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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN TUNNEL BORING EQUIPMENT

(71) We, WILLIAM F. REES LIMITED, a British Company, of Old Woking, Surrey, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to tunnel boring equipment of the kind in which a tubular shield, which may or may not incorporate mechanical ground cutting tools, is progressively advanced along a tunnel as boring proceeds, the advance being effected by means of rams acting between anchor or reaction points on the shield and a tunnel lining which is inserted, section by section, behind or within the rear portion of the shield as the boring proceeds. Such tunnel boring equipment will hereinafter be referred to as "tunnel boring equipment of the kind described".

The invention provides tunnel boring equipment of the kind described in which the rams are mounted on a carriage which is movable, with the rams, along the shield, there being means by which, in at least one position of the carriage, the thrust of the rams may be transmitted to the anchor or reaction points on the shield.

Preferably the carriage and shield have cooperating means by which the thrust from the rams may be transmited to the anchor or reaction points on the shield at two or more positions of the carriage along the shield.

The carriage may comprise two rings concentric with the shield, and means for mounting each ring for movement along the shield, the rams being connected to move said rings towards and away from each other, one ring being capable of engaging the tunnel lining inserted behind or within the rear position of the shield and the other ring having means for engaging said anchor or reaction points.

[*Price 25p*]

Said means for engaging said anchor or reaction points may comprise a plurality of releasable pawls mounted on said other ring.

Said anchor or reaction points may comprise abutments around the internal surface of the shield, which abutments face towards the rear end of the shield.

The invention has the advantage that the rams may be moved forwardly along the shield to provide room at the rear for manipulation of lining sections and may be moved rearwardly to facilitate access to the tunnel face during excavation. Furthermore in the case where the thrust can be transmitted at two or more positions, the length of the rams may be reduced, the shield being advanced by two or more operations of the rams with movement of the carriage between successive operations, for each section of lining inserted. It may also be possible to reduce the length of the shield with the advantage of easier steering of the shield.

A specific embodiment of equipment according to the invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section through the equipment,

Figure 2 shows cross-sections through the equipment, the right hand side being a section on the line A-A in Figure 1 and the left hand side being a section on the line B-B in Figure 1,

Figures 3 and 4 are end and side elevations of one of the roller units for supporting a thrust ring.

Figures 5, 6 and 7 are end and side elevations and plan of one of the roller units for guiding a reaction ring, and

Figures 8, 9 and 10 are end and side elevations and plan of one of the reaction anchor units.

The equipment forming the subject of this example is intended for use in boring tunnels of somewhat small diameter (e.g. about 3 feet 6 inches) and may be used in conjunction with the lining system described in Specification No. 35088/69 (Serial No. 1275268) and may be suitably adapted to be used in conjunction with the lining system described in Specification No. 24383/69 (Serial No. 1238576).

There is a tubular shield 10 with a cutting edge 11 at the leading end. Within the leading end of the shield there is a fixed sleeve 12 ending in a step 13 and spaced behind the step there is fixed a ring 14 which is cut away to provide gaps at four locations 15. There is a flexible sealing ring 16 at the rear end of the shield.

Within the shield there is a carriage for four hydraulic rams 17. The carriage comprises a reaction ring 18 and a thrust ring 20 to which the pistons and cylinders of the rams are secured, respectively. The reaction ring has four equally spaced rollers 21 which run on the internal surface of the shield and the thrust ring has two rollers 22 which run on the lower part of the shield. Accordingly the two rings 18 and 20 and the rams supported by the rings are movable, as a unit, lengthwise of the shield and the two rings are movable towards and away from one another by operation of the rams. The rollers 21 can pass through the gaps at 15.

At each of the attachment points of the four rams to the reaction ring there is a pawl 24 which is engageable behind the step 13 or behind the ring 14 thereby to absorb thrust from the rams.

In the operation of the equipment, the carriage is first moved as far as possible to the rear of the shield thereby to provide maximum space at the front of the shield for excavation of the tunnel face. The pawls are then engaged behind step 13 and the rams energised to engage the ring 20 with the lining section (not shown) last erected and to push the shield forward a distance about equal to the stroke of the rams which is a little more than half the length of a lining section. The rams are then retracted and the carriage moved rearwardly until the pawls may be engaged behind the ring 14. The rams are again extended to complete the forward movement of the shield. The rams are again retracted and the carriage may then be moved into the front of the shield to provide maximum space at the rear for erection of the next lining section.

Figures 3 and 4 show details of the two roller support units for the thrust ring 20. Each of these units comprises a fork 30 in which the roller 22 is journalled, the fork being pivotally supported at 31 in a bracket 32 secured to the ring 20. The fork has an adjustable thrust screw 34 which engages a plate 35 bonded to a rubber pad 36.

Figures 5 to 7 show details of one of the four roller support units for the reaction ring 18. Each roller 21 is supported for rotation in a fork 40 pivoted at 41 to a bracket 42 secured to the ring 18. A screw 44 engages the base of the fork 40 to adjust the position of the roller radially of the shield.

Figures 8 to 10 show details of one of the four pawls 24. The pawl is of channel section and is pivoted at 50 to a bracket 51 which is secured to the reaction ring 18. The piston 53 of one of the rams is also secured to the bracket 51.

The invention is not, of course, restricted to the constructional details of the above example. For instance the tubular shield is not necessarily of circular cross-section. It may, for example, be of rectangular cross-section and used for boring pedestrian subways about 7 ft 6 inches by 7 ft 0 inches. Again, the flexible sealing ring 16 may be omitted if desired.

WHAT WE CLAIM IS:—

1. Tunnel boring equipment of the kind described in which the rams are mounted on a carriage which is movable, with the rams, along the shield, there being means by which, in at least one position of the carriage, the thrust of the rams may be transmitted to the anchor or reaction points on the shield.

2. Tunnel boring equipment according to claim 1 wherein the carriage and shield have cooperating means by which the thrust from the rams may be transmitted to the anchor or reaction points on the shield at two or more positions of the carriage along the shield.

3. Tunnel boring equipment according to claim 1 or claim 2 wherein the carriage comprises two rings concentric with the shield, and means for mounting each ring for movement along the shield, the rams being connected to move said rings towards and away from each other, one ring being capable of engaging the tunnel lining inserted behind or within the rear portion of the shield and the other ring having means for engaging said anchor or reaction points.

4. Tunnel boring equipment according to claim 3 wherein said means for engaging said anchor or reaction points comprises a plurality of releasable pawls mounted on said other ring.

5. Tunnel boring equipment according to any of the preceding claims wherein said anchor or reaction points comprise abutments around the internal surface of the shield, which abutments face towards the rear end of the shield.

* C L M S *

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Within the shield there is a carriage for four hydraulic rams 17. The carriage comprises a reaction ring 18 and a thrust ring 20 to which the pistons and cylinders of the rams are secured, respectively. The reaction ring has four equally spaced rollers 21 which run on the internal surface of the shield and the thrust ring has two rollers 22 which run on the lower part of the shield. Accordingly the two rings 18 and 20 and the rams supported by the rings are movable, as a unit, lengthwise of the shield and the two rings are movable towards and away from one another by operation of the rams. The rollers 21 can pass through the gaps at 15.

At each of the attachment points of the four rams to the reaction ring there is a pawl 24 which is engageable behind the step 13 or behind the ring 14 thereby to absorb thrust from the rams.

In the operation of the equipment, the carriage is first moved as far as possible to the rear of the shield thereby to provide maximum space at the front of the shield for excavation of the tunnel face. The pawls are then engaged behind step 13 and the rams energised to engage the ring 20 with the lining section (not shown) last erected and to push the shield forward a distance about equal to the stroke of the rams which is a little more than half the length of a lining section. The rams are then retracted and the carriage moved rearwardly until the pawls may be engaged behind the ring 14. The rams are again extended to complete the forward movement of the shield. The rams are again retracted and the carriage may then be moved into the front of the shield to provide maximum space at the rear for erection of the next lining section.

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2. Tunnel boring equipment according to claim 1 wherein the carriage and shield have cooperating means by which the thrust from the rams may be transmitted to the anchor or reaction points on the shield at two or more positions of the carriage along the shield.

3. Tunnel boring equipment according to claim 1 or claim 2 wherein the carriage comprises two rings concentric with the shield, and means for mounting each ring for movement along the shield, the rams being connected to move said rings towards and away from each other, one ring being capable of engaging the tunnel lining inserted behind or within the rear portion of the shield and the other ring having means for engaging said anchor or reaction points.

4. Tunnel boring equipment according to claim 3 wherein said means for engaging said anchor or reaction points comprises a plurality of releasable pawls mounted on said other ring.

5. Tunnel boring equipment according to any of the preceding claims wherein said anchor or reaction points comprise abutments around the internal surface of the shield, which abutments face towards the rear end of the shield.

6. Tunnel boring equipment substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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