April 22, 1947. A. D. G. WILSON 2,419,329

MEANS FOR LINING TUNNELS

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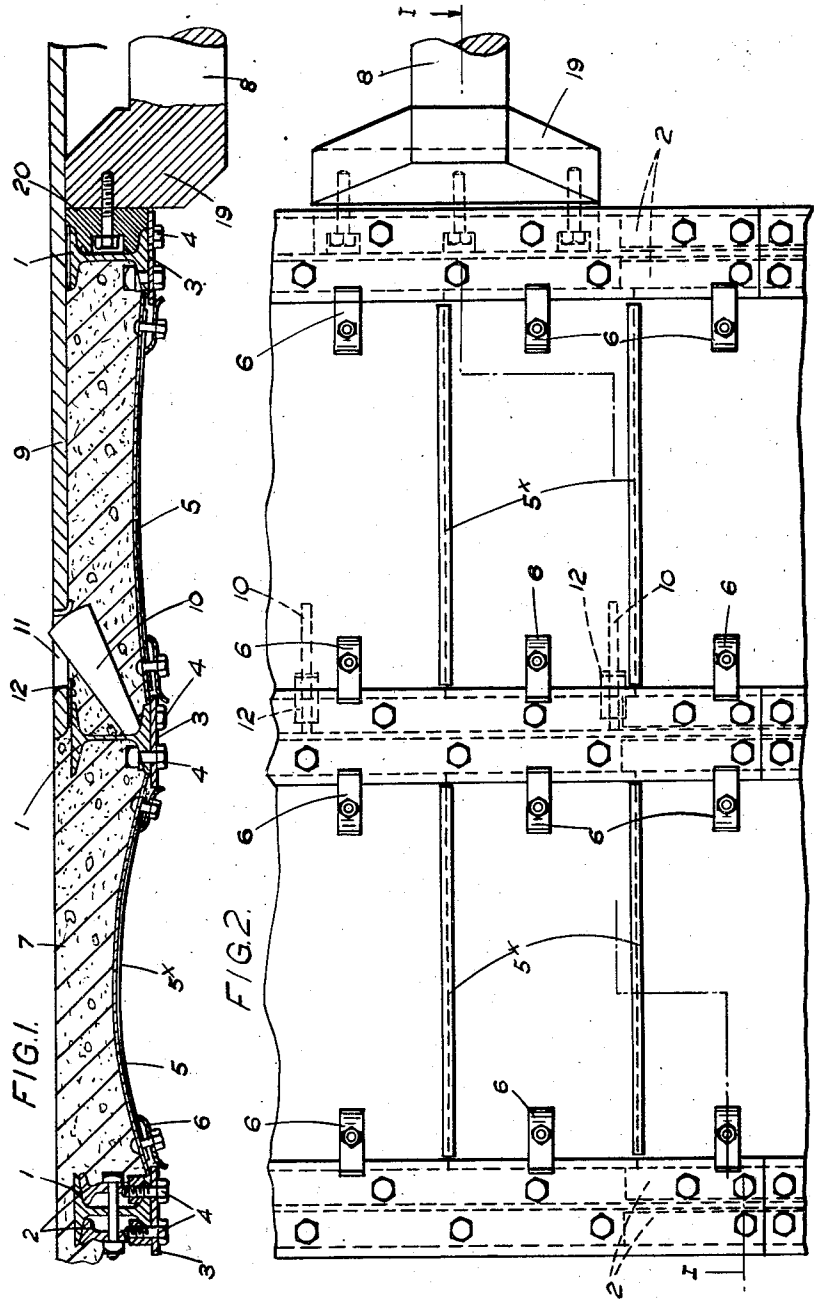


FIG. 1.

FIG. 2.

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FIG.3.

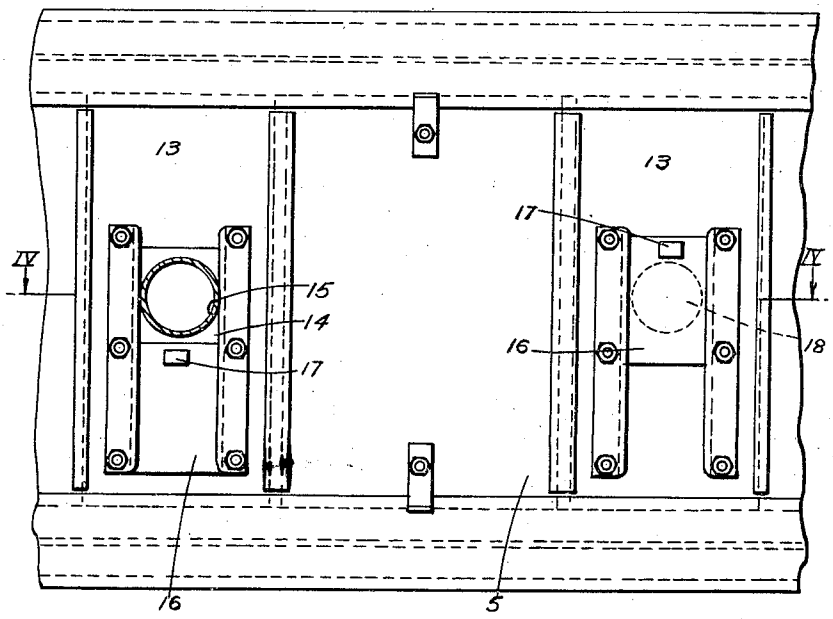
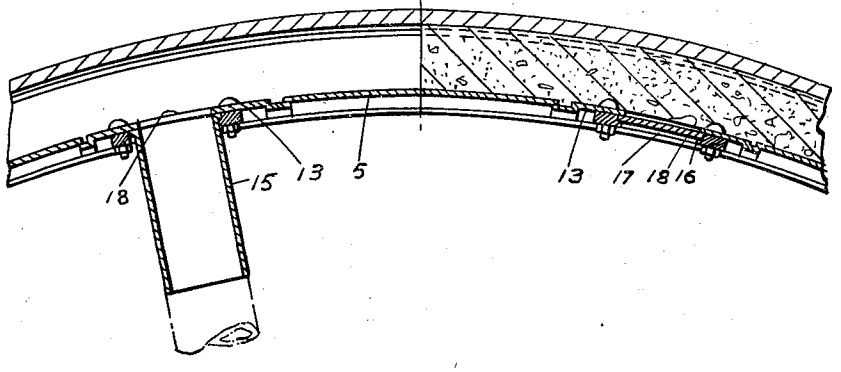


FIG.4.



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MEANS FOR LINING TUNNELS

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Application February 6, 1945, Serial No. 576,492
In Great Britain February 3, 1944

4 Claims. (Cl. 61—45)

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This invention relates to a method of and means for driving and lining tunnels and it has for its object to provide means for simplifying, speeding up and cheapening tunnel driving and lining, and to this end, according to this invention, it is proposed to provide a plurality of prefabricated sections capable of being built up into ribs of circular or other formation, said ribs suitably spaced apart, being utilised to provide an attachment for and to support a plurality of removable and re-usable arch or toggle plates or other longitudinally adjustable shuttering, to support the wet concrete and to resist any ground pressure that may come on pending the setting of the concrete and to reinforce or provide the whole or part of the strength of the permanent lining which may be further strengthened, if required, by the insertion of steel reinforcing bars in the concrete.

The invention further comprehends the utilisation of the built up ribs to act as annular pistons to transfer the thrust of a shield through the arch or toggle plates and the plastic concrete to lining previously erected.

In the accompanying drawings which illustrate this invention:

Figure 1 is a longitudinal section on line I—I of Figure 2.

Figure 2 is a plan of the inner surface of the lining shown in Figure 1.

Figure 3 is a plan of the inner surface of that part of the lining shown in Figure 4.

Figure 4 is a longitudinal section on line IV—IV of Figure 3.

The invention will first be described as applied to hand driven tunnels, and the left hand half of Figures 1 and 2 may be taken as illustrating such an application, and in these figures the built up ribs are of simple I-section as shown at 1, and the ribs thus formed are built up of a plurality of arcuate sections, secured together in any convenient manner such as by means of standard colliery arch fish plates 2. The external diameter of each of the circular joists or rib-sections 1 is less than the diameter of the excavation, or in the case of shield driven tunnels, is slightly less than the internal diameter of the skin of the shield. Each rib-section 1 is furnished on its inner (concave) flange with a cover plate 3 secured to said flange by bolts 4, said cover plate being of such a width that it extends on both sides beyond the edges of the flange to constitute a support for the temporary flexible arch shuttering plates 5 which are arched to the full extent prior to being placed in position, or, if desired, they may be sprung into position to give the desired arch formation. The edges of the shuttering plates are furnished with spring clips 6 so arranged that the edges of the cover plates 3 are clipped between the edges of the arch plates 5 and the clips 6, the function of said clips being to hold the plates in position until the concrete lining 7 has been placed between the plates 5 and the limit or wall of the excavation or the skin of the shield. The arrangement is such that when the concrete filling has set and it is desired to remove the shuttering 5, the bolts 4 securing the cover plates 3 to the ribs 1 are removed thereby enabling the shuttering 5 to fall away. Each section of the shuttering 5 is provided along one edge with a cover strip 5^x welded to the plate, for the purpose of closing the joint between two adjacent plates, as clearly shown in Figure 2. If desired each section of the shuttering 5 may be constructed of a thin sheet with corrugations parallel to the direction of the tunnel and adjacent sections arranged to overlap by one or more corrugations.

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The invention will be further described according to the preferred method of construction, and to this end it is proposed to employ in combination an excavating shield and a second or trailing shield (more particularly described in my copending application No. 576,491 so arranged that while said trailing shield is at rest the rams carried by the rear face of the leading or excavating shield bear against a diaphragm or plate or against thrust blocks provided on the front face of the diaphragm of the trailing shield and when the leading shield has reached the end of its run the rams carried thereby are fully extended. Before the period of excavation begins and before the rams 8 of the trailing shield, the tail of which is shown at 9 in Figure 1, are retracted on completion of a previous shove, a plurality of wedges 10 are fitted around the last completed ring or rib 1 so that one end of each wedge 10 is caused to bear against the inner flange of the last ring or rib 1 while the other end is caused to enter a slot 11 provided in the tail 9 of the shield. At each position of a slot 11 and wedge 10, a thin wedge 12 is forced between the outer face of the rib 1 and the inner surface of the tail 9 of the shield. The wedges 10 and 12 perform the double function of preventing movement of the rib 1 under pressure of the deformed arch plates and the hydrostatic pressure of the wet concrete in the preceding section and of preventing rearwards movement of the trailing shield when it is subjected to the thrust of the

leading shield. The rams 8 of the trailing shield having been retracted after the wedges 10 and 12 have been placed in position, a new rib, completed as above described is brought into correct spaced relationship relatively to the preceding rib by adjusting the rams of the trailing shield, and the shuttering 5 is placed in position as the concrete is filled into the space between the inner surface of the tail 9 of the shield and the arch plates or shuttering. As the filling proceeds the flexible shuttering is extended upwardly, section by section, on each side of the tunnel until at the soffit of the tunnel the ordinary shuttering is replaced by one or two special arch plates 13, each containing a sliding plate 14 furnished with a short length of hose 15 radially disposed relatively to the tunnel as shown in Figures 3 and 4. A complete ring of shuttering having thus been provided, the concrete filling pipes are coupled to the lengths of hose 15 and the filling is completed, as shown on right half of Figure 4, with concrete under pressure, after which the sliding plates 14 are slid out of position and further sliding plates 16, provided with striking lugs 17 are moved simultaneously into a position to close the pipe apertures 18.

Pressure is now supplied to the rams 8 on the rear face of the trailing shield, the free ends of such rams being provided with shoes 19 and bearing pads 20 adapted to seat against the forward face of the rib 1 as shown on the right of Figure 1. As the pressure increases and the rams extend the trailing shield is forced forwardly, the tail 9 thereof being drawn from between the concrete filling and the inner wall of the tunnel and simultaneously the rib against which the rams are bearing is forced rearwardly and the arch plates or shuttering are arched or flexed to a greater degree, as shown on the left of Figure 1, thereby forcing the concrete into the space previously occupied by the tail 9 of the shield. The shoving of the rams proceeds until such time as the shield reaches the correct position for the erection of a further rib 1, at which stage a further series of wedges 10 and 12 are placed in position on the last rib before the rams are again retracted in the manner above described.

What I claim is:

1. Apparatus for lining tunnels having spaced parallel I-section ribs comprising in combination, a plurality of arched shuttering plates, spring clips provided on the edges of said arched shuttering plates and a cover plate, wider than the flanges on the rib section, secured to the inner flange of each such rib section with which cover plate said spring clips co-operate to maintain the arched shuttering plates in position while the space between the wall of the excavation and the arched shuttering plates is being filled and until the concrete has set.

2. Apparatus for lining tunnels having spaced parallel I-section ribs comprising in combination, a plurality of arched shuttering plates, spring clips provided on the edges of said arched shuttering plates, a cover plate wider than the flange on the rib section secured to the inner flange of each such rib section, with which cover plate said spring clips co-operate to maintain the arched shuttering plates in position, means comprising a trailing shield, a tail on the shield, said shield provided with hydraulic plungers, the plungers of the trailing shield arranged to coact with the adjacent rib to force same rearwardly to increase the arching of the shuttering plates as the tail on the trailing shield is withdrawn and the concrete is being filled in the space vacated by the tail on the trailing shield.

3. Apparatus for driving and lining tunnels having spaced parallel I-section ribs comprising in combination, flexible arched shuttering plates spring clips provided on the edges of said arched shuttering plates, a cover plate wider than the flanges on the rib section secured to the inner flange of each such rib section, with which cover plate said spring clips co-operate to maintain the arched shuttering plates in position and means comprising a trailing shield, a tail on the shield, said shield provided with hydraulic plungers, the plungers of the trailing shield arranged to coact with the adjacent rib, the said I-section ribs being so constructed and arranged that when pressure is supplied to the forward face thereof by the shield they act as annular pistons to transfer the thrust of the said shield through the said arch shuttering plates and the plastic concrete to the lining previously erected so that as the said shield is forced forwardly and the tail thereof is drawn from between the concrete filling and the inner wall or lining of the tunnel, the said ribs are simultaneously forced rearwardly, thereby causing the arch shuttering plates to be arched to a greater degree and the plastic concrete to be forced into the space vacated by the tail-piece of the said shield.

4. Apparatus for driving and lining tunnels having spaced parallel I-section ribs comprising in combination, removable arch plates, removable cover plates secured by bolts to the inner concave flange of the said ribs, means comprising a trailing shield, a tail on the shield, said shield provided with hydraulic plungers, the plungers of the trailing shield arranged to coact with the adjacent rib to force same rearwardly to increase the arching of the shuttering plates as the tail on the trailing shield is withdrawn and a plurality of wedges constructed and arranged to fit round the last completed rib whereby one end of each wedge is caused to bear against the inner flange of the said last rib whilst the other end is caused to enter a slot provided in the tail of the shield, a second and thinner wedge being forced between the outer face of the said rib and the inner surface of the tail of the shield at each position of one of the said slots thereby preventing movement both of the ribs under pressure of the deformed arch plates and the hydrostatic pressure of the wet concrete in the preceding section and of the trailing shield when the said trailing shield is subjected to the thrust of the leading shield.

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