No. 715,497. Patented Dec. 9, 1902.

H. MOESER.

TUNNEL.

(Application filed Aug. 29, 1902.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

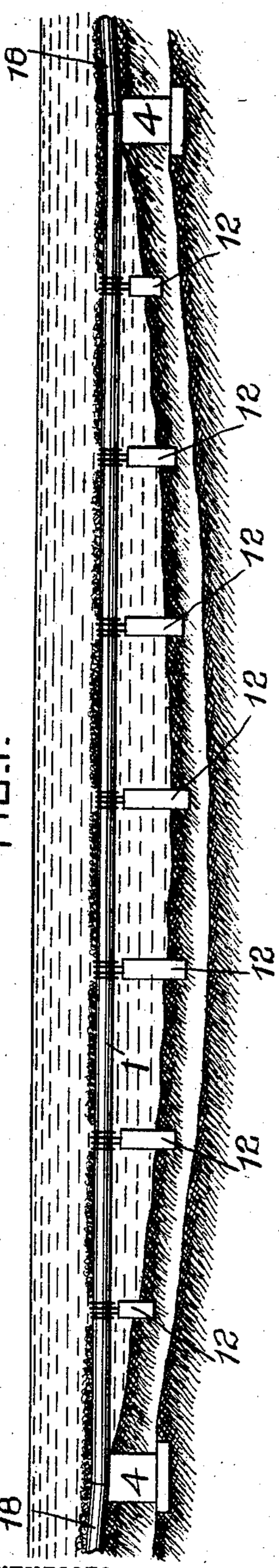


FIG. 2.

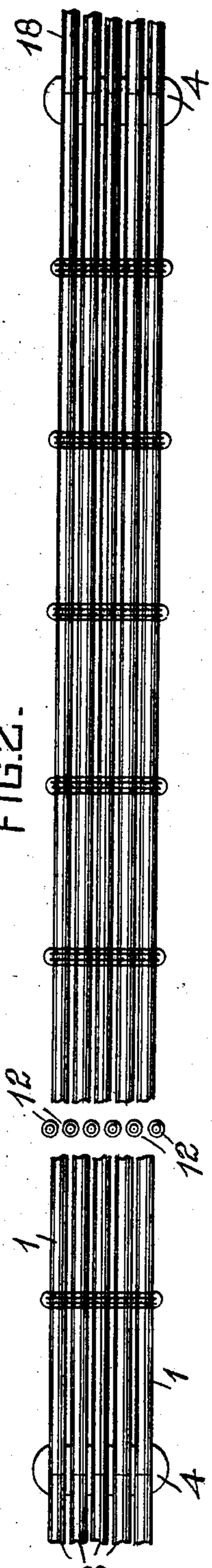
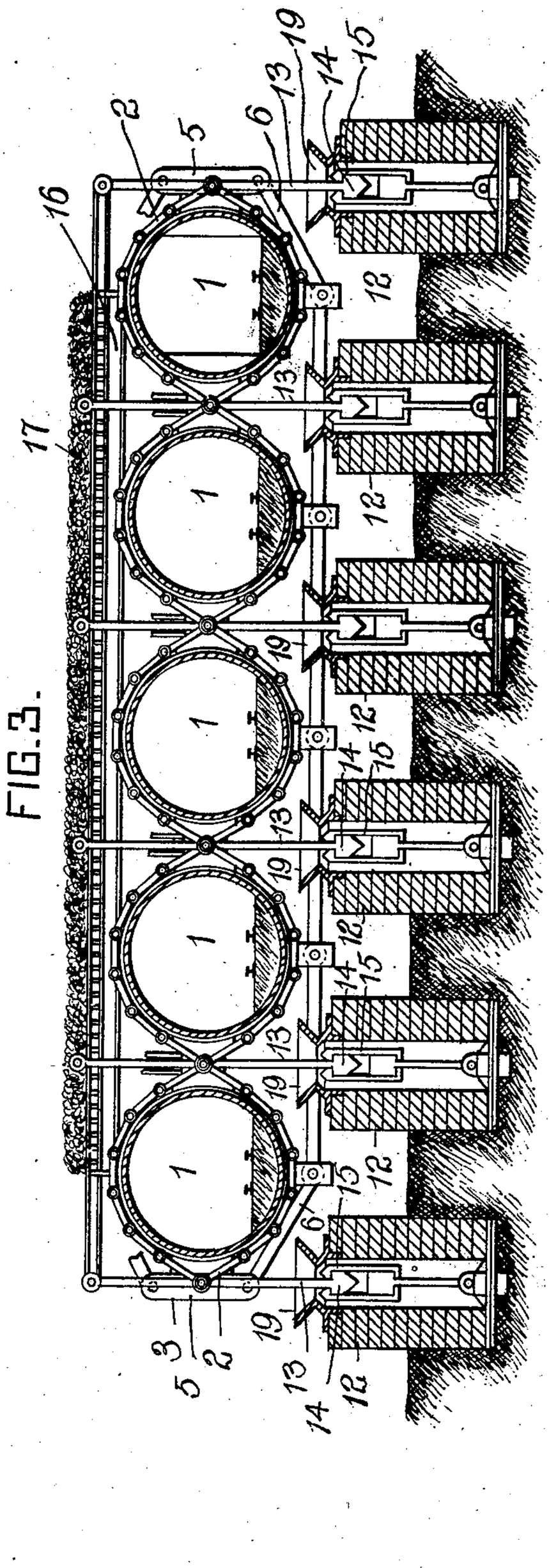


FIG. 3.



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(No Model.) 2 Sheets—Sheet 2.

FIG.4.

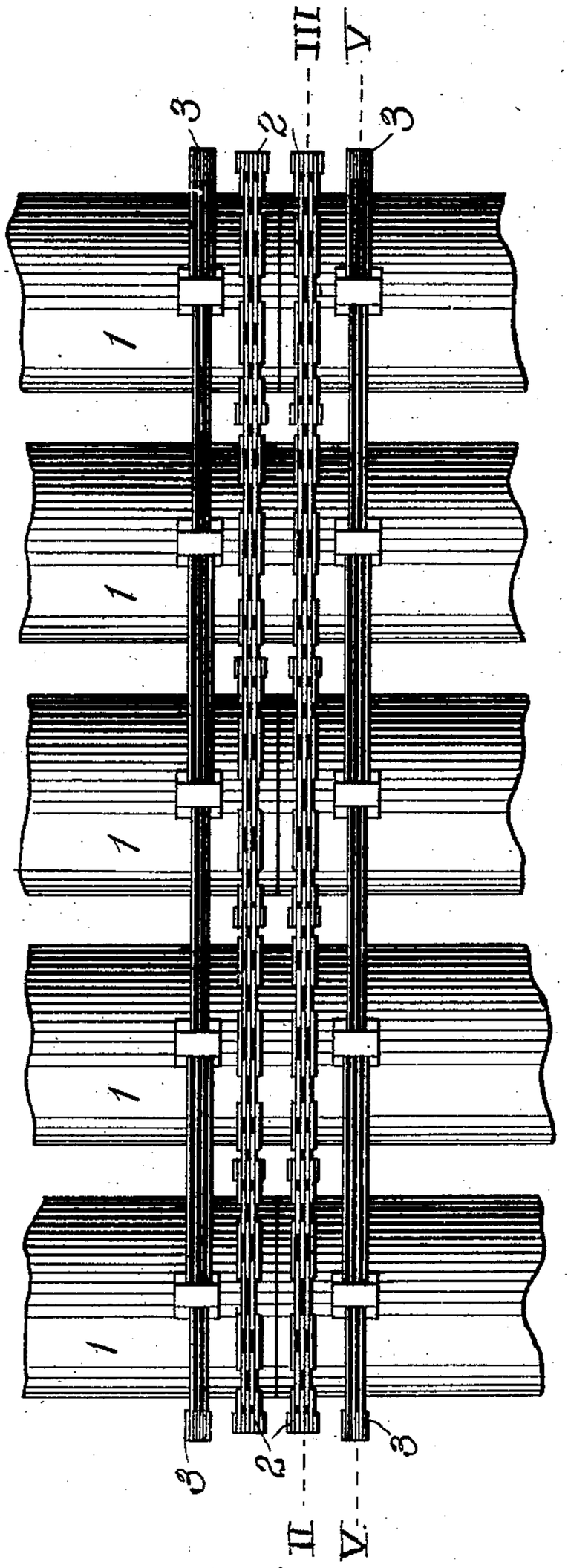
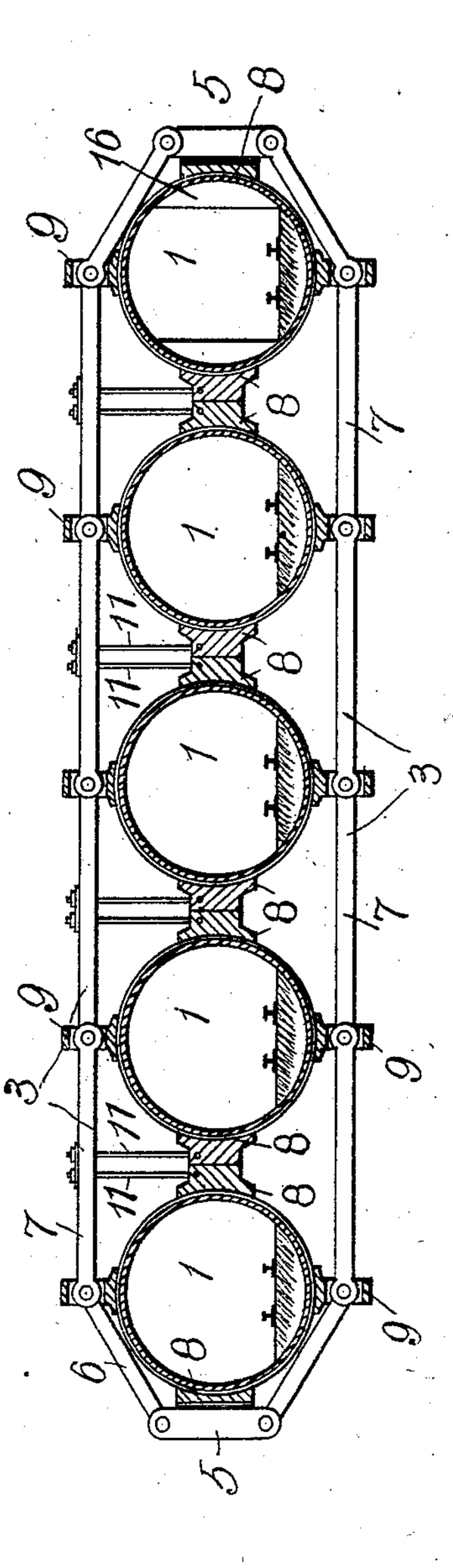


FIG.5.



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TUNNEL.

SPECIFICATION forming part of Letters Patent No. 715,497, dated December 9, 1902.

Application filed August 29, 1902. Serial No. 121,432. (No model.)

To all whom it may concern:

Be it known that I, HENRY MOESER, a citizen of the United States, residing at Allegheny, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Tunnels, of which improvements the following is a specification.

My invention relates to improvements in tunnels for traversing bodies of water; and it consists in matters of construction herein described.

In Letters Patent No. 447,735, granted to me March 3, 1891, I have shown and described what I have therein termed a "floating" tunnel—*i. e.*, a tunnel structure consisting of one or more tubular tunnels extending across a body of water at sufficient depth to be no hindrance to navigation, but held in position by its own buoyancy and not resting necessarily at the bottom of the channel of water which it traverses. My present improvement is directed to matters of construction whereby a tunnel structure of this nature may be built which is particularly adapted to resist lateral strain. It is especially applicable, therefore, to tunnels built to traverse rivers, tideways, and ocean-currents.

In the accompanying drawings, which form part of this specification, Figure 1 is a view in transverse section of a body of water and its bed. A tunnel structure embodying my present invention is shown in elevation traversing the body of water. Fig. 2 is a plan view of the tunnel structure shown in Fig. 1, a portion of the structure being broken away to illustrate the anchor-piers. Fig. 3 is a vertical section of my improved tunnel structure on larger scale. The line of section is indicated at III III in Fig. 4. A portion of one of the encircling bands is in Fig. 3 for the sake of clearness broken away. Fig. 4 is a plan view of a portion of the tunnel structure. Fig. 5 is a vertical section on the line V V, Fig. 4.

Parts which are represented in more than one figure bear the same reference-numerals in each.

It is essential to my present invention that a plurality of tubular tunnels be employed to compose the entire structure and that these tubular tunnels, or, as I shall for convenience term them, "tubes," be arranged in a horizontal layer or tier. In the accompanying drawings a series of tubes so arranged is shown at 1 1, &c. At suitable intervals throughout the length of the structure the several tubes are bound together by flexible bands 2 2, &c. These bands (which are preferably chains formed of links pinned together) pass over one tube, beneath the next, over the third, and so on throughout the series, passing around the outside tubes and back through the series, as before. Each band 2 is thus continuous throughout. It encircles each tube and being entwined throughout the series binds all the tubes together. At other suitable intervals and preferably adjacent to bands 2 2, &c., the layer or tier of tubes is confined by bands 3 3, &c. These bands 3 3, &c., are so constructed and applied that coöperating with bands 2 2, &c., they hold the several tubes which compose the structure in a single plane or layer. In this regard my preferred construction is shown in the drawings. At desired intervals blocks 8 8, &c., are attached to each side of each tube, and blocks 9 9, &c., are attached at the top and bottom of each. Bands 3 3, &c., are made up of sections 6 6, &c., and 7 7, &c. Sections 7 extend from each block 9 to the next, and sections 6 extend from blocks 9 of the outside tubes to links 5 5, &c., which abut upon the outside tubes or upon blocks 8 8, interposed between. These blocks and links are so arranged that the tubes and the blocks 8 are held firmly together. It is not, however, essential that sections 6 and 7 be rigid parts. Bolts 11 11, &c., may be provided extending from intermediate blocks 8 8, &c., to the sections 7 7, &c.

The tubes 1 1, &c., are made up of relatively short sections bolted together. I preferably arrange a band 2 and a band 3 on either side of each joint, as is shown in Fig. 4, and to obtain still greater strength I prefer to "stagger" the joints of the several tubes which compose a tunnel structure—*i. e.*, to so arrange the several tubes that the joints of adjacent tubes shall not be in line. This, too, is indicated in Fig. 4. If desired, the outermost or any or all of the tubes may be pro-

vided with air-chambers (indicated at 16) with air-tight walls as a further precaution against injury.

By uniting a plurality of tubes in a tier in the manner described I have an integral structure which is of relatively small vertical extent, which offers relatively little obstruction to the flow of currents, and which has great strength (when compared with a single tube of equal capacity) to resist lateral strain. It is adapted to sustain the thrust of a current in the manner of a beam. It follows that by employing this construction I may more readily avoid any obstruction of navigation, I may traverse currents with greater security, I may avoid to a great extent the use of laterally-extending guys, and I may traverse much greater spans. By virtue of my improved construction herein described the series of tubes is bound into an integral whole, and the gravity or buoyancy of each single tube under all operative conditions is accordingly distributed throughout the structure as a whole. An accident to a single tube will not impair the usefulness of the other tubes, and should one tube be injured and fill with water it will not break from the others and sink to the bottom, but will be buoyed up by them until repaired.

Referring to Figs. 1 and 2, 4 4 represent piers of masonry built upon firm foundation, preferably upon bed-rock, upon either side of the stretch of water to be spanned, and as far from shore as may be expedient. The position of piers 4 4 will ordinarily be at the greatest depth at which building can be done by using coffer-dams. From piers 4 4 approaches 18 18 extend to either shore. A series of anchor-piers 12 12, &c., are built upon the bed of the body of the water at intervals between the main piers 4 4. These anchor-piers 12 12, &c., are preferably built of masonry or concrete. They are sunk in the silt of the bed to a depth sufficient to give firm anchorage and are built up from the bottom to or approximately to the level at which the tubes are to lie. The weight of the anchor-piers is sufficient to overcome the buoyancy of the structure as a whole. The tier of tubes already described is anchored to these anchor-piers 12 12, &c. The manner of anchoring which I prefer is shown in Fig. 3. Connecting-rods 13 13, &c., extend from the tier of tubes. They are preferably connected to bands 2 2, &c., and at the points where these bands cross between the tubes the rods and anchor-piers are so disposed that they are alined. Each connecting-rod is provided with a head 14 and each anchor-pier with a clutch 15, adapted to engage this head, and the engagement is such that the tier of tubes is held from rising above a certain level.

19 19, &c., indicate guides for directing the heads of the connecting-rods when attachment to the anchor-piers is being made.

Upon the upper side of the tier of tubes and in the intervals between the bands I form suitable platforms 16 16, &c., and upon these platforms I place heavy material 17. The weight of this ballast should preferably approximate or counterbalance the buoyancy of the tunnel structure (exclusive of the anchor-piers) when sustaining the greatest burden which it may receive in use.

In building the tunnel structure the piers 4 4 and anchor-piers 12 12, &c., are erected and the shore-approaches 18 18 are built. These shore-approaches may be built of a series of tubes, as the main span of the tunnel is built, or they may be built in any other desired manner. The main span of the tunnel structure will preferably be assembled above water. It will then be floated to position between piers 4 4, weighted, and sunk to final position, where the connecting-rods are locked to the anchor-piers. A portion of the weight used to sink the structure may then be removed, for, as already noted, the ballast 17 should be sufficient to counterbalance the buoyancy of the structure when the latter is carrying its greatest load; but it should not greatly exceed that amount. When the main span of the tunnel structure is brought to final position, the ends of it are built into piers 4 4 and the several tubes opened to the shore-approaches in the manner described in my former patent referred to above.

I claim herein as my invention—

1. A floating tunnel structure composed of a plurality of tubular tunnels bound together by flexible bands entwined about the tubular tunnels, substantially as described.

2. A floating tunnel structure composed of a plurality of tubular tunnels united by flexible bands entwined about the tubular tunnels and other bands encircling the united tunnels, substantially as described.

3. A floating tunnel structure composed of a plurality of tubular tunnels united by flexible bands in a horizontal tier, substantially as described.

4. In a floating tunnel structure the combination of a series of tubular tunnels, bands uniting said tubular tunnels, anchor-piers built in the bed of the body of water to be traversed, and connecting-rods extending from the series of tubular tunnels to the anchor-piers, substantially as described.

5. In a floating tunnel structure the combination of a series of tubular tunnels, bands uniting said tubular tunnels, anchor-piers to which the said series of tubular tunnels is connected, and ballast which the said series of tubular tunnels bears, substantially as described.

In testimony whereof I have hereunto set my hand.

HENRY MOESER.

Witnesses:
FRED KIRCHNER,
GEO. B. BLEMING.