W. BLANCHARD.

SUBMERGED BRIDGE.

APPLICATION FILED APR. 30, 1909.

949,791.

Patented Feb. 22, 1910.

3 SHEETS—SHEET 1.

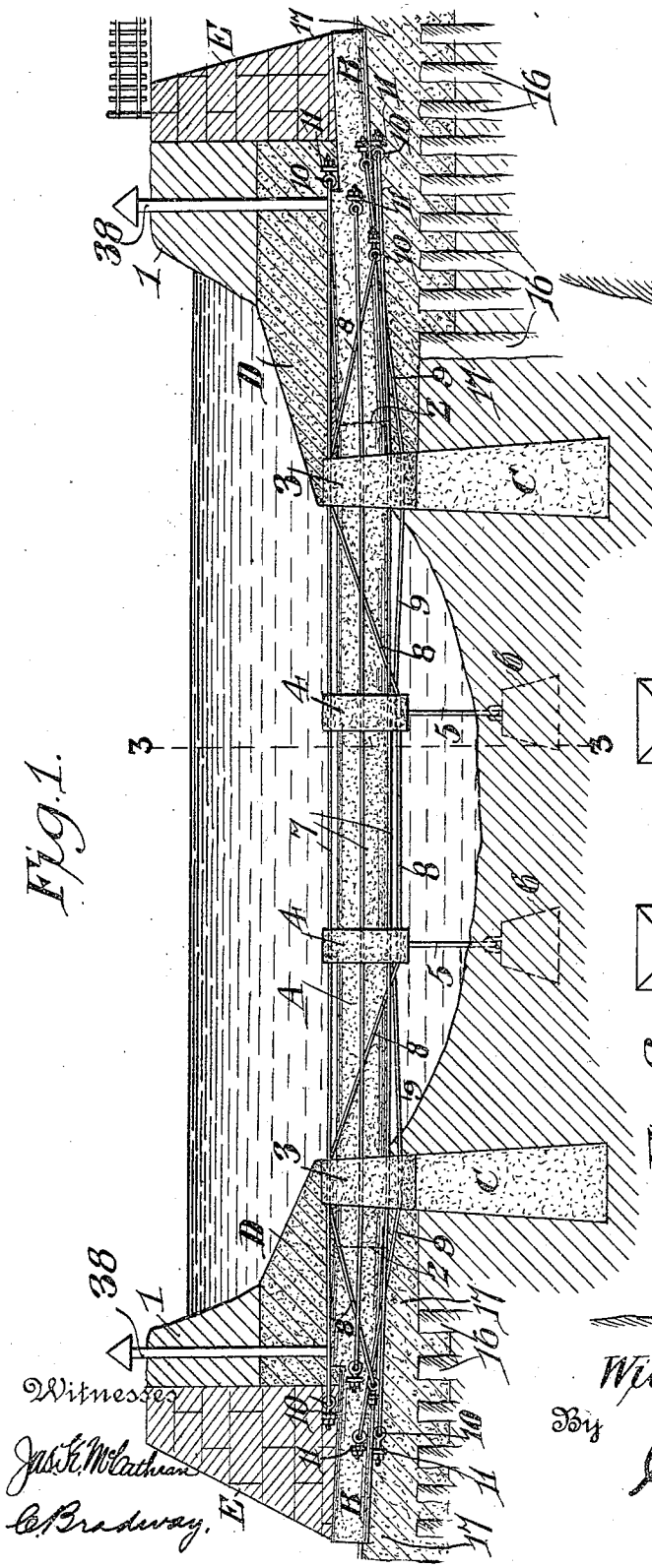

Fig. 1.

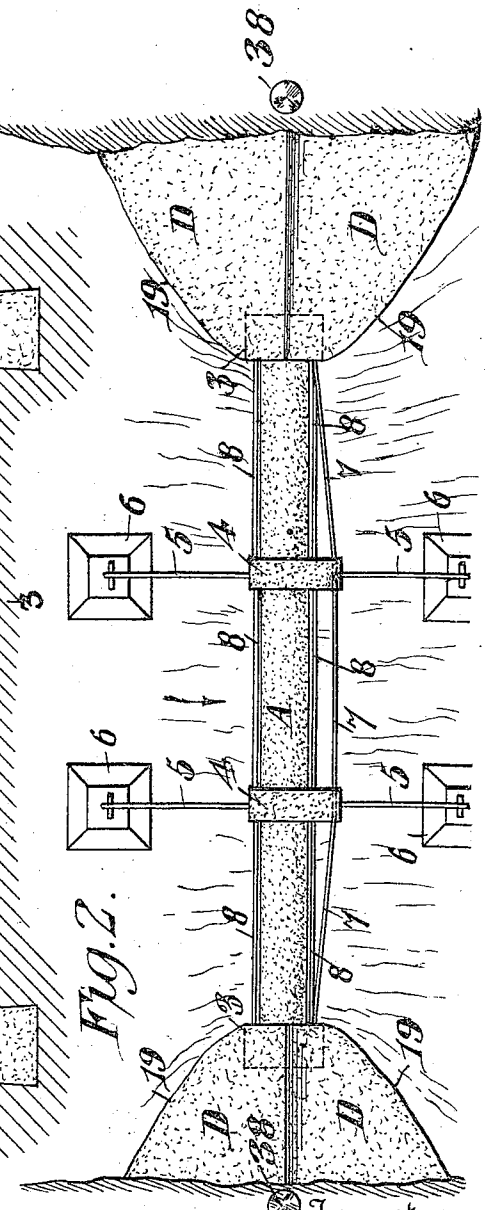

Fig. 2.

Witnesses,

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3 SHEETS—SHEET 2.

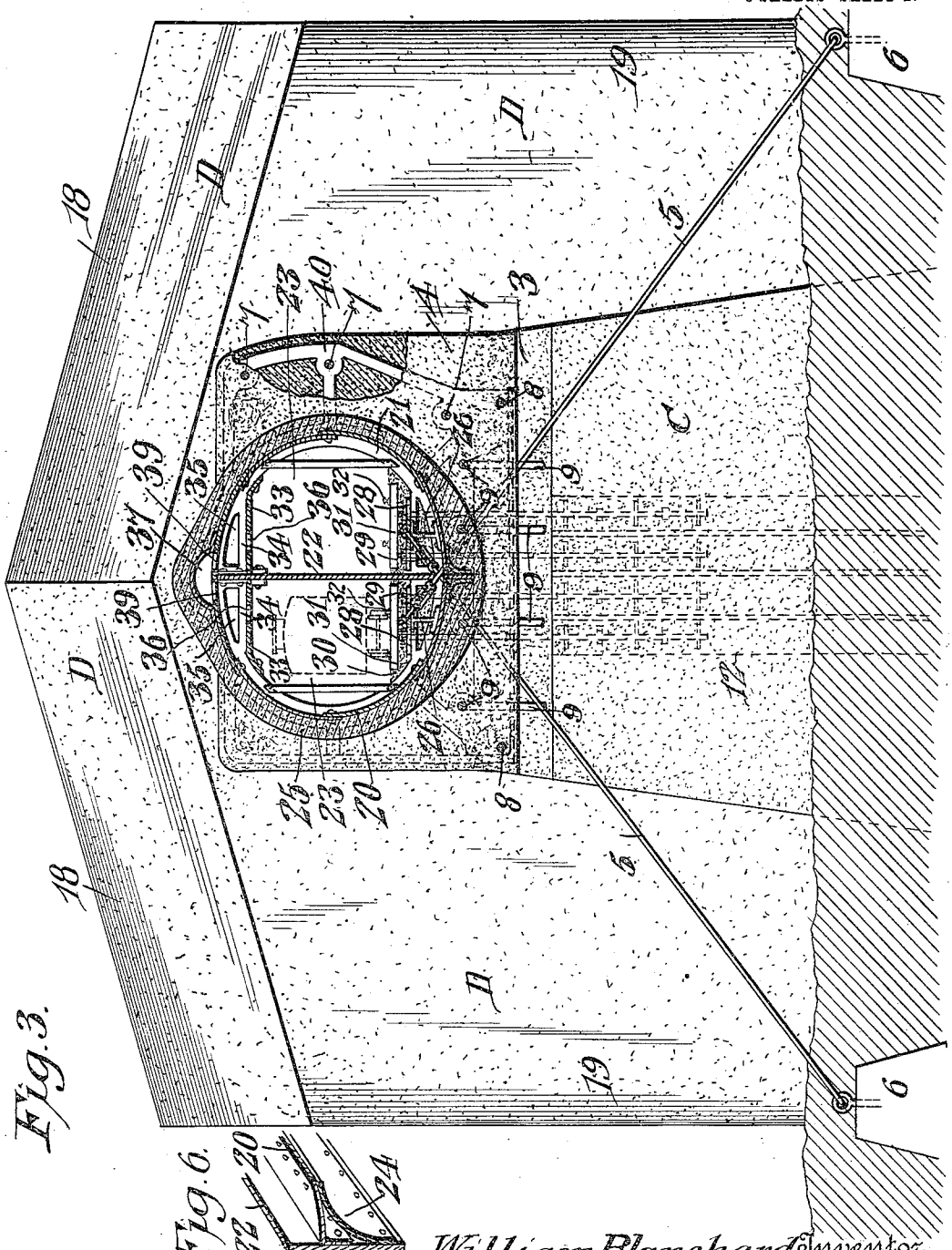


Fig. 3.




Fig. 6.

Witnesses

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3 SHEETS—SHEET 3.

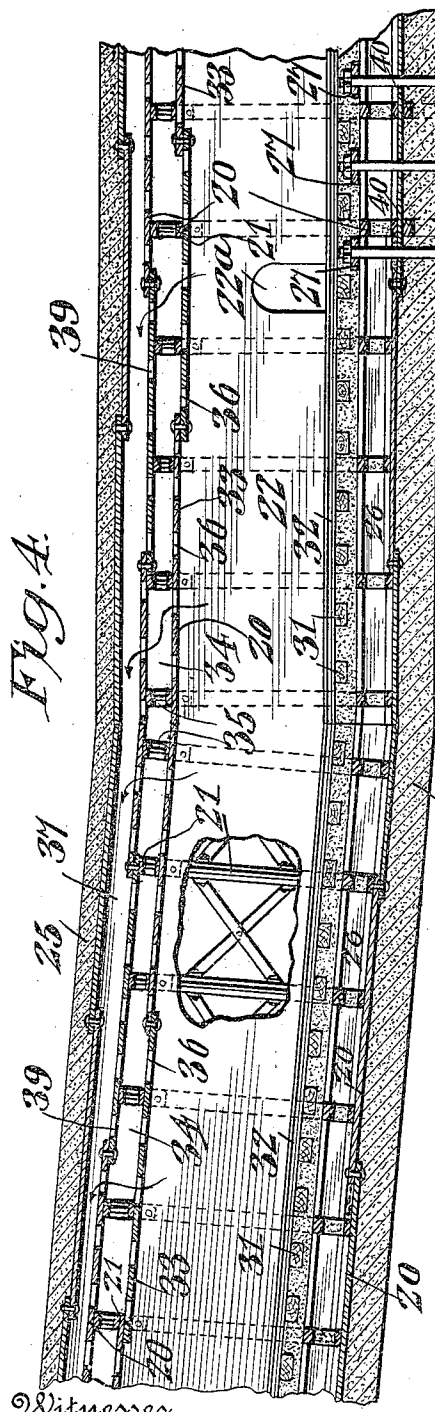

Fig. 4.

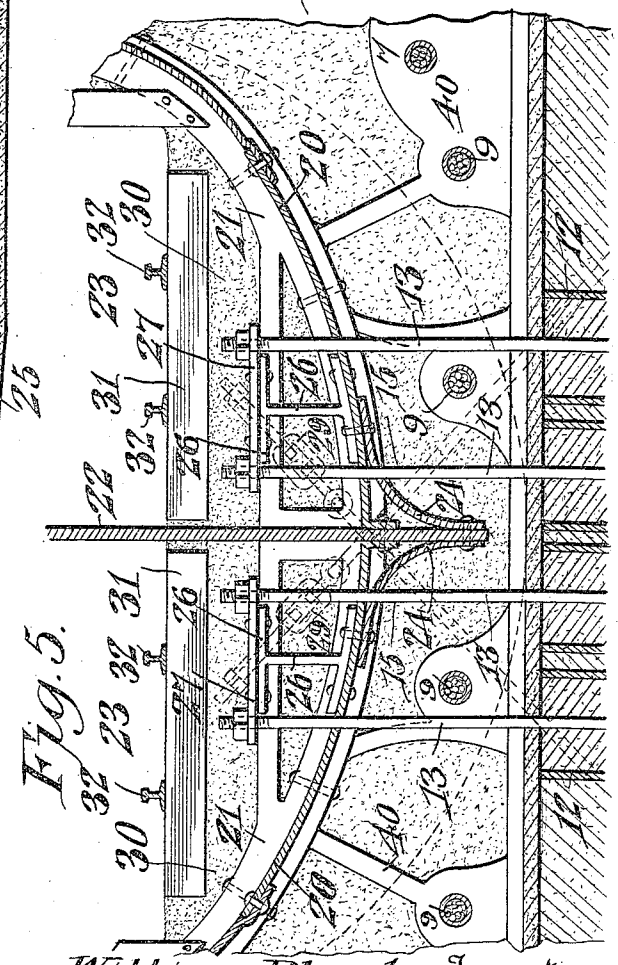

Fig. 5.

Witnesses
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# UNITED STATES PATENT OFFICE.

WILLIAM BLANCHARD, OF NEW ORLEANS, LOUISIANA.

## SUBMERGED BRIDGE.

949,791. Specification of Letters Patent. Patented Feb. 22, 1910.

Application filed April 30, 1909. Serial No. 493,217.

*To all whom it may concern:*

Be it known that I, WILLIAM BLANCHARD, a citizen of the United States, residing at New Orleans, in the parish of Orleans and State of Louisiana, have invented a new and useful Submerged Bridge, of which the following is a specification.

This invention relates to a submerged bridge or viaduct for transportation purposes, in navigable bodies of water, and is especially designed for those localities where the soil is of such a nature that it is practically impossible to construct foundations, unless at prohibitive cost, as for instance, along the lower regions of the Mississippi River.

The principal object of the present invention is the provision of a subaqueous viaduct composed of a central river section mounted on terminal piers adjacent the shore and connected with land or shore sections, whereby a complete water-tight tubular structure is provided partially submerged to render the employment of expensive foundations unnecessary since the buoyancy of the submerged portion is utilized for this purpose, the central river section being braced, strengthened and reinforced by novel arrangement of cables for withstanding the various strains to which it is subjected.

Another object of the invention is to provide a sheet metal tubular structure mounted on a skeleton framework and coated with concrete or other protective material and formed with saddles at its ends for connection with supporting and retaining piers, and also provided with saddles at intermediate points to which guy cables are fastened, the said saddles forming means of attachment for trussed cables extending longitudinally of the bridge.

With these objects in view and others, as will appear as the description proceeds, the invention comprises the various novel features of construction and arrangement of parts which will be more fully described hereinafter and set forth with particularity in the claims appended hereto.

In the accompanying drawings, which illustrate one embodiment of the invention, Figure 1 is a transverse section of a river in which the improved bridge is built. Fig. 2 is a plan view thereof. Fig. 3 is an enlarged vertical transverse section on line 3—3, Fig. 1. Fig. 4 is an enlarged fragmentary sectional view of that portion of the bridge where the river section joins with one of the shore sections. Fig. 5 is an enlarged detail sectional view taken through the bridge at one of the supporting piers. Fig. 6 is a detail perspective view, showing the keel construction of the bridge.

Similar reference characters are employed to designate corresponding parts throughout the views.

In the accompanying drawings, A designates the central section of the bridge which is of such length as to extend approximately from one shore of the river to the other, and the extremities of the central river section are united with shore sections B which are slightly inclined inwardly toward the river with their outer ends extending off at a gradual grade to the surface of the land at points more or less remote from the river, the river being shown in the present instance as confined between levees 1. Close to the shore are piers C which support the section A, there being only two such supports or piers, as these can be readily constructed by the use of coffer-dams extending outwardly from the banks of the river, the section A being built on the land and launched like a boat and floated into place, there being removable bulkheads in the ends thereof with valves or other devices for admitting water to submerge the hollow tubular section when properly positioned with respect to its supporting piers. The section A is of greater length than the distance from one pier to the other and unites with the shore sections B at the dotted lines 2, Fig. 1. The ends of the section A thus extend landward with respect to the piers C and are formed with saddles 3 which rest on the piers. Intermediate the main saddles 3 are spaced secondary saddles 4 which serve to reinforce the tubular structure A and form means for connection with the truss cables. Attached also to the saddles 4 are guy cables 5 extending up and down stream with their outer ends fastened to heavy concrete anchors 6 which effectively brace the bridge at points intermediate its piers.

Extending longitudinally of the bridge and exterior to the section A thereof, are a plurality of sets of cables 7, 8 and 9 which stiffen the said section to withstand the pressure of the stream, and also any upward or downward tension. These cables are all applied to the section A, before the latter is completed on the land, and the ends of the

cables are gathered together, so as to be out of the way during the operation of placing the section A in position, and after the said section is positioned, the ends of the cables are unfastened and straightened out to extend along the land sections of the bridge to which the ends are anchored. The bridge is trussed against the pressure of the water by the set of parallel cables 7 arranged along the downstream side and passing through the secondary saddles 4, which are extended laterally, as shown in Fig. 2, for the double purpose of spacing the cables from the middle portion of the bridge section and to assist in withstanding the pressure of the downward flowing water, and the ends of the cables extend through the main saddles 3 and are suitably anchored on the shore sections of the bridge. The bridge is braced against downward strains by the set of cables 8 which are located, as shown in Fig. 2, along the up and down stream side of the section A and extend along the bottom thereof between the saddles 4, and after passing through the latter, they extend upwardly to and through the top of the saddles 3 and thence downwardly to be suitably anchored to the shore sections of the bridge. Four or any other desired number of cables 9 are used to withstand the upward tension on the bridge, and these cables extend under the section A with their middle portions passing through the saddles 4 and also through the saddles 3 at a point below where they penetrate the saddles, and thence upwardly to connect with the shore sections B of the bridge. These various truss cables and guy cables are made up of numerous strands or ropes of wire that are inclosed in a lead or other protecting sheath so as to prevent deterioration or corrosion. Any desired tensioning and anchoring devices may be employed for tightening these truss cables, these devices being shown in the present instance as eye bolts 10 passing through lugs 11 on the shore sections B of the bridge.

The piers C are constructed after the coffer-dams are built and each pier is formed of a number of hollow metallic cylinders 12, which are driven into the river bottom to the desired depth and the mud or earth is then removed from the interior of the cylinders and the latter filled with concrete. These cylinders are tied together in any suitable manner and concrete is molded around them to form piers of any desired dimensions. Embedded in the concrete in the upper ends of the cylinder are bolts 13 having anchoring devices 14, and these bolts project upwardly through passages 15 formed in the saddles 3. In placing the section A of the bridge on the piers, the bolts pass through the passages 15 and nuts or equivalent devices bolt the section A firmly to the piers. The piers not only hold the bridge against lateral displacement, but serve as anchoring means whereby the bridge is held down against the tendency to rise by reason of its buoyancy.

In constructing the land sections B of the bridge, the levees or banks of the river are excavated behind the coffer-dam, and after a foundation has been laid, consisting of piles 16 that support a bed of concrete 17, the sections B of the bridge are built up. When these two sections are completed and the section A assembled between them, the extremities of the sections are united at the dotted lines, Fig. 1. After being thus united, the shore sections are enveloped in a casing of concrete D which extends laterally both up and down stream and shoreward from the piers C, whereby a practically indestructible anchoring means for the ends of the bridge is provided. After the casing D, which, as shown in Figs. 2 and 3 has downwardly and oppositely-sloping top surfaces 18 and oppositely-curved side surfaces 19 whereby little obstruction is offered to the flow of the water, has been constructed, the levees or banks of the river are restored, and, if desired, a retaining wall E may be built on the land side of the levees for insuring greater security.

Each section of the bridge is constructed in the form of a sheet metal tube composed of plates 20 riveted together and also riveted to a skeleton framework consisting of vertically-disposed approximately semi-circular ribs 21. These ribs are riveted to a vertically-disposed bulkhead 22 extending longitudinally of the bridge and through the center thereof for providing separate passageways 23 for trains or other vehicles, the bulkhead having manholes $22^a$ so that trackhands and the like can conveniently pass from one passage 23 to the other without having to go to the terminals of the bridge. The bulkhead, which may be constructed of sheet metal plates, projects downwardly below the shell formed by the plates 20 to constitute a keel extending the full length of the bridge, and between opposite sides of the keel and the bottom of the tubular shell are arcuate bracing plates 24, as shown in Figs. 5 and 6. After the shell is thus constructed, the same is covered with a protective coacting 25 of concrete which entirely houses the metal parts of the structure, so that there is no chance of deterioration from the effects of water.

In joining the sections of the bridge together, the meeting ends are left unfinished so that the plates of the shell will have to be fitted together and the concrete protecting covering applied over the plates after they are riveted, so that, in reality, a practically single piece bridge is formed extending from one entrance to the other. The ribs 21 are

enlarged at their upper and lower ends where they are connected with the bulkhead, so as to provide horizontally-disposed transversely-extending stiffening members for withstanding the lateral strains exerted by the pressure of the water. Disposed between the enlarged feet portions of the ribs are eye beam sections 26 arranged in a line at opposite sides of the bulkhead to form stringers extending the full length of the bridge, and these eye beam sections are riveted or otherwise fastened to the ribs.

As shown in Fig. 5, cross plates 27 are arranged on the stringers and ribs at the saddles 3, and through these cross plates extend the fastening bolts 13 which secure the section A of the bridge to the piers. Each pair of guy cables 5 are disposed with their upper ends attached to the bridge by passing inwardly through each saddle 4 of the tubular section A with their extremities crossing or overlapping and secured to anchoring means located within the tube at opposite sides of the bulkhead.

As shown in Fig. 3, cross plates 28 are provided on the skeleton framework of the tube and the guy cables are secured to these cross plates and are equipped with tightening devices of any suitable character, as for instance, turnbuckles 29 whereby the guy cables can be tensioned.

The bridge is provided with a concrete floor 30 into which are creosoted wood ties 31 for the track rails 32, and this floor can be laid in such a manner as to provide for draining water which might collect in the bridge to certain points from which it can be drawn off by pipes through the instrumentality of a pump. The bridge is provided with roof plates 33 arranged in each passage and secured to the bulkhead 22 and oppositely-disposed ribs 21. The bridge is provided with ventilating passages 34 formed between the roof plates 33 and top of the bridge, and the enlarged upper ends of the ribs are made with openings 35 whereby continuous passages are formed at opposite sides of the bulkhead and running, if desired, the entire length of the bridge.

The roof plates are provided with ports 36 that communicate with the ventilating passages 34, and over the shell of the bridge is arranged a ventilating conduit 37 that terminates in up-takes 38 at the banks of the river, any suitable means being employed for drawing off the gases and smoke from the tunnel in case forced ventilation is necessary. The free passage 37 communicates with the inside passages 34 by means of ports 39, the said ports, as well as the ports 36, being arranged at short intervals, so that the gases can readily escape. At the saddles of the bridge are reinforcing frames 40 riveted or otherwise secured to the metallic shell, and these frames are embedded in the concrete which forms saddles or lateral ribs 3 and 4 of the central section of the bridge. The truss cables preferably connect with these frames, so that there is no danger of cracking the concrete by excessive strains.

A bridge constructed in this manner is especially adapted for rivers or other bodies of water where navigation is carried on and where the soil is of such a nature that heavy structures cannot be supported without extensive foundations. Furthermore, the bridge is of durable and substantial construction, and when once laid, will require practically no repair owing to its durable character. Furthermore, since the main section can be built upon the land and launched and floated into place when finished, and then submerged during the positioning thereof with respect to the shore sections, it is obvious that less labor and time is required in its construction as compared with aerial bridges.

From the foregoing description, taken in connection with the accompanying drawings, the advantages of the construction and of the method of operation will be readily apparent to those skilled in the art to which the invention appertains, and while I have described the principle of operation of the invention, together with the apparatus which I now consider to be the best embodiment thereof, I desire to have it understood that the apparatus shown is merely illustrative, and that such changes may be made when desired as are within the scope of the claims appended hereto.

Having thus described the invention, what I claim as new, and desire to secure by Letters Patent, is:—

1. In a submerged bridge, the combination of a central tubular section made in a single piece and extending approximately from one shore to the other of the body of water to be bridged, supporting piers arranged only at the ends of the said section, and shore sections secured to the central section.

2. In a submerged bridge, the combination of a central tubular section extending approximately from one shore to the other of the body of water to be bridged, terminal supporting piers disposed inwardly from the ends of said section, and shore sections joined to the ends of the central section.

3. In a submerged bridge, the combination of separately-formed shore sections supported entirely upon the land, a separately-formed single-piece central section placed between and joined to the shore sections, and supporting means for the ends of the central section.

4. In a submerged bridge, the combination of separately-formed tubular shore sections supported entirely upon the land, a separately-formed single-piece tubular central section of such length as to extend from one

shore section to the other and joined to both, supporting piers for the extremities of the central section, and a guy device connected with the central section at a point between the piers for withstanding lateral strains.

5. In a submerged bridge, the combination of a continuous tubular structure anchored at its ends to the shores with its intermediate portion sustained free from the bed of the body of water bridged, external reinforcing devices connected with the said structure and extending longitudinally of the intermediate suspended portion, and a plurality of anchoring devices connected at spaced points with the tubular structure for withstanding lateral strain.

6. In a submerged bridge, the combination of a continuous tubular structure anchored at its ends to the shores with its intermediate portion sustained free from the bed of the body of water bridged, external reinforcing devices connected with the said structure and extending longitudinally of the intermediate suspended portion, guy cables fastened to the tubular structure at points intermediate the ends thereof and extending upwardly and down stream, and anchor devices fastened to the cables and resting on the bed of the said body of water.

7. In a submerged bridge, the combination of a tubular structure supported at its ends, pairs of transversely-extending guy cables having their inner ends crossing and fastened to the structure, anchors fastened to the outer ends of the cables, a plurality of cables arranged exterior to the structure and independently connected therewith at different points to coöperate with the guy cables to withstand transverse strains on the structure.

8. In a submerged bridge, the combination of a tubular structure, supporting piers therefor, spaced transversely-extending exterior ribs forming saddles, a pair of guy cables extending from opposite sides of the saddles and having their inner ends secured to the structure, and anchors fastened to the outer ends of the guy cables.

9. In a submerged bridge, the combination of a continuous tubular structure, land supports at the ends thereof, and a plurality of truss cables extending longitudinally of the structure for withstanding transverse strains on the latter.

10. In a submerged bridge, the combination of a tubular structure composed of separately-constructed central and shore sections joined together, and a plurality of truss cables extending longitudinally of and connected with the central section and having their extremities fastened to the shore sections for withstanding transverse strains on the central section.

11. In a submerged bridge, the combination of a tubular structure composed of separately-constructed central and shore sections joined together, a plurality of truss cables extending longitudinally of and connected with the central section and having their extremities fastened to the short sections for withstanding transverse strains on the central section, supporting piers at the ends of the central section, and guy cables connected with the central section at points between the piers, said guy cables having anchoring devices for coöperating with the truss cables to brace the said structure.

12. In a submerged bridge, the combination of a tubular structure, a plurality of truss cables on the down stream side thereof, a plurality of cables along the bottom of the structure for trussing the same against upward pressure, and additional truss cables fastened to the structure for opposing downward pressure.

13. In a submerged bridge, the combination of a tubular structure, supporting piers, saddles on the structure for seating the latter on the piers, additional saddles at points on the structure between the piers, a plurality of truss cables arranged exterior to the structure and connected with the saddles to withstand transverse strains, and devices for anchoring the ends of the cables on the shore portions of the structure.

14. In a submerged bridge, the combination of a tubular structure, supporting piers, saddles on the structure for seating the latter on the piers, additional saddles at points on the structure between the piers, a plurality of truss cables arranged exterior to the structure and connected with the saddles to withstand transverse strains, devices for anchoring the ends of the cables on the shore portions of the structure, and guy devices connected with the structure and extending transversely thereto to coöperate with the truss cables for withstanding lateral strains.

15. In a submerged bridge, the combination of a central section, piers supporting the ends thereof, shore sections joined to the central section, a supporting foundation for the shore sections, a concrete casing extending from the piers to the shore and coöperating with the said foundations to envelop the bridge at the points of juncture between the sections, and levees on the casings.

16. In a submerged bridge, the combination of a supporting pier consisting of a concrete structure having a plurality of hollow reinforcing cylinders, bolts anchored in the cylinders by concrete and extending upwardly above the pier, a tubular bridge structure formed with a saddle for resting on the pier and having openings through which the bolts extend inwardly, and tightening devices on the bolts arranged within the tubular structure for fastening the latter to the pier.

17. In a submerged bridge, a tubular

structure comprising a longitudinally-extending bulk-head, approximately semi-circular ribs secured to opposite sides thereof, a sheet metal shell fastened to the ribs, and a road-bed extending along the bottom of the structure at opposite sides of the bulk-head.

18. In a submerged bridge, a tubular structure comprising a longitudinally-extending bulkhead, spaced ribs at opposite sides of the buklhead, a shell carried by the ribs, and a protecting envelop around the shell.

19. In a submerged bridge, a tubular structure comprising a vertically-disposed longitudinally-extending bulkhead, ribs fastened thereto, a shell carried by the ribs, said bulkhead extending below the shell to form a keel, and a coating of concrete surrounding the shell.

20. In a submerged bridge, a tubular structure comprising a skeleton framework, a shell carried thereby, saddle frames secured to the shell, and a concrete casing surrounding the shell and the saddle frames.

21. In a submerged bridge, a tubular structure comprising a skeleton framework, a shell carried thereby, saddle frames secured to the shell, a concrete casing surrounding the shell and the saddle frames, and truss cables connected with the saddle frame and with the terminal portions of the structure.

22. In a submerged bridge, a tubular structure consisting of a longitudinally-extending central bulkhead, ribs having their upper and lower ends secured to the bulkhead, beam sections secured to the lower ends of the ribs to form longitudinal stringers at opposite sides of the bulkhead, a shell composed of sectional plates fastened to the ribs, a concrete casing surrounding the shell, a road-bed disposed over the stringers and extending along opposite sides of the bulkhead.

23. In a submerged bridge, a tubular structure consisting of a bulkhead, ribs disposed at opposite sides thereof, a shell carried by the ribs, roof plates disposed within the shell and secured to the ribs and bulkhead to form internal ventilating passages, ports in the roof plates, an external ventilating passage running longitudinally along the top of the shell, ports in the shell to connect the internal and external passages, and outlet devices connected with the ends of the external passage and located adjacent the terminals of the bridge.

24. In a submerged bridge, the combination of a tubular structure, supports for the ends thereof, saddles arranged at spaced points along the unsupported portion of the structure and extending laterally from the down stream side of the latter, and truss cables extending across the saddles and longitudinally of the structure with their terminal portions fastened to the latter.

In testimony, that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

WILLIAM BLANCHARD.

Witnesses:
JOHN H. SIGGERS,
EDITH L. BROWN.