Sept. 24, 1935. D. C. DOIG 2,015,102

TUNNEL LINING

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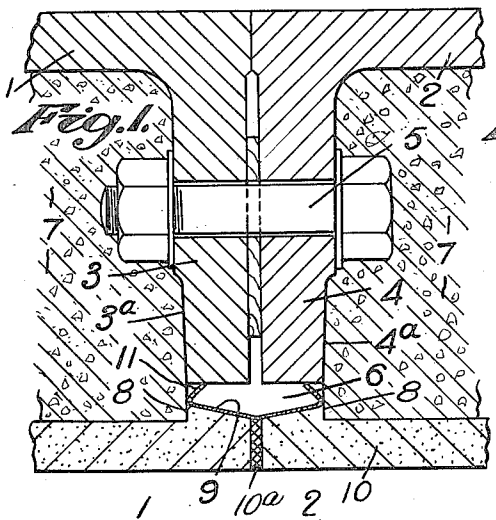

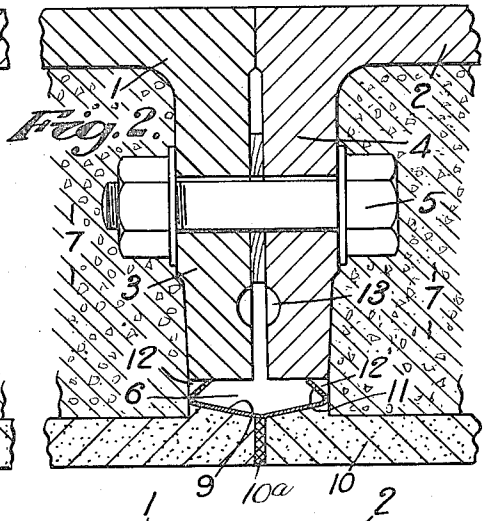

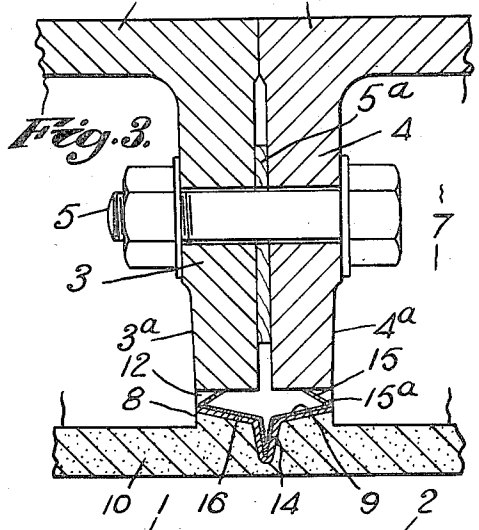

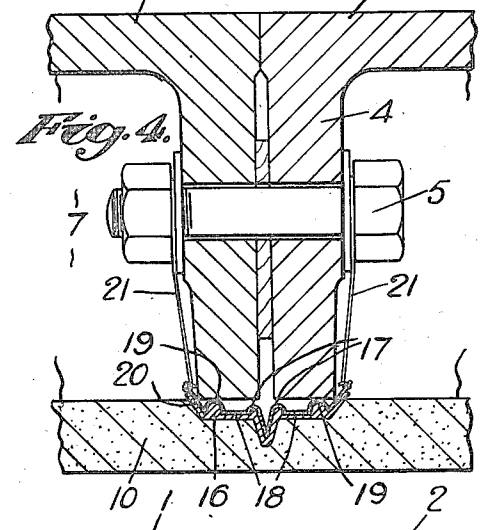

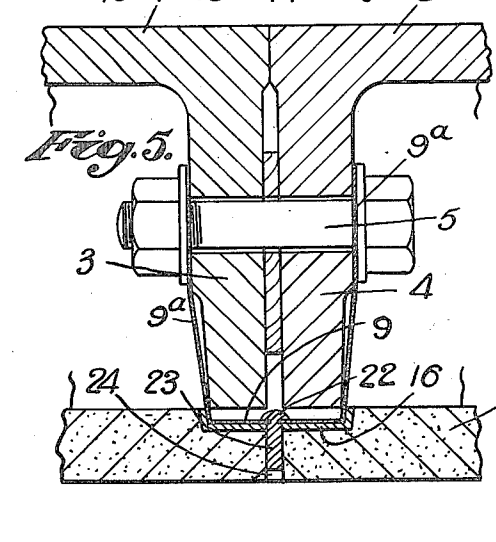

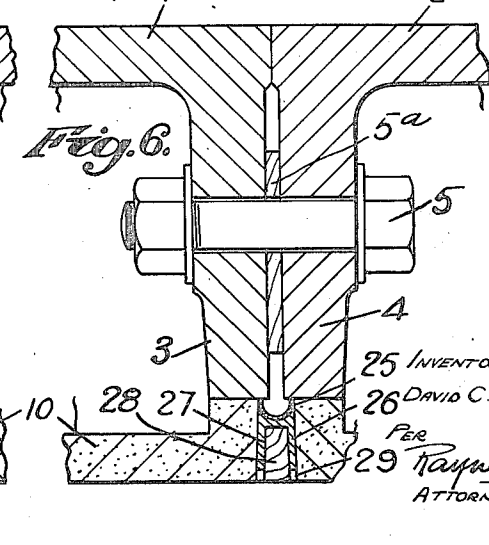

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2,015,102

TUNNEL LINING

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13 Claims. (Cl. 61—45)

This invention relates to improvements in connection with the joints between sections of iron or other tunnelling elements as used for escalators, shaft sinking, tube railways and other tunnels. The elements may be tubular, part tubular or flat or angle plates.

The object of this invention is to provide means for collecting and draining away any leakage which may pass between the joints of the tunnel sections in such a manner as to avoid leakage of moisture into the interior of the tunnel or tunnel lining. This enables the interior of the tunnel or tunnel lining to be maintained in a clean condition and avoids damage to the lining material or surface decoration.

According to the present invention a cavity is provided adjacent to the joint between the tunnel sections and so arranged that any moisture leaking past the joint will enter the cavity and be conducted away to a suitably placed draining channel. An expansion joint of relatively soft resilient waterproofed material is located in the inner lining material of the tunnel substantially parallel to the joints between the tunnel sections so as to avoid cracking or damage to the inner tunnel lining due to movement between the sections. The cavities and expansion joints are arranged substantially parallel to the circumferential and longitudinal joints between the tunnel sections, and the various circumferential and longitudinal channels interconnect with one another and with a draining channel preferably located at the lowest point of the tunnel so that any moisture leaking through the joints between the tunnel sections will be effectively drained away and cannot disfigure or damage the interior lining of the tunnel.

In order that this invention may be clearly understood and readily carried into effect I have appended hereto a sheet of drawings illustrating embodiments thereof and in which six figures are shown all in broken sectional plan taken through abutting flanges of tube or wall elements and showing six different modifications.

Referring to the drawing the tube or wall sections 1 and 2 have abutting flanges 3 and 4 respectively coupled by bolts 5 in known manner to provide the joint. Packing material as indicated at 5a is placed between the flanges 3 and 4. The flanges 3 and 4 may be the internal flanges by which tube sections of underground passages or railways are secured together and in such an arrangement I apply to the interior of the tunnel a layer 7 of concrete or other suitable material in the usual manner, but extend this concrete filling as at 8 to a convenient distance beyond the flanges of the tunnel sections so as to leave a recess or channel 6 therein parallel to and preferably of a width substantially equal to the thickness of the flanges. This may be effected by placing wooden or other strips along the edges of the flanges and then filling in the concrete flush with their surface the strips being subsequently removed when the concrete has set. Into the recesses or channels thus formed a shaped channel member 9 of perforated zinc or other suitable material is inserted. The perforated zinc channel member is placed in position with its open side toward the flanges of the tunnel sections so as to leave a clear space or channel 6 between the edges of the flanges and the base of the perforated zinc or other channel. The interior lining 10 of the tunnel is next applied and may consist of any suitable waterproof rendering or composition applied over the concrete filling and the perforated zinc channels. This inner lining or rendering is preferably divided into sections by means of interposed strips of bituminous packing material 10a or other suitable waterproofed material of a slightly resilient character. These strips serve as expansion joints between the rendering so as to permit a small amount of relative movement between the sections without damaging the interior lining.

The space between the edges of the flanges of the tunnel sections and the interior of the perforated zinc or other channel strips forms a series of cavities 6 extending parallel to the joints between the tunnel sections and in which any moisture leaking through the joints will collect. The circumferential cavities can be interconnected with longitudinal cavities and with a draining channel in the lower part of the tunnel so that all moisture will be collected and drained away thus preventing it from leaking through to the interior of the tunnel or damaging or disfiguring the interior lining 10 thereof. The channel strips 9 of perforated zinc or other suitable material can as shown in Figs. 1 and 2 be formed with a wide V shaped or concave base and with edges 11 inturned towards each other so as to leave spaces 12 between the outer face of the edges and the recess in which the channel strips are fitted. This enables moisture which may leak, past the bolts or other means by which the flanges are secured together, into the concrete filling to pass from the filling into the cavity formed by the channel strips, the inturned parts 11 having perforations for this purpose.

In a modified arrangement as shown in Fig. 2

more particularly intended for use in connection with new tunnelling or tunnel sections constructed especially for use with my invention, the draining cavity may be formed directly in or between the flanges of the tunnel sections by means of recesses 13 in the meeting faces of the flanges which may be cast or otherwise formed therein. These are so arranged that the recesses in the two meeting flanges are opposite to each other and thus form a channel between them. A perforated zinc or other strip 9 may also be arranged at the edges of the meeting flanges and these may be so shaped as to provide a channel or space through which moisture from the concrete filling may be conducted to the draining channels. Alternatively the edges of the flanges of the tunnel sections may be so shaped that when placed together they will form a recess. This recess may be suitably covered by means of a perforated zinc or other strip thus forming a cavity in which moisture may collect.

It is preferred to supplement the above described moisture collecting means with means for absorbing the compression set up by the expansion of the tube sections and/or lining and for automatically compensating for contraction of the tube sections and/or lining. One method of effecting this is shown in Fig. 3 which consists in providing a perforated zinc or other suitable channel section strip 9 having a maximum cross sectional dimension approximately equal to the normal space between the inner or more remotely situated faces 3*a* and 4*a* of the flanges or webs of the opposed metal tube sections. The cross section of the strip can be such as to contain an outwardly directed V 14 at its centre, preferably a small angle V for example about twenty degrees. This V will provide sufficient resiliency in the sheet metal channel section strip 9 to compensate for compression and expansion of the rendering which encloses the said strip. The extremities of the said cross section can be bent acutely inwards at an angle so that the free ends 15 of the limbs 15*a* thereby provided and which constitute the longitudinal free edges of the strip are urged resiliently against the inner peripheries of the said flanges or webs 3 and 4 between the edges of such flanges or webs. An outer covering 16 of waterproofed material, for example a plastic, bitumastic composition which retains its elasticity indefinitely is laid against the outer face of the metal strip, that is between the said strip and the said rendering, this covering being shaped to conform with the configuration of the strip between its outermost corners.

In a modification of the foregoing embodiment as shown in Fig. 4 the said central V shaped part is at its inner ends with substantially semi-circular cross section parts 17 merged into two symmetrical straight section parts 18 of the strip which lie parallel with the transverse edges of the said flanges or webs. The outer ends of these straight cross section parts are bent towards said flanges or webs into substantially half elliptical bends 19 which contact at their median parts with the inner peripheries of the said flanges or webs. The outer ends of these half-elliptical cross section parts are bent acutely into two symmetrical outer limbs 20 the free ends of which constitute the longitudinal edges of the said strip and overhang the inner edges of the said flanges or webs. These outer limbs can be secured by wires 21 under tension to the bolts 5 which are passed through the said flanges or webs. This modification provides four longitudinally (viz. circumferentially relatively to the said flanges or webs) disposed arcuate section channels 17 and 19 in the said strip into which can be extended part of the waterproof coating material 16 laid against the outer face of the said strip.

In a still further modification as shown in Fig. 5 a wide U section zinc or other suitable strip 9 can be split along its longitudinal centre to provide a narrow gap 22 to compensate for the said expansion and contraction and a filling 23 of waterproof material is extruded rivet fashion through such gap and into a channel 24 provided in the said lining 10 opposite such gap. The outer part of this channel can be filled in with cement. The ends 9*a* of the cross section of this strip can be carried over the outer faces of the flanges or webs of the tube sections and secured under the heads and nuts of the bolts 5 passed through such flanges or webs 3 and 4. The waterproof material 16 is also laid against the outer face of the strip at the parts beyond the inner peripheries of the said flanges or webs.

Instead of a channel section metal strip extending completely across the peripheries of the flanges or webs a zinc or other suitable trough or substantially semi-circular strip 25 as shown in Fig. 6 can engage the flanges or webs at its edges so as only to slightly overlap the opposed edges of the flanges or webs. This trough can be formed in cross section with a pair of outwardly directed legs 26 (or in side elevation annular flanges). The space 27 between these legs is rectilinear and filled with a hard wood ring 28 of a section corresponding to said space but extending beyond the free edges of said legs or annular flanges so as to be in continuity with the inner surface of the said rendering. A cement filling can be introduced into the narrow annular channels 29 between the outer parts of said block and the rendering.

I claim:—

1. Means for diverting and removing water entering through the joints between the opposed ends of tunnel and like sectional linings, said means comprising an internal covering for each of said joints recessed to form a conduit like space in the said covering open to said joint, and a lining of impervious sheet material fitted across the interior surface of said space.

2. Means for diverting and removing water entering through the joints between the flanges of tunnel and like sectional linings, said means comprising channel section strips of impervious material bridging the free edges of the flanges, an internal covering for the sections extending beyond said flanges to provide channels in said covering accommodating said channel section strips.

3. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and extended beyond said flanges so as to leave recesses in which said joints lie, a layer of facing material bridging said recesses so as to form thereof channels open to said joints, and channel section metal strips lining said recesses and bridging said channels.

4. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and extended beyond

the free edges of said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, and a layer of facing material laid over the said filling material so as to bridge said recesses.

5. Means for diverting and removing water entering through the joints between inwardly-directed flanges of tunnel and like sectional linings, said means comprising a channel section strip of impervious material laid against each joint edge, and bolts passing through adjacent flanges, material in tension connecting the projecting ends of said bolts to the edges of said channel section strip to maintain the channel strip in position.

6. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material of substantially wide V section with inwardly bent outer edges laid in each recess with each of its edges against one flange edge, and a layer of facing material laid over the said filling material so as to bridge said recesses.

7. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material of substantially wide V section with inwardly bent outer edges having perforations therein laid in each recess with each of its edges against one flange edge, and a layer of facing material laid over the said filling material so as to bridge said recesses.

8. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, said channel section strip having a maximum cross section equal to the normal space between the remote faces of said flanges, and a layer of facing material laid over the said filling material so as to bridge said recesses.

9. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, said channel section strip having a maximum cross section equal to the normal space between the remote faces of said flanges and the cross section of said strip containing an outwardly-directed V, and a layer of facing material laid over the said filling material so as to bridge said recesses.

10. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, said channel section strip having a maximum cross section equal to the normal space between the remote faces of said flanges and the cross section of said strip containing an outwardly-directed V, said V being curved at its inner ends into two substantially semi-circular cross section parts, and a layer of facing material laid over the said filling material so as to bridge said recesses.

11. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, said channel section strip having a maximum cross section equal to the normal space between the remote faces of said flanges and the cross section of said strip containing an outwardly-directed V, said V being curved at its inner ends into two substantially semi-circular cross section parts and two outwardly-directed straight section parts extended therefrom, and a layer of facing material laid over the said filling material so as to bridge said recesses.

12. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, said channel section strip having a maximum cross section equal to the normal space between the remote faces of said flanges, and the cross section of said strip containing an outwardly-directed V, said V being curved at its inner ends into two substantially semi-circular cross section parts, and two outwardly-directed straight section parts extended therefrom and merged into outer arcuate section parts, and a layer of facing material laid over the said filling material so as to bridge said recesses.

13. Means for diverting and removing water entering through the joints between the inwardly-directed abutting flanges of tunnel and like sectional linings, said means comprising impervious filling material laid against each lining section between the flanges thereof and upstanding beyond said flanges so as to leave recesses in which said joints lie, a channel section strip of impervious material laid in each recess with each of its edges against one flange edge, a layer of facing material laid over the filling material so as to bridge the said recesses, and a strip of compressible material inserted in said facing material to form an expansion joint.

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