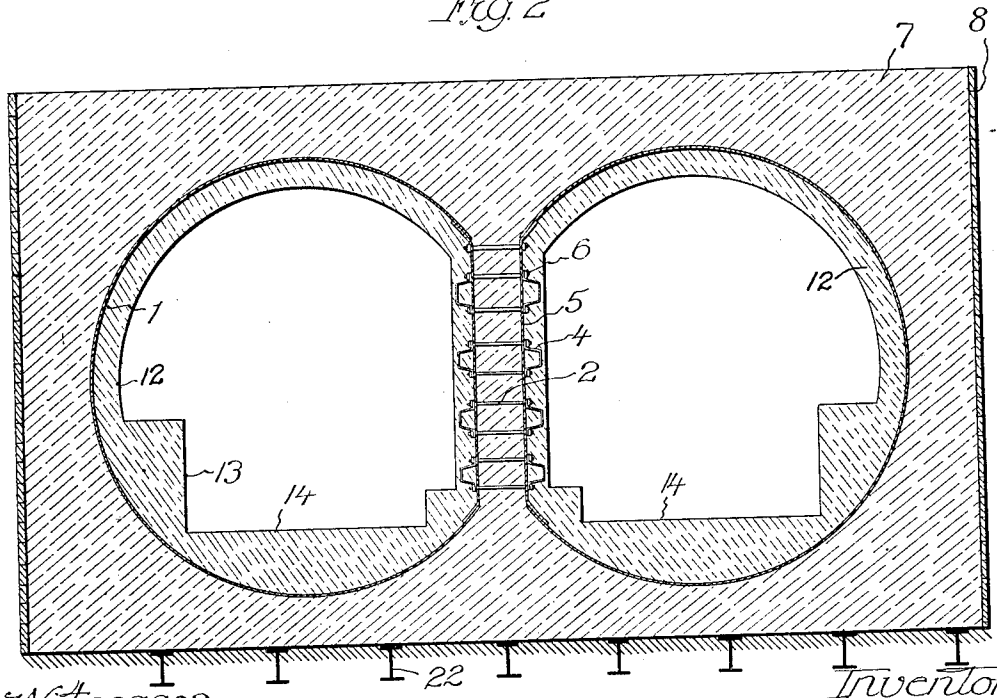


Fig. 2



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2 SHEETS—SHEET 2.

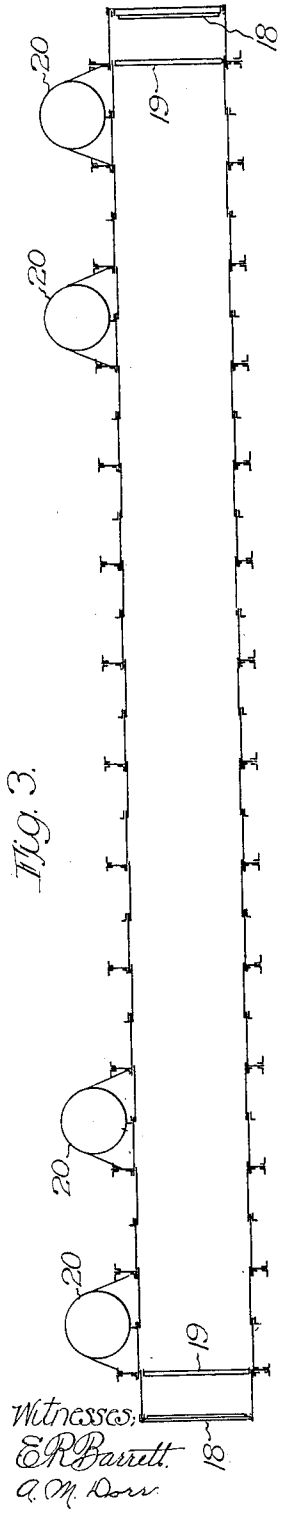


Fig. 3.

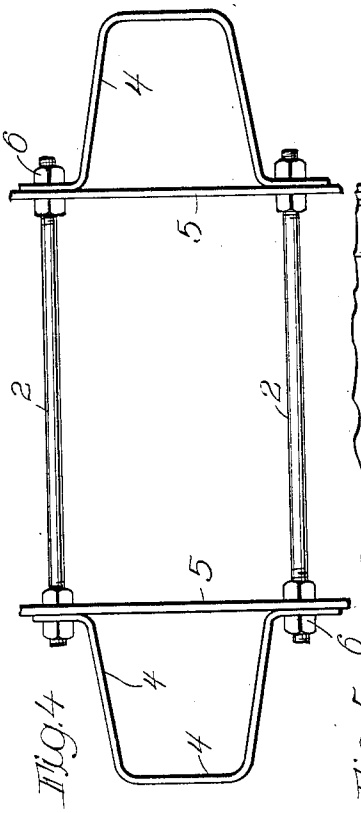


Fig. 4

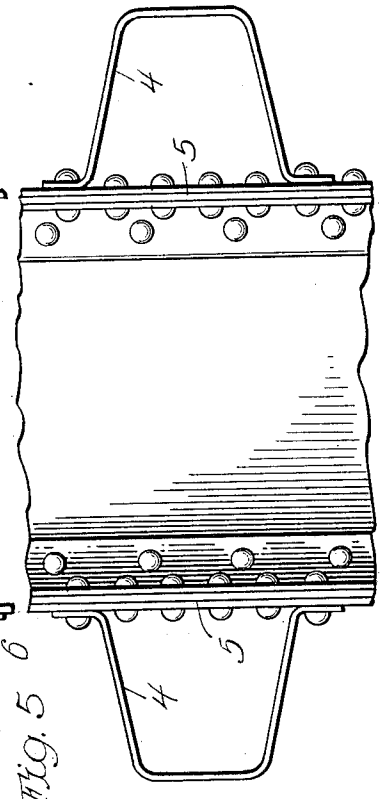


Fig. 5

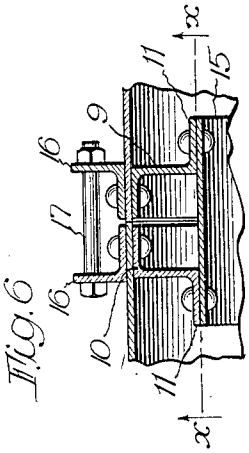


Fig. 6

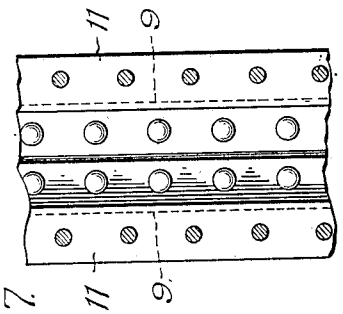


Fig. 7.

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UNITED STATES PATENT OFFICE.

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SUBAQUEOUS TUNNEL STRUCTURE.

1,085,338. Specification of Letters Patent. Patented Jan. 27, 1914.

Application filed October 8, 1913. Serial No. 794,027.

To all whom it may concern:

Be it known that I, OLAF HOFF, a citizen of the United States of America, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Subaqueous Tunnel Structures, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to subaqueous tunnels of the class in which tube sections are first built up with removable bulk heads in the ends thereof whereby they may be floated to the place of use, with controlling means for admitting water to them, and sinking them into place on a previously constructed bed, which latter may be provided with grille work sunk into a trench in the river bottom or otherwise arranged to securely support the sections when submerged.

The invention includes sections built up of two or more tubes, preferably of sheet metal secured side by side and provided at intervals with outer fins that carry at their extremities a sheathing of wood or the like whereby pockets are formed that are filled with concrete or other cementitious material when the sections are in place, the connections between the tubes being such that the filler between the tubes is reinforced by the tube walls and holding members, and an inner lining of concrete or the like is also reinforced and anchored into position adjacent the division walls of the tubes by the same securing means, and is thereby made an integral part thereof.

The invention also includes means for forming a close joint between the end portions of adjacent sections after the tubes are in position in such a manner that the continuity of the face of the lining of the completed ground is unbroken.

The invention consists in the matters hereinafter set forth and more particularly pointed out in the appended claims.

Referring to the drawings, Figure 1 is a view in end elevation of a pair of tube sections that involve features of the invention, the inner lining being indicated only in contour by a dotted line; Fig. 2 is a view in transverse section through a section between a pair of fins; Fig. 3 is a diagrammatic view of a section showing one arrangement for controlling it while it is being submerged; Fig. 4 is a view in detail of securing and reinforcing members; Fig. 5 is a view in detail of other reinforcing members; Fig. 6 is a view in detail of a preferred form of joint for securing the end portions of sections together; and Fig. 7 is a view in section taken on or about line X—X of Fig. 6.

As herein shown, a pair of substantially cylindrical tube shells 1 are built up of sheet metal riveted or otherwise secured together, and are held in spaced, parallel relation by bolts 2 that pass through the adjacent wall portions of the shells. To increase the rigidity of the structure as well as economize in space the portions 5 of the shells engaged by the bolts are flattened so that the tubes may be set closely together. Spacing plates 3 that are suitably riveted or otherwise made fast to the exteriors of the tubes coöperate with the bolts in holding the parts in proper relation. Concrete reinforcing members 4 project from the inner faces of the walls 5 preferably being anchored into position by the holding nuts 6 of the bolts 2 or else riveted in place as indicated in Fig. 5. At regular intervals transverse fin plates 7 on the exterior of the united tubes support outer side walls or sheathing 8, preferably of wood or the like. The fin plates 7 are preferably in the planes of and secured to adjacent spacing plates 3. At the ends of the tubular shells of the sections, inner substantially annular plates with web members 9 and outwardly extending flanges 10 are riveted or otherwise made fast to the body plates with inwardly extending flanges 11. Preferably the inner flanges 11 are so disposed that they are flush with an interior lining 12 of concrete or the like which may be applied to the interior of the tube, or at least to that portion of the lining which forms the upper arch of the completed tunnel, the lower portions such as indicated at 13 and 14 being of course arranged to provide the necessary road and trackway. An inner plate 15 is riveted or otherwise made fast to the flanges 11. A pair of angle irons 16 encircle the adjacent end portions of the tubes of each section, substantially in alinement transversely with the webs 9 of the inner holding members. Bolts 17 that pass through suitable apertures in the flanges are used to draw the parts firmly together.

When a pair of tubes forming the section have been applied and temporary bulk heads indicated at 18, Fig. 3, have been used to close the ends, preferably with the inner bulk heads 19 temporarily inserted near the

end bulk heads, the section is floated to position and there submerged by admitting water through suitable controlling valves. In such operation the method used in my Patent No. 907,357 issued Dec. 22, 1908 is preferably followed and, as described therein, the balance tanks indicated at 20 are temporarily attached at each end of a section to aid in preserving the equilibrium of the latter and regulating its movement as it settles to place. It is to be understood that in addition to the regulating means for controlling and directing the movement of the section as it settles there are pilot members similar to those described in said patent provided for guiding a sinking section into alined and abutted relation with one already set. For example, there may be a guide plate 21 on each tube at the ends thereof and pilot bolts may be used to engage apertures in these guide plates and thereby insure proper alinement of the parts. When a section is fully submerged and at rest on its cradle or bed, the pockets formed by the outer sheathing 8 and the transverse fittings 7 are filled with cementitious material as by the use of tremies or other preferred forms of conductors that guide the material into place.

It is understood that the exterior form of the fins 7 is made to give the desired cross section to the tunnel structure as a whole. While herein shown as rectangular such section may obviously be as desired. It is to be understood that the sections may not be limited to two tubes but may be built up of three or four or more, in which construction of course, the intermediate tubes are flattened on both sides with the same anchoring means for holding them together. The bed 22 on which the sections rest when in place is shown diagrammatically in Fig. 2, only.

As described in my former patent above referred to the sections after they are submerged, are pumped out and the inner lining put in. At the same time the coupling joints are made. By the use of the double bulk heads, it is of course, feasible to complete the ends joint which lies between the inner bulk heads by filling the space between the webs 9 and applying the holding plate 15 before the main lining of the tubes is filled in. Thus a tight, hermetically sealed joint is obtained with little labor and when the main lining to the body of the tubes is added, a substantially flush interior surface results while the joint is non-leakable and the use of perishable gaskets and like packing members is obviated. When the inner lining is put in position the division walls between the tubes form a reinforced concrete structure which is in effect a stiffening web that is an integral part of the structure and has the tension and sheer resisting strength of metal with the crushing and weight carrying qualities of a masonry body.

Obviously, changes in the details of construction may be made without departing from the spirit of my invention and I do not care to limit myself to any particular form or arrangement of parts.

What I claim is:—

1. A subaqueous tunnel structure comprising tubular shells having flattened adjacent wall portions, spacing members securing the flattened portions in spaced relation, transverse fin plates on the united structure, an outer cementitious filler and an inner lining of cementitious material forming with the flattened portions of the walls and the spacing members thereof a reinforced concrete wall between the compartments.

2. A subaqueous tunnel structure having sections formed of tubular shells in spaced relation whose adjacent walls are flattened, securing means for maintaining the tubes in spaced relation arranged to reinforce any cementitious material introduced between the adjacent portions of the walls, transverse fin plates secured at intervals on the united structure and adapted to coöperate with the securing means to maintain the tubular sections in proper relation, means on the section ends for drawing and holding a section in alinement with an adjacent section, and means for coupling the adjacent ends of sections when submerged and forming an internal substantially flush tight joint therewith.

3. A subaqueous tunnel structure comprising tubular shells having flattened adjacent wall portions, means securing flattened portions of adjacent tube walls in parallel spaced relation, transverse fins extending from the united structure at regular intervals, sheathing members on the extremities of the fins forming therewith retaining pockets around the tubes for cementitious material, the securing means of the adjacent walls having reinforcing members extending inwardly from the face of the wall, a lining of cementitious material for the respective tubes, and a filling of cementitious material occupying the fin pockets of the submerged structure, the lining and filling together with the spacing and reinforcing members forming a reinforced concrete wall between each pair of tubes that is substantially integral with the structure.

4. A subaqueous tunnel structure comprising tubular shells having flattened adjacent wall portions, means securing the flattened portions of adjacent tube walls in parallel spaced relation, transverse fins extending from the united structure at regular intervals, sheathing members on the extremities of the fins forming therewith retaining pockets around the tubes for cementitious

material, the securing means of the adjacent walls having reinforcing members extending inwardly from the faces of the wall, a lining of cementitious material for the respective tubes, a filling of cementitious material occupying the fin pockets of the submerged structure, the lining and filling together with the spacing and reinforcing members forming a reinforced concrete wall between each pair of tubes that is substantially integral with the structure, means for drawing and holding the end of a section into alinement with the previously submerged section, and means for coupling the adjacent ends of alined submerged sections and forming a substantially flush joint between them.

5. A subaqueous tunnel structure comprising sections each formed of tubular shells whose adjacent wall portions are flattened and are held in spaced relation by members disposed between them at intervals, fin plates encircling the united structure and extending transversely therefrom at intervals, sheathing on the extremities of the fin plates forming therewith retaining pockets for cementitious material around and between the shells, inner reinforcing members on the flattened portions of the tube walls, an outer filling of cementitious material in the fin pockets, an inner lining of cementitious material in each tube forming with the outer lining and the spacing reinforcing members of the adjacent walls, a substantially integral reinforced concrete division wall between the tubes, and means within the tubes for securing the adjacent ends of alined sections and forming a close joint substantially flush with the interior lining of the tube.

6. A subaqueous tunnel structure comprising sections each formed of tubular shells having adjacent flattened walls that are secured in spaced relation by spacing members and securing members disposed at intervals between them, transverse fin plates on the shells of each section, sheathing on the extremities of the fin plates coöperating with the latter and the spacing members to form retaining pockets for cementitious material, inner annular plates at the tube ends of each section, annular holding plates adapted to be secured to the adjacent annular plates of abutting sections, a filler of cementitious material in the pockets formed by the fin plates, and an inner lining of cementitious material with which the holding plates of abutted sections are flush, the inner lining and outer filler together with the spacing and securing members and the adjacent flattened walls of the shells forming a substantially integral reinforced concrete division wall between each pair of tubes.

7. A subaqueous tunnel structure comprising a substructure foundation, sections adapted to be sunk into alined position thereon, each consisting of tubular shells that are secured in parallel relation by spacing members and transverse fin plates forming pockets around the tubes, and a filler of cementitious material filling the pockets and the spaces between the tubes, and resting on the substructure, the filling and spacing members constituting a reinforced concrete division wall between the tubes that is substantially integral both with the foundation and with the section structure.

8. A subaqueous tunnel structure comprising a foundation formed in the bed of a water course, sections adapted to be sunk into alined, abutting relation thereon, each consisting of tubular shells, whose adjacent wall portions are flattened, securing and spacing members holding the walls in parallel relation, fin members forming with the foundation pockets around the sections when submerged, and a filler of cementitious material in the pockets, that forms with the foundation and spacing members, a reinforced concrete wall between the tubes that is integral with the sections and with the substructure.

9. In a subaqueous tunnel structure, sections each comprising tubular shells having upright flattened, adjacent wall portions, spacing plates connecting the walls, securing members passing through the adjacent walls, and inner concrete anchor members projecting from the inner faces of the walls, fin plates on the exterior of the tubes, a filler of cementitious material around the tubes, and a lining of cementitious material in the tubes, the lining and filler forming with the spacing, securing and anchoring members an integral, reinforced concrete wall between the tubes.

10. In a subaqueous tunnel structure, sections consisting of tubular shells secured together in parallel, spaced relation by spacing and securing members, outer annular plates on each tube adjacent the ends thereof, inner annular plates in each tube near the ends thereof, holding bolts passing through the outer plates of abutted tubes, and holding plates each secured on the inner peripheries of inner annular plates of abutted tubes over the joints between the tube ends, the holding plates forming inner retaining members for cementitious material placed between the annular plates.

In testimony whereof I affix my signature in presence of two witnesses.

OLAF HOFF.

Witnesses:
MAY E. MANN,
ERLING NORMANN.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."