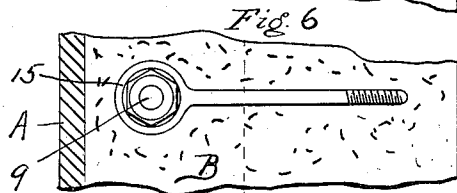
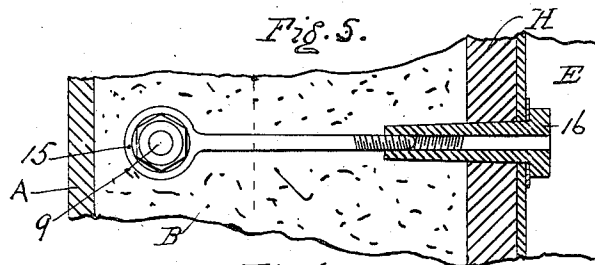
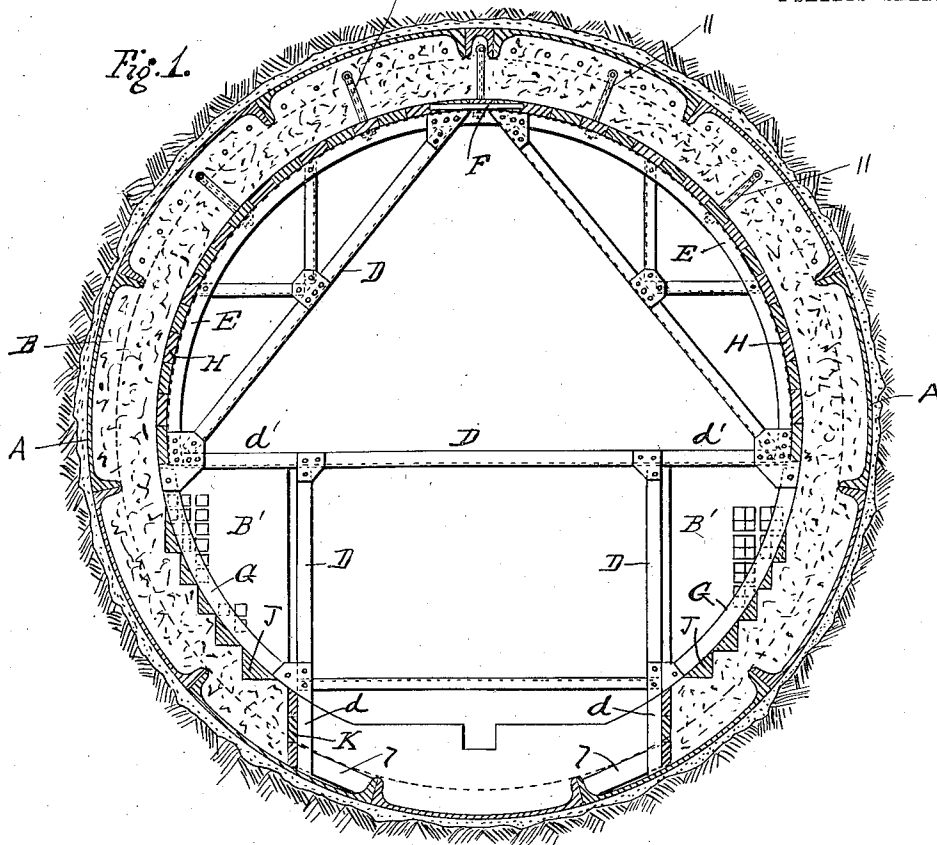


E. W. MOIR.  
MEANS FOR LINING TUNNELS.

APPLICATION FILED JULY 6, 1906.

2 SHEETS—SHEET 1.



WITNESSES:

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2 SHEETS—SHEET 2.

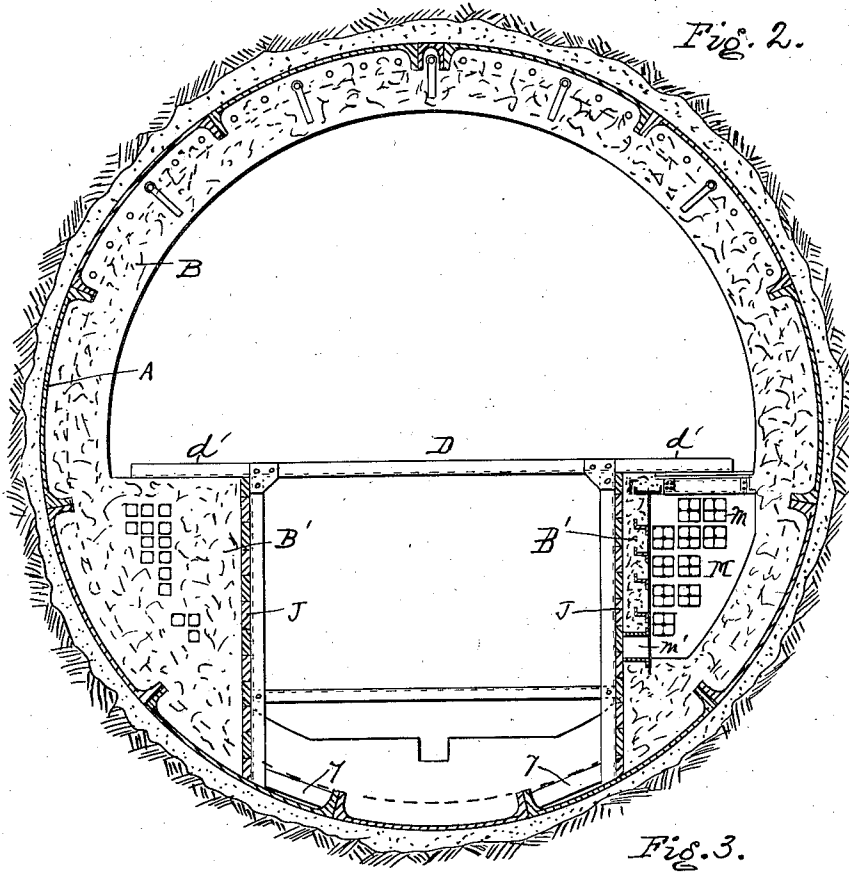


Fig. 2.

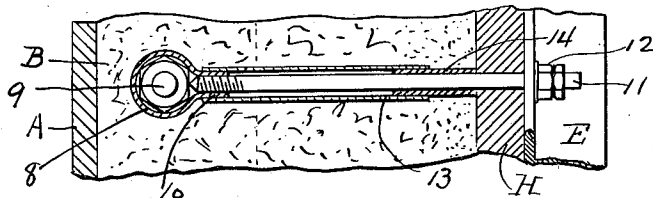


Fig. 3.

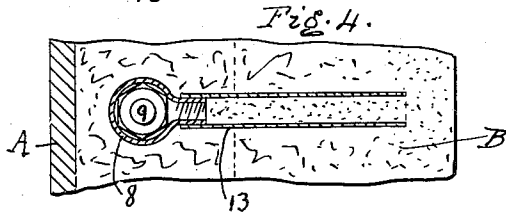


Fig. 4.

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# UNITED STATES PATENT OFFICE.

ERNEST W. MOIR, OF LONDON, ENGLAND, ASSIGNOR TO S. PEARSON & SON, INC., OF LONG ISLAND CITY, NEW YORK, A CORPORATION OF NEW YORK.

## MEANS FOR LINING TUNNELS.

No. 852,891.

Specification of Letters Patent.

Patented May 7, 1907.

Application filed July 6, 1906. Serial No. 325,008.

*To all whom it may concern:*

Be it known that I, ERNEST W. MOIR, a subject of the King of Great Britain and Ireland, residing in the city of London, England, have invented certain new and Improved Means for Lining Tunnels, of which the following is a full, clear, and exact specification.

The object of my invention is to provide a convenient means for lining tunnels with concrete, cement, or other masonry or brick quickly and accurately. This object I attain by the means which I will now describe.

In the accompanying drawings Figure 1 is a transverse section of a tunnel showing my lining means in place for one part of the operation; Fig. 2 is a transverse section showing another part of the operation; Fig. 3 is a sectional view drawn to an enlarged scale showing the detailed construction of one of the hangers, with the lagging in place; Fig. 4 is a corresponding view, after the lagging has been removed; and Figs. 5 and 6 are views corresponding to Figs. 3 and 4, but of a modification.

My invention is mainly intended for use in connection with tubular tunnels which are built up of flanged iron or steel segments bolted together to form a tube, and in these drawings I have shown my invention applied to the lining of a tunnel of that character with concrete, cement, or the like.

A, A, are the flanged segments of iron or steel bolted together in the usual manner, and B represents the concrete lining. In the present instance I have shown the upper half of the tunnel as provided with a concrete lining of uniform depth or thickness, that is to say, with its inner wall concentric with the metal tube, but this need not be the case. The lower half of the tunnel is shown as provided with banquettes B<sup>1</sup>, in which may be embedded tubes or conduits for electric wires, etc., while on the bottom between the banquettes may be laid the tracks for the cars. The banquettes need not of necessity be there, however.

I provide rectangular frames D, each of angle iron or other suitable material, of a width slightly less than the desired width between the banquettes and each frame has extension feet *d*, *d*, to rest on the bottom wall of the tunnel, and be braced by filler blocks 7, 7, between the feet and the adjacent

flanges of the segments. Each frame has laterally extending arms *d*<sup>1</sup>, *d*<sup>1</sup>, which may be in one with the top bar of the frame, and to the ends of these arms are bolted the ends of two braced arches, or other curved ribs E, E, which are above the frame D and are to be coupled together by a suitable junction piece F at the top, to make one complete arch somewhat over half a circle in length and reaching from one arm *d*<sup>1</sup> to the other. Below the arches E, E, are curved or straight ribs G made of angles or other suitable sections, these ribs G uniting the extremities of the arms *d*<sup>1</sup>, *d*<sup>1</sup>, to the lower corners of the frame D. Two or more such frameworks of angle iron are provided and mounted within the tunnel at a suitable distance apart, to support suitable longitudinal lagging H placed over the arches E, E, lagging bars J placed back of the bars G, and lagging K placed back of the legs *d*, *d*, all as shown in Fig. 1. The bars J are made of angular or any section. I have shown them angular so as to form steps in the adjacent concrete, the better to support the concrete afterward put in to form the banquettes. To support these frames and the lagging, I provide hanging bolts 11, which are secured to the flanges of the upper segments of the tunnel tube. These bolt connections pass through the lagging and the angle irons of the arches and are secured thereto by nuts or wedges in slots or by other means.

In the form of hanger shown in Figs. 3 and 4, there is a collar 8 which fits over the head 9 of a bolt secured to the segment flange, and it has an internally threaded nipple 10 to receive the threaded end of a bolt 11, whose opposite end extends through the lagging and through a hole in the flange of the angle iron of the arch E, and may be secured by nuts 12. The bolt 11 may be covered by a tube 13, which is fitted at one end over the nipple 10 and has its other end closed by a wooden plug 14, Fig. 3.

After the lagging has been put in place, as shown in Fig. 1, the concrete is put in back of the lagging, as illustrated, and for the full length of the lagging. When the concrete has set, the arches E, E, and bars G, and the lagging H and J, are all taken out, and lagging is put back of the upright members of the frame D, as shown in Fig. 2, so that the concrete banquettes B<sup>1</sup> may then be formed.

At the right of Fig. 2, I have shown a man hole at M to get at the wire conduits *m*, with an outlet *m'* to the central space for the tracks. After the concrete banquettes have thus been made, the frames; D, D, and filler pieces *d* are removed, and concrete is laid on the bottom of the tunnel. At a suitable point, in taking down or after taking down the arches E, E, and removal of the bolts 11, the holes left may be filled by grouting or other means as indicated in Fig. 4.

In the modified form of hanger shown in Figs. 5 and 6, there is an eye-bolt 15 secured back of the bolt head or nut 9 of the tunnel segment. The opposite threaded end of this bolt 15, receives the internally threaded neck of a long nut 16, which may be tapered and which passes through the flange of the frame work E, Fig. 5. As shown in Fig. 6, the bolt 15 is left embedded in the concrete, as were the collar, nipple and tube in the construction, Figs. 3 and 4.

I claim as my invention

1. The combination of a tunnel composed of flanged segments with a supporting frame for lagging for use in lining the tunnel and detachable means for hanging the frame from the flanges of the tunnel segments.

2. The combination of a tunnel composed of flanged segments with detachable arch frames to support the lagging for use in lining the tunnel and detachable means for hanging the frames from the flanges of the tunnel segments.

3. The combination of a tunnel with a rectangular underframe having laterally projecting arms and an arched upper frame to support the lagging for use in lining the tunnel and bolts to hang the arched frame from the tunnel segments.

4. The combination of a tunnel with an arched frame to support lagging for use in lining the tunnel with concrete, and bolt and nut connections to hang the arched frame from the tunnel segments, parts of the connections which extend into the concrete being removable and the other parts being adapted to be left embedded in the concrete.

5. The combination of a tunnel built of flanged segments with a rectangular lower frame of angle iron, and a two-part upper arched frame also of angle iron to be bolted to the lower frame to support lagging, and bolt connections to hang the arched frame from the flanges of the tunnel segments.

6. The combination of a tunnel with a frame, arched at its upper part to support lagging; and curved bars at its lower part with lagging of angular cross-section back of the curved bars to form steps in the concrete lining.

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

ERNEST W. MOIR.

Witnesses:

ARTHUR WOODROFFE MANTON,  
W. I. SEIG.