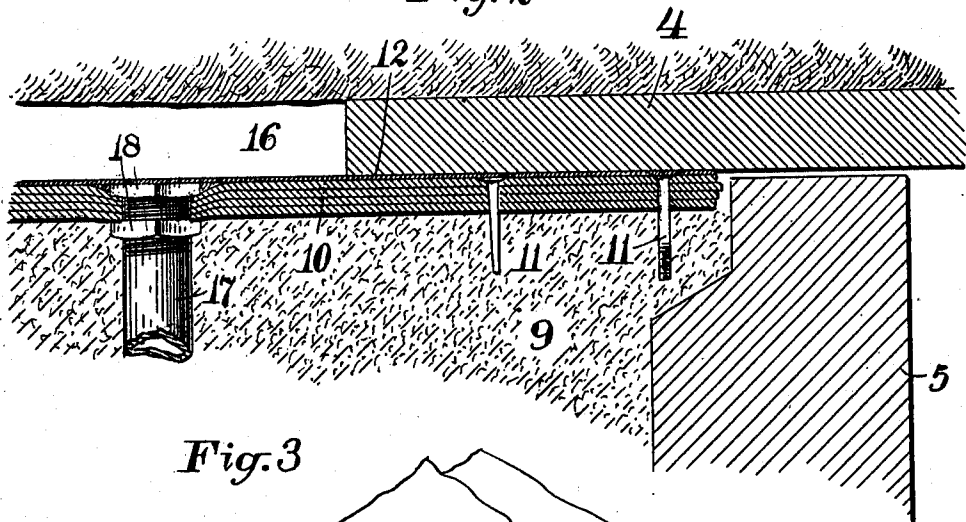
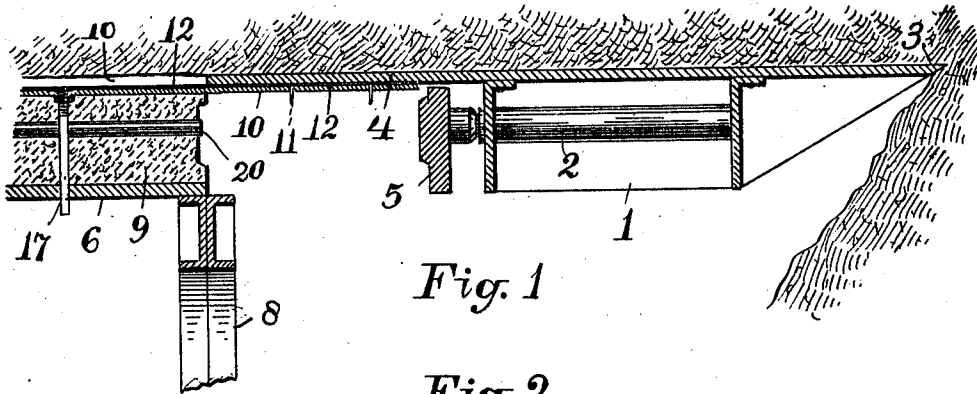


H. A. CARSON.
PROCESS OF WATERPROOFING TUNNELS.
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Witnesses,

Margaret L. Waite.
Thomas MacLaffin

Inventor,

Howard A. Carson;

By S. B. Bingham,
Attorney.

UNITED STATES PATENT OFFICE.

HOWARD A. CARSON, OF MALDEN, MASSACHUSETTS.

PROCESS OF WATERPROOFING TUNNELS.

970,683.

Specification of Letters Patent. Patented Sept. 20, 1910.

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To all whom it may concern:

Be it known that I, HOWARD A. CARSON, a citizen of the United States, residing at the city of Malden, in the county of Middlesex and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Processes of Waterproofing Tunnels, of which the following is a specification.

10 This invention relates to tunnels which are constructed beneath the surface of the earth or water by the aid of shields which are forced in advance of the tunnel walls. In tunnels thus formed, the shield supports
15 the earth or other material while a fresh section of the tunnel wall is being put in the rearward section, usually called the tail; after which the shield is advanced another space and the next wall-section is put up.
20 In the case of concrete or other masonry tunnel walls, suitable centering is erected for the retention thereof until the cement is set.

While my invention is applicable to either
25 concrete or other tunnel walls for rendering them water-proof, it is especially adapted for concrete, and the illustrations and description are consequently made to disclose my invention as applied to concrete walls.

30 My invention consists essentially in removably applying a water-proof coating to the inner surface of the shield-tail, in such a manner that the coating will remain in position both before and during the introduction of the soft concrete between the
35 same and the lagging, but will remain fixed to the concrete after the latter has set and while the shield and its tail are being forced forward to provide space for the next succeeding section of tunnel wall.

Referring to the drawings forming part of this specification, Figure 1 is a longitudinal section of a portion of a shield being employed in the excavation of a tunnel, showing
45 the removable water-proof coating applied to the shield-tail. Fig. 2 is a longitudinal section, on a larger scale, showing the tail at an intermediate position during the forward movement of the shield. Fig.
50 3 is a perspective view of the inner surface of a section of shield-tail, showing the water-proof coating affixed thereto. In order to render the details clearer, these drawings are not to scale.

55 The shield illustrated in Fig. 1 comprises a body-portion 1 containing the hydraulic

jacks 2 by which the shield is forcibly advanced; 3 being the cutting edge; 4 the tail, and 5 the dam connected with the plunger of the jack. 6 is the lagging supported by
60 ribs 8, and 9 is the concrete filling most of the space between said lagging and shield-tail. This figure represents the shield after it has been advanced, the plunger retracted, another water-proof coating applied to the
65 tail, and which will, after further centering has been placed, render the parts ready to receive another section of tunnel-wall.

One material which may be employed for the water-proof coating, in earth-tunneling,
70 is tarred paper, or "felting" as it is termed, in layers, such as has been extensively used in water-proofing the exterior of concrete structures built in damp ground; and the means which may be used for temporarily
75 affixing the same to the inner surface of the shield-tail is some substance which, while being nearly or quite water-proof, is also sufficiently adhesive to cause the felting to stick to said tail, and is also sufficiently unctuous to allow the tail to slide over and
80 away from said felting without disturbing the latter; this being necessary when the shield is moved ahead. Some forms of crude paraffin, for instance what is commercially
85 known as wax tailings, have these qualities. Such wax tailings 12 having been applied in a thin coat to the inner surface of the tail 4, or to the exterior surface of the felting 10,
90 the latter can then be pressed firmly against said tail and will remain there during the work of putting in the concrete. When the shield is now forced forward, the felting 10 will in ordinary cases cling to the concrete
95 laid against it, and detach itself from the shield-tail; thus remaining in the place where its water-proof qualities are needed. In some cases, however, the felting becomes
100 more or less detached from the concrete and will be carried along to a greater or less extent with the shield-tail, thereby leaving an imperfect water-proof coating. To guard against this, I prefer to provide for
105 anchoring the felting or other water-proof layer, to the concrete, and for this purpose insert bolts, nails, tacks or other anchors 11 water-tightly through the coating 10, having the same project far enough from the
110 latter to suitably engage the concrete 9, and so insure the retention of the water-proofing on the tunnel walls. Instead of said anchors, portions of the edges of the felting

can be corrugated or folded over, as indicated at 13 in Fig. 3, which folds, by their embedding in the concrete, will hold the felting in place on the walls when the shield-tail is moved forward.

I do not restrict myself to the use of paraffin for removably securing the water-proof coating to the shield-tail, as other slightly adhesive pastes composed in part of asphalt, clay and the like, may be employed for the same purpose. Further, mechanical expedients can be used, as by driving tacks through the felting into wooden plugs embedded in the shield-tail indicated in Fig. 3, where 14 indicates such plugs and 15 the tacks. These tacks can be withdrawn as the concrete is put in and they are no longer needed. I prefer, however, to use an adhesive material, enough of which will remain upon the felting after the shield-tail has been advanced to further increase the water-proof qualities of the felting and to render the overlapping joints of the layers thereof more resistant to the infiltration of moisture.

It may be desired to fill with liquid cement grout the void space 16 outside the tunnel due to the displacement of the tail when the shield moves forward. To this end, grout pipes 17 may be left in the water-proof coating; the same, if sufficiently numerous, serving the purpose of the anchors above referred to. Said pipes as well as said anchors should have substantially water tight joints between themselves and the coating 10. This may be aided for said pipes by means of nuts 18 threaded onto the pipe-ends.

The part 20 shown in Fig. 1 is the iron bar embedded in the concrete for the plunger of the hydraulic jack to react against, as has been done in work under my directions as described on page 38 of the *Third Annual Report of the Boston Transit Commission*; and also in other reports.

What I claim as my invention and for which I desire Letters Patent is as follows, to wit:—

1. The herein described method of water-proofing tunnel walls, which consists in temporarily securing to the inner surface of the tail of a tunnel-shield a water-proof coating, building the wall-section in contact with said coating, and then advancing the shield and leaving said coating in permanent position on said wall-section.

2. The herein described method of water-proofing tunnel walls, which consists in ap-

plying a water-proof coating to the inner surface of the tail of the tunnel-shield, putting a section of concrete wall in contact with said coating, and then advancing the shield and tail and leaving said coating in permanent position on such wall-section.

3. The herein described method of externally coating tunnels, which consists in temporarily securing the desired coating to the inner surface of the tail of the tunnel-shield, building the wall-section in contact with such coating, and then advancing the shield and tail and leaving such coating in place on said tunnel wall.

4. The herein described method of water-proofing tunnel walls, which consists in applying paraffin to a water-proof coating, pressing said paraffined surface against the inner surface of the tail of the tunnel-shield, building the wall-section in contact with such coating, and then advancing the shield and tail and leaving said paraffined coating in place on the wall-section.

5. The herein described method of water-proofing tunnel walls, which consists in adhesively securing a water-proof coating to the inner surface of the tail of a tunnel-shield, building the wall-section in engagement with said coating, and then advancing the shield and leaving said coat in position on the wall-section.

6. The herein described method of water-proofing tunnel walls, which consists in temporarily securing a water-proof coating to the inner surface of the tail of a tunnel-shield, providing such coat with projections, introducing the concrete wall-section in engagement with said projections and coating, and then advancing the shield and leaving said coating in place on the said wall-section.

7. The herein described method of water-proofing tunnel walls, which consists in adhesively securing a water-proof coating to the inner surface of the tail of a tunnel-shield, providing said coating with interiorly extending projections, putting in the wall-forming concrete in engagement with said projections and coating, and then advancing said shield and leaving said coating in place on said wall-section.

In testimony that I claim the foregoing invention, I have hereunto set my hand this 11th day of October, 1909.

HOWARD A. CARSON.

Witnesses:

A. B. UPHAM,

PAUL R. BLACKMUR.