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J. S. MACDONALD

1,866,416

APPARATUS FOR AND METHOD OF FORMING A TUNNEL

Filed Nov. 15, 1928

Fig. 1.

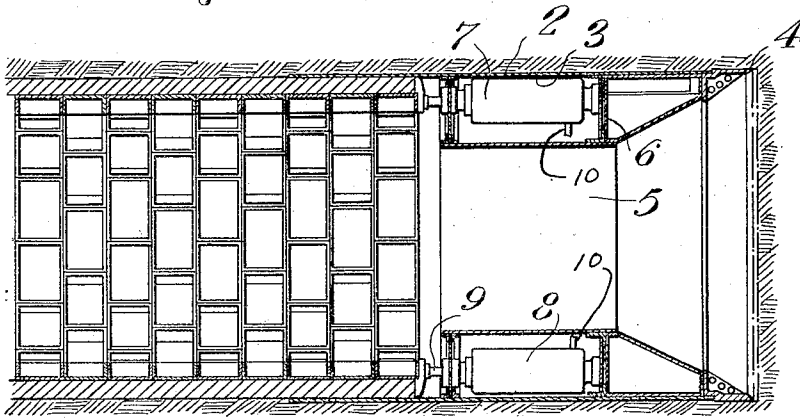


Fig. 2.

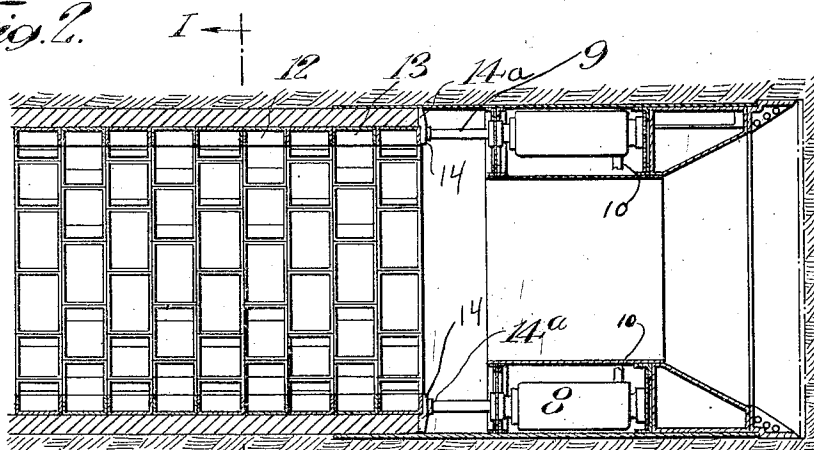


Fig. 3.

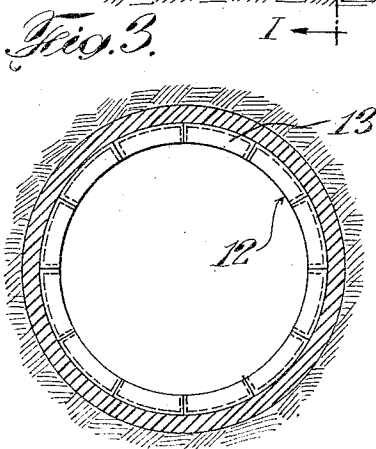


Fig. 4.

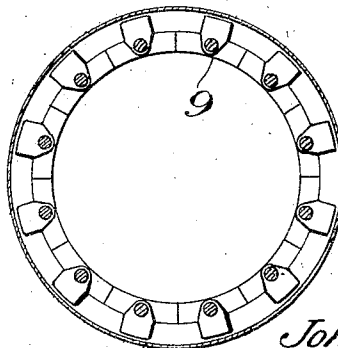
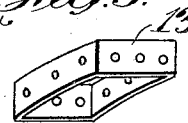


Fig. 5.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR AND METHOD OF FORMING A TUNNEL

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My invention relates to a method and apparatus for constructing concrete tunnels and will be understood from the following description read in conjunction with the drawing, in which:

Fig. 1 is a longitudinal section through a preferred embodiment of my invention employed in conjunction with a tunnel undergoing construction;

Fig. 2 corresponds to Fig. 1, except that the shield by which the tunnel is projected is shown as it appears after an advance;

Fig. 3 is a cross section of Figs. 1 and 2 on the plane denoted by I—I;

Fig. 4 is a rear view of a part of Figs. 1 and 2; and

Fig. 5 is a perspective view of a part of Fig. 1.

My invention refers to the construction of tunnels composed principally of concrete. Such tunnels are built up by advancing a shield in the path of the projected tunnel and casting the concrete tunnel in progressive sections in the path of the shield. In Fig. 1 I have illustrated a tunnel of this type. The tunnel is projected by means of the shield 2 which consists of an outer sleeve 3, advancing edge or cutting bit 4 of annular form, the inner sleeve 5 and support 6 for the shield advancing means. The shield advancing means may be of any form but preferably comprises a series 7 of jacks operated by a fluid such as air or water. These jacks may conveniently be of the piston type comprising cylinders 8 having pistons internal thereto rigidly secured to shafts, such as 9, adapted to be projected by the introduction of a fluid under pressure to the cylinders by means of inlets 10. In Fig. 2 the jacks are shown at the termination of an advance with the shafts 9 in extended position. It will, of course, be understood that the earth may be cut away in advance of the shield in the conventional manner and that any earth loosened by the bit or cut away in advance of the shield may be continuously or periodically removed by any suitable means. In constructing the tunnel I employ a form having an exterior corresponding to the interior of the projected tunnel. The outer sleeve

of the shield 2 and the bit 4 are preferably of a diameter substantially equal to the outside diameter of the finished tunnel. The form 12 may be of any desired type but preferably consists of a number of arcuate sections 13 having internally projecting flanges by which the individual sections may be joined to other sections to make up the assembled form. The shield advancing means is provided with feet 14 adapted to bear directly upon the assembled form 12 so that the shield may be advanced utilizing the assembled form as an abutment, thereby rendering it possible to expedite the work and advance the shield independently of the time of setting of the concrete. It will, of course, be understood that I leave a sufficient length of the assembled form in the constructed portion of the tunnel in which the concrete is set so that the resistance of the form to longitudinal slip is sufficient to permit it to serve as an abutment for this purpose without substantial movement relative to the tunnel. After each advance of the shield the shafts 9 and attached feet 14 are retracted and the form 12 is built up and advanced to a point adjacent the new position of the shield. I may make successive advances of the shield in this manner independently of the method of placing the concrete or place concrete in the annular space surrounding the advanced form 12 prior to each succeeding advance of the shield. I preferably, however, make a number of advances of the shield and after each advance extend the form to a point adjacent the shield to serve as an abutment for each succeeding advance, and after having made a number of advances of the shield and extensions of the form in this manner place concrete in the annular space surrounding the extended form. I may also utilize the shield advancing means to compress the unset concrete. For this purpose the feet 14 which engage the form 12 are provided with externally projecting portions 14a which may engage planks or plates or any other means for distributing a load onto the unset concrete at the advancing edge of the tunnel.

By placing planks or plates in position with respect to the feet 14 prior to an advance

of the shield these planks or plates are forced against the unset concrete and operate to compress the unset concrete and force it into the space left vacant by the advance of the outer sleeve 3 or any other holes, cavities or soft spots which may exist in the surrounding stratum, and thereby effectually prevent subsidence of the earth above the tunnel. This also furnishes an effective means for tamping the concrete and imparting homogeneity and high strength thereto. It will, of course, be understood that the projecting portions 14a may be made so wide as to distribute the compressive load onto the unset concrete without the use of planks or plates for this purpose. It will also be understood that after each advance of the shield, or at any time thereafter, I may remove sections of the form remote from the advancing edge and, if desired, may bring these sections forward and utilize them at the advancing edge to extend the form 12.

It will be understood that the specific embodiment of my invention hereinabove described is by way of illustration and not of limitation. It is my intention that the invention be limited only by the appended claims in which I have endeavored to claim broadly all inherent novelty.

I claim:

1. The method of constructing a concrete tunnel which comprises forming a tunnel and advancing a shield having a tail portion, successively placing in the tunnel rearwardly of the shield and in contacting relation to each other sections of a sectional form having the contour of the tunnel and of dimensions to provide a space between the outer walls of the form and the inner walls of the tunnel and the tail portion of the shield, placing concrete in the said space, advancing the shield by means which simultaneously engage the forward edge of the form and the concrete and, through the advancing means, applying pressure simultaneously to the concrete, to the form and to the shield, whereby the concrete is compressed and forced into the space left by the tail of the advancing shield and also into other cavities existing in the surrounding stratum simultaneously with the advancing of the sleeve and its tail portion.

2. An apparatus for constructing concrete tunnels comprising an advancing shield, an assembled form consisting of a number of sections contacting with each other at their margins, said form being of lesser outside radial dimensions than the shield so as to leave a space between the walls of the form and the walls of the tunnel to receive concrete, and means bearing against the shield for advancing it and having abutments to bear against the forward edge of the form, said abutments having offset portions overlapping the entire space between the form and the

tunnel, whereby pressure may be exerted simultaneously on the shield to advance it, and on the form and on concrete within the said space to compress it and force it into cavities in the tunnel wall.

In testimony whereof, I have signed my name to this specification this 2nd day of November, 1928.

JOHN S. MACDONALD.