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PATENTED JAN. 1, 1907.

R. H. KEAYS.

TUNNEL AND METHOD OF CONSTRUCTING THE SAME.

APPLICATION FILED OCT. 28, 1905.

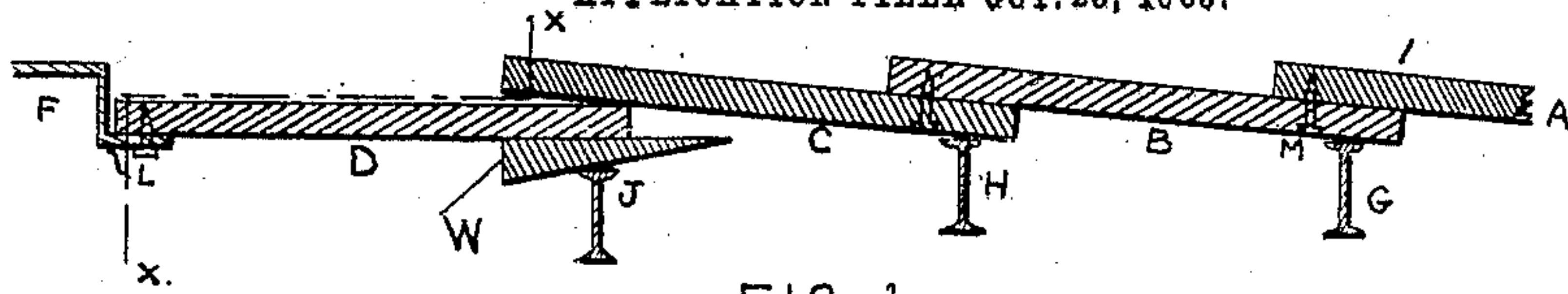


FIG 1

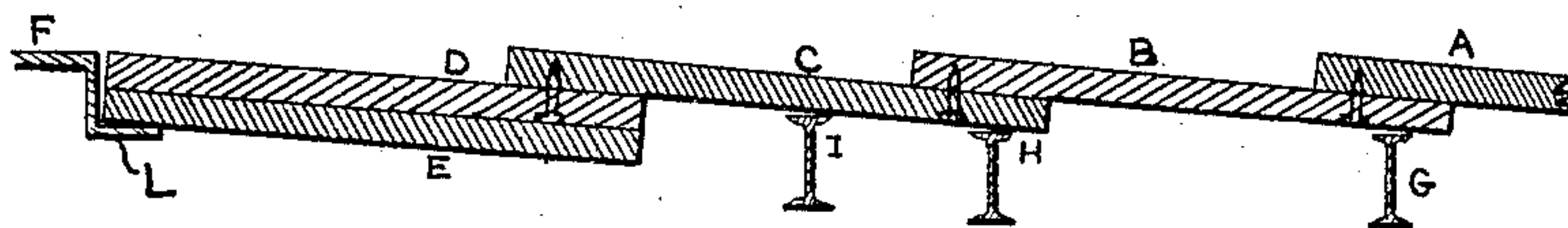


FIG 2

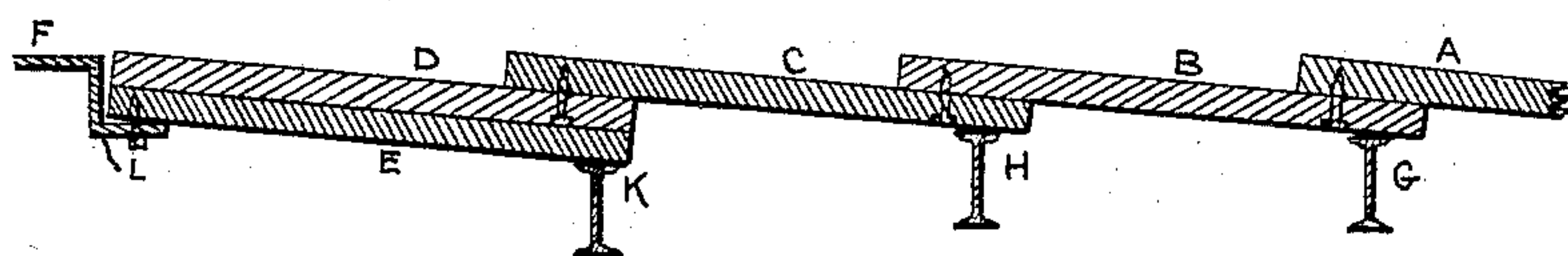


FIG 3

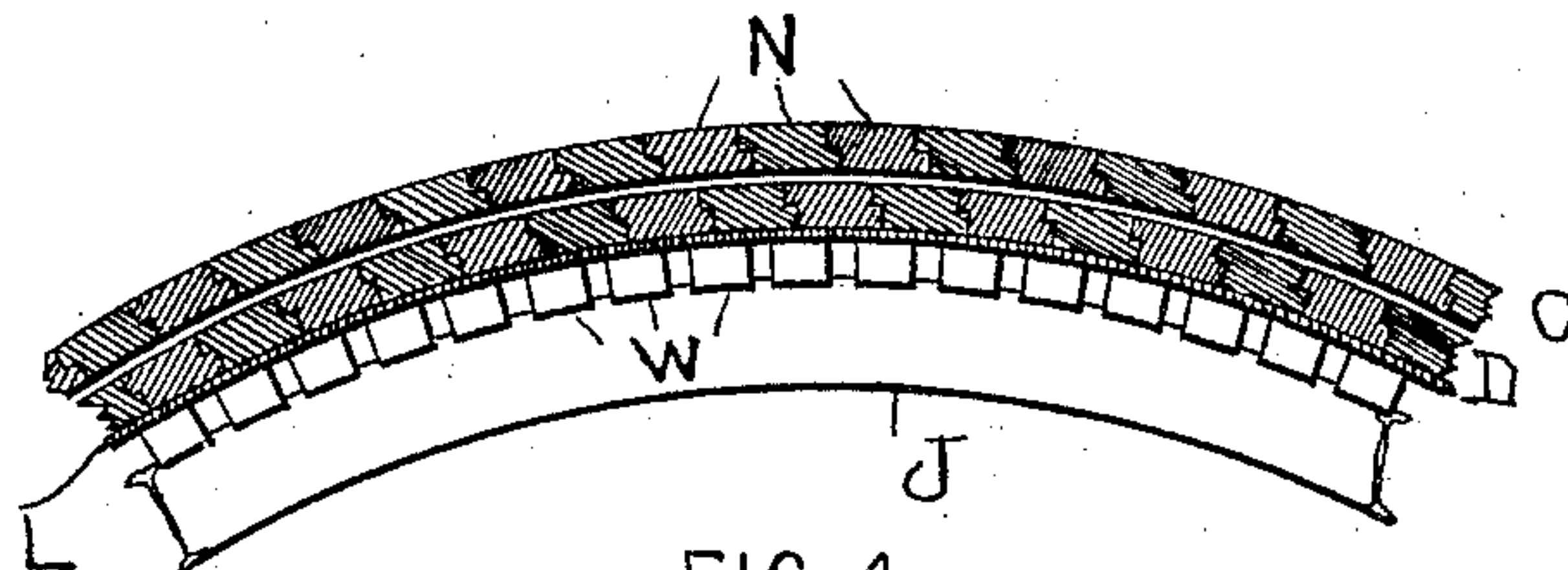


FIG 4

WITNESSES:

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TUNNEL AND METHOD OF CONSTRUCTING THE SAME.

No. 839,856.

Specification of Letters Patent.

Patented Jan. 1, 1907.

Application filed October 28, 1905. Serial No. 284,825.

To all whom it may concern:

Be it known that I, REGINALD HORTON KEAYS, a citizen of the United States, and a resident of the city of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Tunnels and Methods of Constructing the Same, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to tunnels and methods of constructing the same, and particularly to tunnels in the construction of which the shield system is used.

The object of my invention is to provide a tunnel made up of successive rings of permanent lagging, each ring lapping upon the one in front of it. Each stave in the rings of lagging is made to fit into the adjacent stave by means of a tenon-and-groove construction. The several rings of permanent lagging are braced on the inside, preferably by steel shapes bent to fit the form of the tunnel. The tunnel may be lined with concrete suitably waterproofed and placed according to well-known methods.

In the drawings illustrating the principle of my invention and the best mode now known to me of applying that principle, Figures 1, 2, and 3 are longitudinal sectional views showing successive stages in the construction of a tunnel according to my new method, and Fig. 4 is a sectional view on the line *x x* of Fig. 1.

Heretofore, so far as known to me, it has been the common practice in constructing tunnels by the shield system to build up in the tail or rear end of the shield a ring made up of segmental cast-iron plates flanged at the ends and sides and secured together by bolts passing through the flanges, the faces of which are machined to insure a close fit. The shield is advanced by means of hydraulic rams interposed between the shield and the ring last erected, which of course is entirely free from any connection with the shield. The shield keeps the surrounding material from the rings during the process of erection, and as its diameter is necessarily somewhat greater than that of the rings in the advance of the shield a space is left between the tunnel and the surrounding material, which it is necessary to fill in some way.

Referring now to Fig. 1, (which illustrates a "shove" nearing completion,) the rings A and B of permanent lagging are shown in

permanent position supported by the permanent curved I-beams G and H, the front end of the ring A overlapping the rear end of the ring B. The rear end of the shield F is bent inwardly and then rearwardly to form the shelf L, to which the ring D of permanent lagging is secured, preferably by lag-screws, as shown. The ring C of permanent lagging placed during the last shove is supported upon the rear of the ring D, which in turn rests upon wedges W, interposed between the ring D and the temporary curved I-beam J. Between the I-beam H and the I-beam G short struts are placed, and similar struts are placed from the I-beam G to the I-beam next in rear, and so on until firm backing is reached. Hydraulic rams are interposed between the shield and the I-beam H, and the operation of these hydraulic rams serves to push the shield forward. As the shield advances the wedges W are forced in, thereby maintaining the front end of the ring C at the diameter of the tunnel and keeping the rings C and D in contact. The shove having been completed, the rear end of the ring D is secured to the front end of the ring C, preferably by lag-screws, if the lagging is composed of wood. The wedges W and the I-beam J are removed, and the temporary I-beam I is erected about midway of the ring C to support the latter. The front end of the ring D is then detached from the shelf L and is pressed outwardly by mechanical means—such as levers, wedges, screw-jacks, or the like—and in this way room is made for the insertion of the next ring E of lagging, Fig. 2. As the lagging D is detached from the shelf and forced outwardly the lagging E is inserted and secured in place upon the shelf L. A temporary I-beam K is placed under the rear end of the ring E of lagging, and the temporary I-beam I is removed, Fig. 3. Power is then applied to the shield and a new shove is made. As the shove nears completion the ring E of lagging will assume toward the ring D the same relative position as the ring D is shown to have in Fig. 1 relatively to the ring C. A complete cycle of operations has now been described, and it will be understood by all skilled in this art that successive rings to form the outer shell members of a completed tunnel may be positioned by merely repeating the cycle described. It will be further evident to all skilled in this art that my invention is not limited to the positioning of lagging members, but that rings of metal or

other suitable shapes adapted to form the outer shell members of a completed tunnel may be by the same method placed in position.

5 As is clearly shown in Fig. 4, the several staves N of which the rings of lagging are composed overlap each other to form the close compact structure commonly called "ship-lap." The outer diameter of the
10 shield is substantially the same as that of the tunnel, and in my new method of tunnel construction hereinbefore described the need which exists in the shield method heretofore commonly used of filling in the annular open
15 space left between the outside of the outer shell members and the surrounding material is avoided.

So far as known to me, I am the first to construct a tunnel by causing the shield in its
20 advance to pull into place the members designed to form the outer shell of the completed tunnel.

What I claim is—

1. A step in the method of constructing a
25 tunnel which consists in securing an outer shell member to a shield and positioning the same by advancing the shield.

2. The method of constructing a tunnel which consists in attaching an outer shell
30 member to a shield; advancing the shield and thereby drawing said member into place; detaching said member from the shield; attaching another outer shell member thereto; and advancing the shield and thereby drawing
35 the said other member into place

3. The method of constructing a tunnel which consists in attaching a series of lagging to a shield; advancing the shield and thereby drawing said lagging into place; detaching
40 said lagging from the shield; attaching a new series of lagging to said shield; advancing said shield and thereby drawing said new series of lagging into place beneath the first-named series of lagging; and supporting said
45 lagging by suitable bracing.

4. The method of constructing a tunnel which consists in attaching an outer shell member to a shield and positioning the same by advancing the shield; detaching said
50 member from the shield and attaching another outer shell member thereto within the first-named member; again advancing the shield to position said other member within the first-named member; and maintaining
55 the front end of said first-named member at substantially the diameter of the tunnel during the movement of said other member.

5. The method of constructing a tunnel which consists in attaching an outer shell

member to a shield and positioning the same
60 by advancing the shield; detaching said member from the shield and attaching another outer shell member thereto within the first-named member; again advancing the shield to position said other member within
65 the first-named member; and wedging the front end of said first-named member out during the movement of said other member.

6. The method of constructing a tunnel which consists in attaching an outer shell
70 member to a shield and positioning the same by advancing the shield; detaching said member from the shield and attaching another outer shell member thereto within the first-named member; again advancing the
75 shield to position said other member within the first-named member; and suitably supporting said members during the movement of the shield.

7. The method of constructing a tunnel
80 which consists in attaching an outer shell member to a shield; advancing the shield to position said member; and suitably bracing said member when so positioned.

8. A tunnel made up of successive series of
85 lagging; the lagging being interlocked along their longitudinal edges and the rear end of one series projecting rearwardly within the front end of the series next in rear; said front end resting directly on said rear end; and
90 suitable braces for said ends.

9. A tunnel made up of successive rings of overlapping lagging, said rings permanently positioned and secured together; and suitable braces for said lagging.
95

10. A tunnel made up of successive rings permanently positioned to form outer shell members, successive rings overlapping each other and being secured together; and suitable braces for said rings.
100

11. A tunnel made up of successive rings of permanently-positioned outer shell members interlocking along their longitudinal edges and having their front ends resting directly upon the rear ends of the ring next in
105 front.

12. A tunnel made up of successive rings of permanently-positioned outer shell members having their front ends resting directly upon the rear ends of the ring next in front
110 and secured thereto.

In testimony whereof I hereunto set my hand, in the presence of two witnesses, this 26th day of October, 1905.

REGINALD HORTON KEAYS.

Witnesses:

JANET H. KEAYS,

JESSIE H. WILLARD.