No. 725,029. PATENTED APR. 14, 1903.

# I. A. BRADDOCK.

## SUBAQUEOUS TUNNEL.

APPLICATION FILED MAR. 7, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

*Fig. 1.*

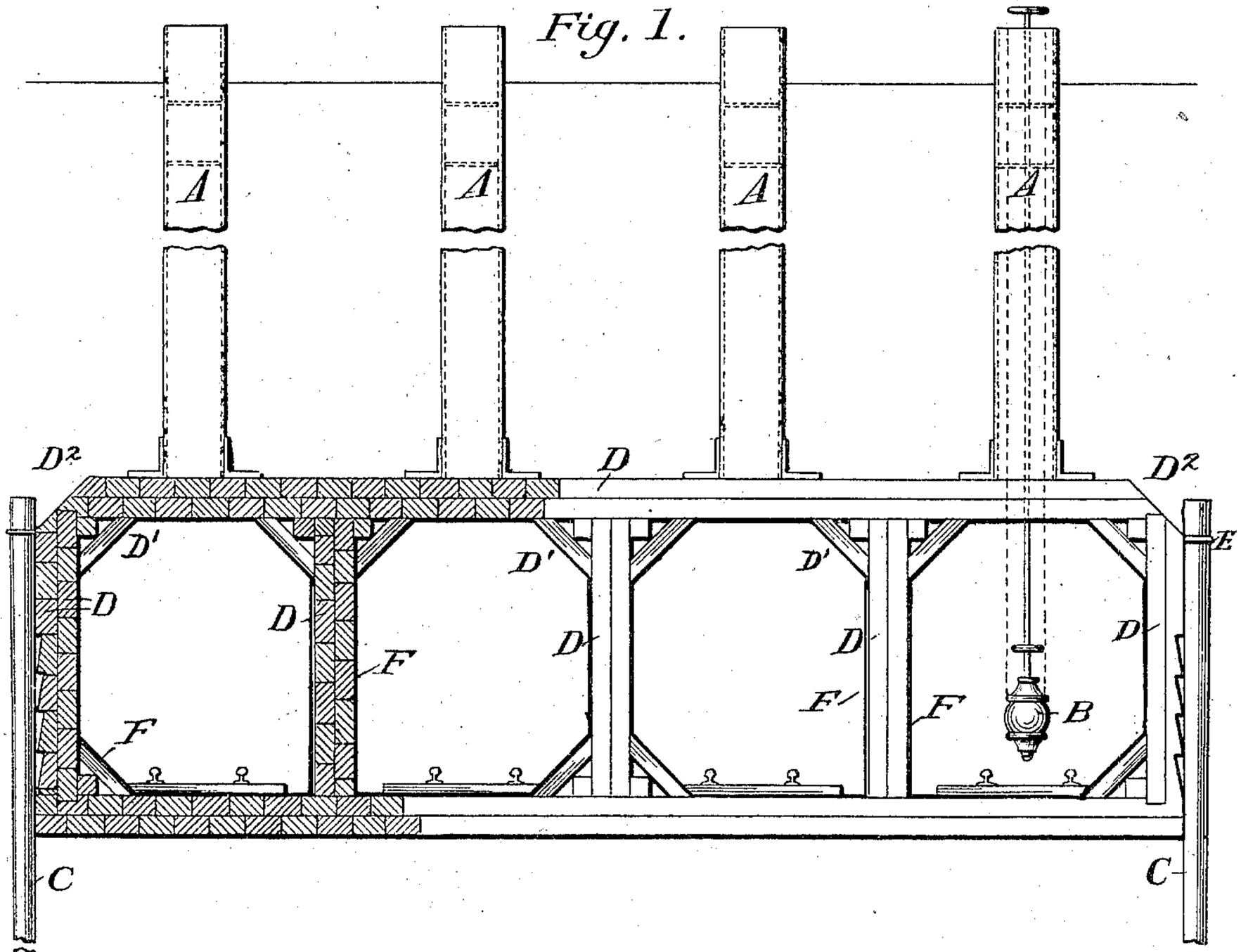
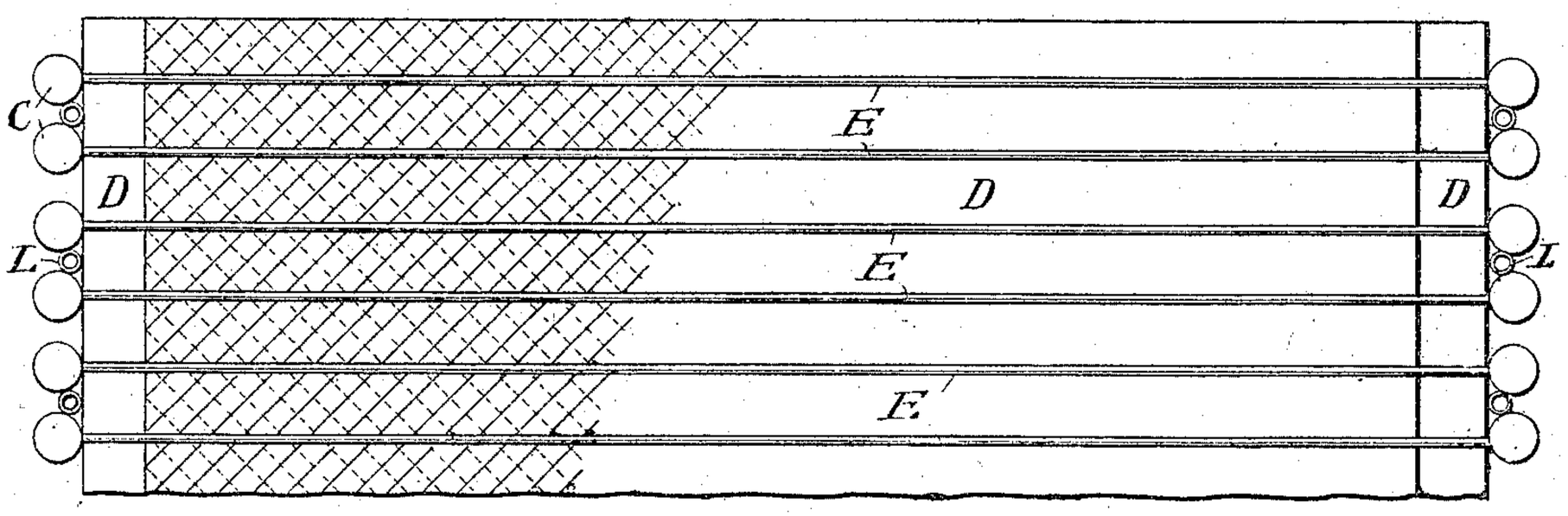



*Fig. 5.*

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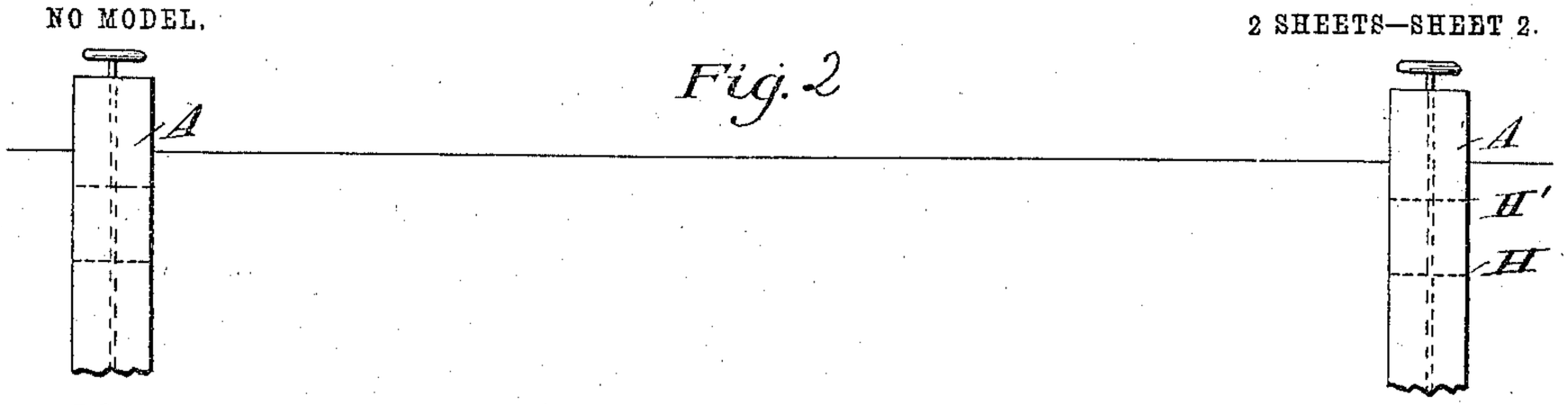
SUBAQUEOUS TUNNEL.

APPLICATION FILED MAR. 7, 1902.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2



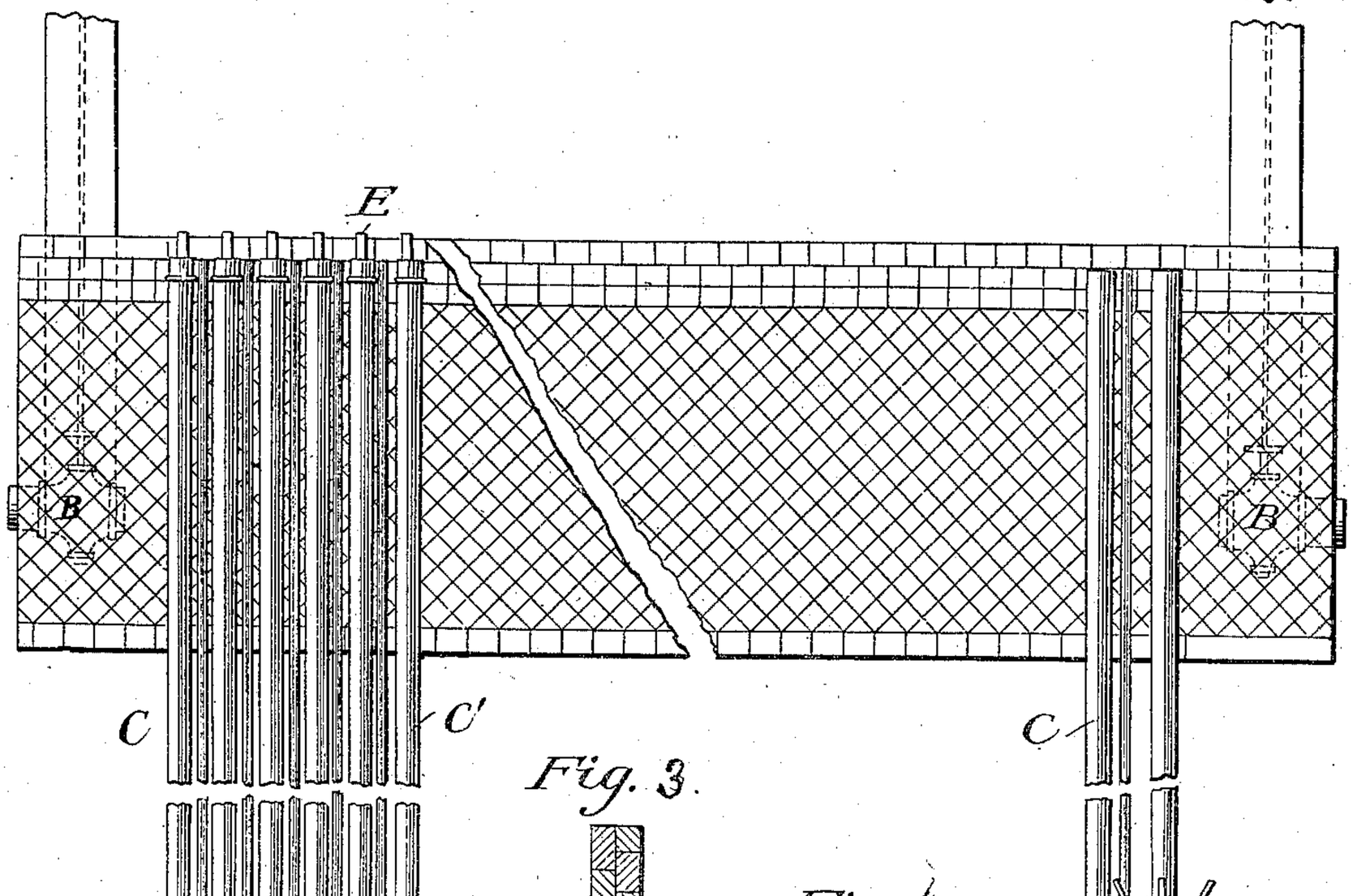




Fig. 3.

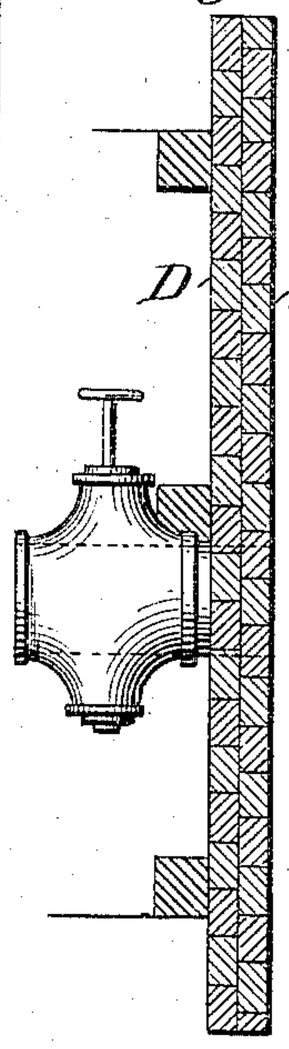



Fig. 4.

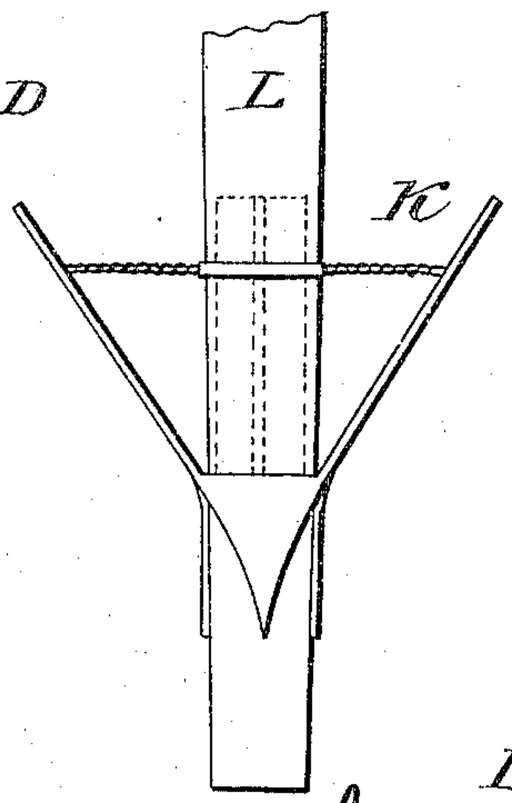



Fig. 6.

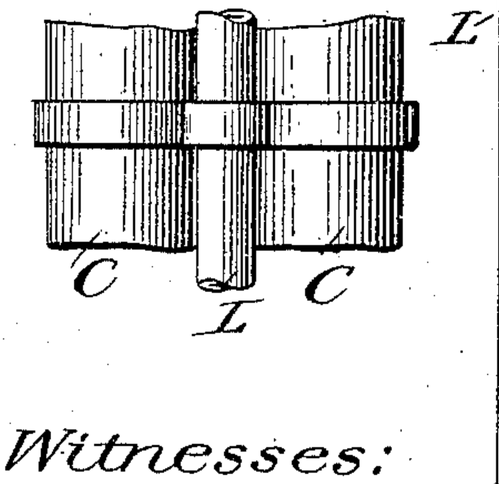
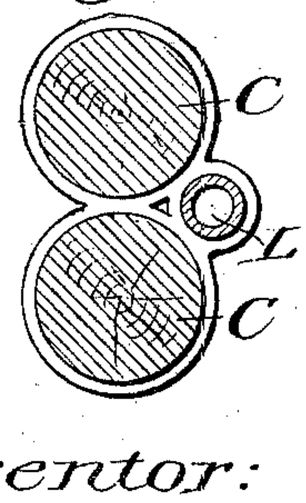



Fig. 7.




Witnesses:

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# UNITED STATES PATENT OFFICE.

ISAAC A. BRADDOCK, OF HADDONFIELD, NEW JERSEY.

## SUBAQUEOUS TUNNEL.

SPECIFICATION forming part of Letters Patent No. 725,029, dated April 14, 1903.

Application filed March 7, 1902. Serial No. 97,136. (No model.)

*To all whom it may concern:*

Be it known that I, ISAAC A. BRADDOCK, a citizen of the United States, residing at Haddonfield, in the county of Camden and State of New Jersey, have invented a new and useful Improvement in the Construction of Subaqueous Tunnels for Traffic or other Purposes.

This invention relates to tunnels of the kind which are constructed in sections at a place other than that at which they are finally located and which are floated to near the position of permanent location, then sunk, connected, and secured.

The object of the invention is to so combine timber and metal in such a construction as to secure great strength and capacity and at the same time avoid such great weight as would tend to strain the material.

Figure 1 is an end view, partly in section, showing the general structure of a four-passage tunnel, the air-vents therefor, and means for anchorage. Fig. 2 is a broken side elevation of same, showing only part of the anchorage devices. Fig. 3 is a broken detail cross-section of one of the timber walls of the tunnel-section with valve applied. Fig. 4 is a broken detail elevation of an anchoring device. Fig. 5 is a top plan of a part of one of the tunnel-sections, showing piles and anchor-tubes. Fig. 6 is a broken elevation; and Fig. 7 is a cross-section showing two piles and a tube interposed in the space between them and a surrounding band to retain the piles and the tube in their relative position, such being one of the many ways which may be employed to hold the piles and tube together.

The tunnel-sections are constructed on land or in a basin or dry-dock in sections for convenient flotation, and the sections are composed of wood and metal, preferably arranged as shown—that is to say, timbers D D are arranged in layers lattice fashion and are firmly bolted together to form parallel trunks or passage-ways of rectangular form with strong and tight joints and preferably braced at the corners, as indicated at D′, Fig. 1. In Fig. 1 four ways are shown; but this number may be departed from. The outer corners of the latticed timber structure are preferably beveled, as at $D^2$. The inner surfaces of the passage-ways are preferably lined with heavy metallic sheathing, as F. This sheathing is firmly secured to the inner faces of the latticed timbers inside the passage-ways. The sections of the tunnel are constructed in any suitable position, and the ends of the passage-ways are closed by bulkheads. The sections are provided with upwardly-extending air-tubes A, which air-tubes have air-locks, (dotted lines H.) These air tubes and locks govern the air-supply within the passage-ways. Valves B B may be used to control air-escape from the passage-ways. This location or site is to be marked by substantial piles and the bed for the tunnel thoroughly dredged to the full depth required and about double width in case of tidal streams to allow for drifting of material into it, and when all is ready at a selected time when tides are low the tunnel-section is floated to a position over its final resting-place and is allowed to sink by admitting water through suitable valves placed in the temporary bulkheads at each end of the sections (which may be one thousand feet or more in length, as location may demand) and also by control of the air in said tunnel by means of vertical shafts rising from either end of the sections and reaching above the water-line and containing air-locks, these sections to be sunk joining each other and to the shore ends in a manner prescribed by the engineer in charge. These sections may consist of one or more tunnels built or joined together on the side, making single or double or quadruple tracks in case of traffic-tunnels.

On the shore and on a suitable foundation or launching-ways the tunnel is to be constructed in the best manner of the bridge and ship builders' arts, well bolted together, preferably of latticed timbers of heavy section and adapted to the strains, tensions, and compressions to which it may be subjected both in launching and floating to its location and in sinking to its bed and pressure of water and mud surrounding it.

The timbers D D are intended to be shown as twelve by twelve inches, pine or other suitable wood. To these timbers are thoroughly bolted, say, one-inch plates F, of steel, either joined together by plain riveted joints or flanged at the edges and forming continuous metal lining and tension and stress mem-

bers of the tunnel-bridge construction, making a continuous and enormously strong bridging, usually nearly the width of the deep-water section of the stream or arm of water.

When the tunnel has been lowered to its bed, the piles C are preferably joined in pairs, secured together and to a pipe of suitable size and also joined to the corresponding set on the opposite side of the tunnel by the coupling-rods E. These pipes, connected with the piling C, are joined by a flexible hose or other means to a powerful pump, and water is forced through them, causing them to lower by their own or by added weight or driving to a suitable depth, where by the agitation of the forcing stream of water the anchors are expanded and the tunnel secured against floating out of its prepared bed when ready for traffic.

The four-track tunnel here shown has a capacity of four thousand eight hundred tons per one hundred and fifty feet in loose material.

The railroad-track may be constructed in the usual manner within the tunnel either before launching or after the placing in position, preferably before, as it helps make ballast in floating. After being connected with the shore ends or before, if desirable to work from within the tunnel, the water can be pumped out and the tunnel extended to the shore by the aid of the air-locks and a previously-constructed shield to operate through the removable bulkheads.

The great advantage of this style of tunnel is the expedition of its construction, its great and continuous strength, its cheapness in using the enormous strength of timbers and their durability in such a position, and the specific gravity of the combined timber and steel being about that of mud it has no inclination to sink into yielding material even when full of water, and the comparatively smoother and uniform sides of the inside of the tunnel presenting the least possible surface to oxidation, and also condition of water exclusion both from the filling of the seams of the timber with liquid melted pitch and the tight joints of the steel-riveted construction.

As shown in Figs. 2 and 5, the tubes L extend between the piles C and are secured thereto in any suitable manner. These pipes have expanding anchors or flukes K, which may be below the piles. In Fig. 1 the piles are shown as provided with expanding anchors or flukes. Piles with flukes are common. (See, for example, Patent No. 517,880, dated April 10, 1894.) I may adopt the construction shown in that patent or any other suitable device for the purpose.

I claim—

1. A subaqueous tunnel-section, having its outer walls surrounding a substantially rectangular passage-way, the walls composed of two layers of timbers arranged latticewise, and having an inner lining composed of metallic plates.

2. The combination with a subaqueous tunnel of substantially rectangular cross-section, of anchorage-piles driven at each side of said tunnel, the piles at the opposite sides connected by tie-rods passing above the tunnel.

3. The combination with a subaqueous tunnel, substantially rectangular in cross-section, of anchorage-piles arranged in pairs at one side of said tunnel, and a vertical tube between said piles, connected to both, and provided with an anchor.

4. A tunnel-section composed of external walls of timbers arranged latticewise, an inner lining of metal, and an air-trunk connected to the inside of the passage-way by suitable valves, said air-trunk extending upward, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ISAAC A. BRADDOCK.

Witnesses:

L. A. WILLITS,

CHAS. S. BRADDOCK, Jr.