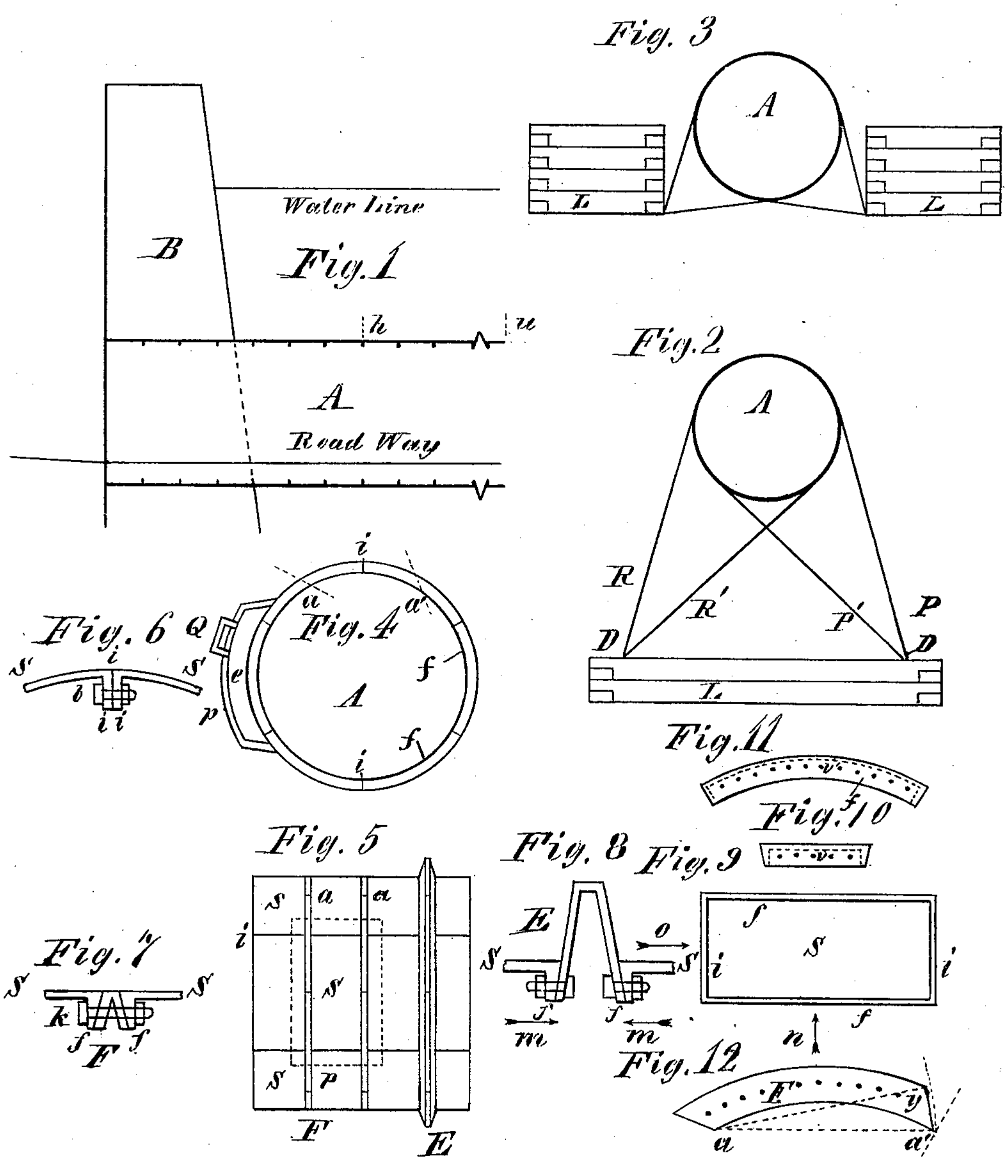
(No Model.)

J. T. WILLIAMS.

BUOYANT AND SUBAQUEOUS TUNNEL.

No. 262,524. Patented Aug. 8, 1882.



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BUOYANT AND SUBAQUEOUS TUNNEL.

SPECIFICATION forming part of Letters Patent No. 262,524, dated August 8, 1882.

Application filed August 15, 1881. (No model.)

To all whom it may concern:

Be it known that I, JOHN T. WILLIAMS, a citizen of the United States, residing in the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Buoyant Subaqueous Tunnels for Crossing Rivers and other Bodies of Water, of which the following is a specification.

The nature of my invention relates to a new method of constructing buoyant subaqueous tunnels, in which the tunnel proper consists of a tube of peculiar construction entirely submerged and held firmly in position by the action of properly-arranged guys or tension-braces in conjunction with suitable cribs of timber and stone. The ends of said tube terminate in suitable entrances and approaches.

The objects of my invention are, first, to construct a buoyant subaqueous tunnel in such a manner that any part may be replaced or changed without the use of said tunnel for traffic being interfered with; second, by the peculiar arrangement of the guys or tension-braces to secure perfect stability. I attain these objects by the novel combination of parts and principles arranged as shown in the accompanying drawings, in which—

Figure 1 is a vertical longitudinal section of a portion of the tube or tunnel A and abutment-wall B. Figs. 2 and 3 are transverse sections of the tube or tunnel A, showing the arrangement of the guys or tension-braces and the position of the cribs of timber and stone. Fig. 4 is an enlarged transverse section of the tube A on the line *h*, Fig. 1, showing the curved flanges F of the sheets *s* and a section of the protection-shield *p*. Fig. 5, (same scale as Fig. 4,) is a longitudinal elevation of a section of the tube A between the dotted lines *h* and *u*, Fig. 1, showing the exterior of the combined sheets *s* and annular ribs F, also the expansion-rings E. The dotted lines show the position of the protection-shield *p* when a sheet, *s*, is to be removed or changed. Fig. 6 (scale still more enlarged) is a portion of a transverse section of the tube A at *u*, Fig. 1, showing how the sheets *s* are united. Fig. 7 (same scale as Fig. 6) is a portion of a longitudinal section of the tube A, showing how the sheets *s* and ribs F are united. Fig. 8 (same scale as Fig. 7) is a similar section to Fig. 7, but through an expansion-ring, E, showing the manner of bolting and the freedom of the sections to expand in the direction of the arrows *m m*. Fig. 9 (scale intermediate between Figs. 5 and 6) is a plan of one of the sheets *s*, seen from the center of the tube A. *f i* are the flanges. Figs. 10 and 11 are edge views of the sheet *s*, (seen in the direction of the arrows *o n*, Fig. 9.) The dotted lines show transverse sections and exhibit comparatively the thickness of the sheet and flanges. Fig. 12 (same scale as Fig. 6) is an elevation of one of the segments of the annular ribs F, seen in the direction of the axis of the tube A, showing the oblique joints of the segments F and the manner of getting this obliquity.

Similar letters refer to similar parts throughout these drawings.

To enable those skilled in the art to construct such a tunnel, I will give a detailed description.

It is assumed that it is a navigable river which is to be crossed, and the tunnel sunk to such a depth as not to interfere with navigation. Abutments and entrances are built on each bank of said river, in which the tube or tunnel terminates. A portion of such an abutment-wall and entrance is shown at B, Fig. 1. As the entrances I use differ in no essential manner from those used for the ordinary subaqueous tunnel, (except they are made to securely inclose the end of said tube or tunnel in such a manner as to prevent any water from flowing between the abutment-wall B and tube A,) they need no further description.

The above-mentioned cribs of timber and stone for securely holding said tube or tunnel A in position are placed and arranged according to the depth of water through which the tunnel is to pass. If the water is shoal, the cribs are placed on each side of the tube or tunnel, as shown in Fig. 3. If the water is deeper—from sixty to one hundred feet—a single crib is used, as shown in Fig. 2. If the water should be quite deep—one hundred feet or more—two rows of cribs are used, arranged somewhat as shown in Fig. 3; but the distance between the cribs should increase with and in proportion to the depth of water. The great tube which serves for a tunnel is made of steel or other metal, and is composed of parts securely bolted together. These parts, which are duplicates in kind, considered in detail, consist, first, of flanged sheets, (shown at *s*, Figs. 5 and 9;) second, of annular ribs, (shown at F, Figs. 5, 7, and 12;) third, of expansion-rings, (shown at E, Figs. 5 and 8.) The flanged sheets *s* are curved to the form of the tube A, and are of such extent of arc that a given number united will form a section of said tube, said section being at right angles to the axis. No especial number of sheets are essential to form a section, except there cannot be less than three. A plan of a sheet is shown at Fig. 9, and edge views at Figs. 10 and 11. The flanges *f i* are erected on the concave side and perforated for bolts, as shown at *v v'*, Figs. 10 and 11. The straight flanges *i i* run parallel to the axis of the tube A. The curved flanges *f f* run around the tube A at right angles to its axis; but the face of such flanges *f* is not at right angles to the axis of said tube A, but oblique, as shown at Fig. 7. The angle made by the face of the flange *f* to the axis of the tube A is not fixed by any rule, but should be such as will readily admit of the removal of the sheet *s* outward when the bolts *k b* are removed.

The annular ribs F are made in segments to embrace the same arc as the sheets *s*. Said ribs are **V**-shaped in a section on a plane to the axis of the tube A, the apex of the **V** coming flush with the outer surface of the sheets *s*, as shown in Figs. 5 and 7. The depth of the ribs F, measured on a radial line, should be the same as the curved flanges *f*. These annular ribs F can be either solid or channeled, as shown; or they could even be extended until they presented as much exterior surface as the sheets *s*. They would then present two flanges and have to be bolted, as shown, for the expansion-rings. These segments F meet end to end, but not on a radial line. The joint is oblique, as shown at *a*, Figs. 4 and 12. The object of this oblique joining is to permit the ribs F to be taken out on the inside of the tube A after the bolts *k* are withdrawn. At *a' y*, Fig. 12, is shown the line on which the annular segments join. If the line *a y'* is shorter than *a a'*, the segment F can be turned on *a* as a center, and removed inside the tube A. As the sheets *s* and annular ribs F form, when united in their proper order, the bulk of the tube, it will now be supposed that enough of these parts will be put together to explain the manner and order of combination. Two sheets are united (to form double their arc) by bolting their straight flanges *i* together. This process is repeated until a section of the tube A is produced, as shown at Fig. 4. Let this last-described process be repeated until another section of the tube A is produced. These sections are now placed end to end on the line of their axes, but a space left intervening equal to the thickness of the annular ribs F. The joints between the straight flanges *i i* should come in line, as shown in Fig. 5, the annular ribs F breaking joints with the sheets *s*. The two sections of the tube A should now be bolted together, as shown in Fig. 7.

The tube A is constructed, as above described, in sections of, say, one hundred feet in length, when it will be necessary to introduce an expansion-ring, E, to counteract the effects of heat and cold. The expansion-rings E are identical in construction with the annular ribs F, except that they are made deeper (measured on a radial line) and extend outward beyond the exterior surface of the tube A, and also in having each leg of the **V** bolted separately to each of the two sections of tube A, united by the expansion-ring E, thus admitting of expansion or contraction of the tube A in the direction of the arrows *m m*, Fig. 8. The expansion-rings E are divided into segments, and meet at oblique joints the same as the annular ribs F.

At *p*, Figs. 4 and 5, is shown a shield made of metal or other suitable material, and of such shape as shall conform to the exterior of the tube A, and cover so much of the surface that when said shield *p* is properly placed and the water pumped from the space *e* any piece of said tube A can be removed and changed, said shield to be provided with rubber packing where it comes in contact with the tube, and have man-hole Q and such other appliances as may be needed.

It is unnecessary to describe any method for putting the tube A into place or position, as any skillful engineer would soon devise means to do this, as well as to determine the size and position of the anchoring-cribs L.

The remaining feature of this invention to be noticed is the manner of arranging the guys or tension-braces P R for holding the tube A in position.

Fig. 2 shows a vertical section of the tube A, and the double arrangement of the guys or tension-braces. These guys or tension-braces are made of iron or other suitable material, and are arranged as follows: The guy or tension-brace R starts from D, Fig. 2, goes more than half-way around the tube A, and returns to D, as the guy or tension-brace R'. The same arrangement and order apply to the guy or tension-brace P. This peculiar arrangement of the guys or tension-braces is to protect the tube A from the effects of tides and currents.

Attention is invited to three points in this invention: first, to the beveled flanging of the sheets *s*, and the corresponding shape of the annular ribs F, to facilitate change and repair; second, to the oblique joints in the annular ribs F, which permit their being removed on the inside of the tube A; third, to the system of double guys and tension-braces so arranged as to protect the tunnel from lateral motion and torsion produced by currents.

I am aware of the English patent of Edward Cowan, November 9, 1861, and of the American or United States patents of R. Foley, July 23, 1867, and of Henry Anderson, September 17, 1872, and disclaim any similarity of construction; nor do I claim the buoyant tube or tunnel, except when constructed substantially as described. Neither do I claim anchors and cables in a broad sense; but

What I do claim, and wish to secure by Letters Patent, is—

1. The buoyant tube A for a subaqueous tunnel or thoroughfare, when constructed as herein described, together with the double loop or double system of tension-braces, in which a guy or tension-brace starts from its point of attachment to the anchoring-cribs of timber and stone, and, passing around said tube A, returns to the same point of attachment, substantially as set forth.

2. The combination, in a buoyant tube for a subaqueous tunnel, of the flanged sheets and annular ribs in segments, the flanges of said sheets forming oblique joints with said ribs, and the annular ribs meeting at oblique joints, substantially as described.

3. In the construction of buoyant subaqueous tunnels, plates having beveled flanges to adapt them to be readily applied and removed in repair, substantially as described.

4. A buoyant subaqueous tunnel composed of plates and means, substantially as set forth, whereby any part can be taken out and changed while said tunnel is in actual use as a thoroughfare, all combined and constructed substantially as described.

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Witnesses:

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