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[21] Appl. No. **14,339**

[22] Filed **Feb. 26, 1970**

[45] Patented **Dec. 28, 1971**

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[32] Priority **Mar. 3, 1969**

[33] **Great Britain**

[31] **11,316/69**

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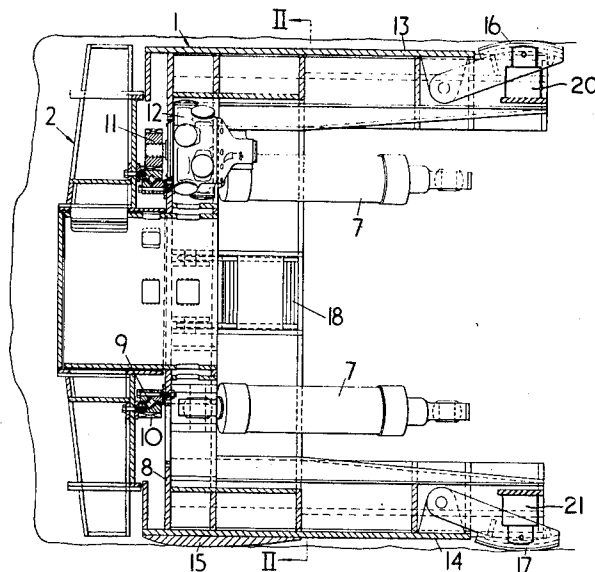
[54] **TUNNELING MACHINE WITH STEERING SHIELD**
6 Claims, 3 Drawing Figs.

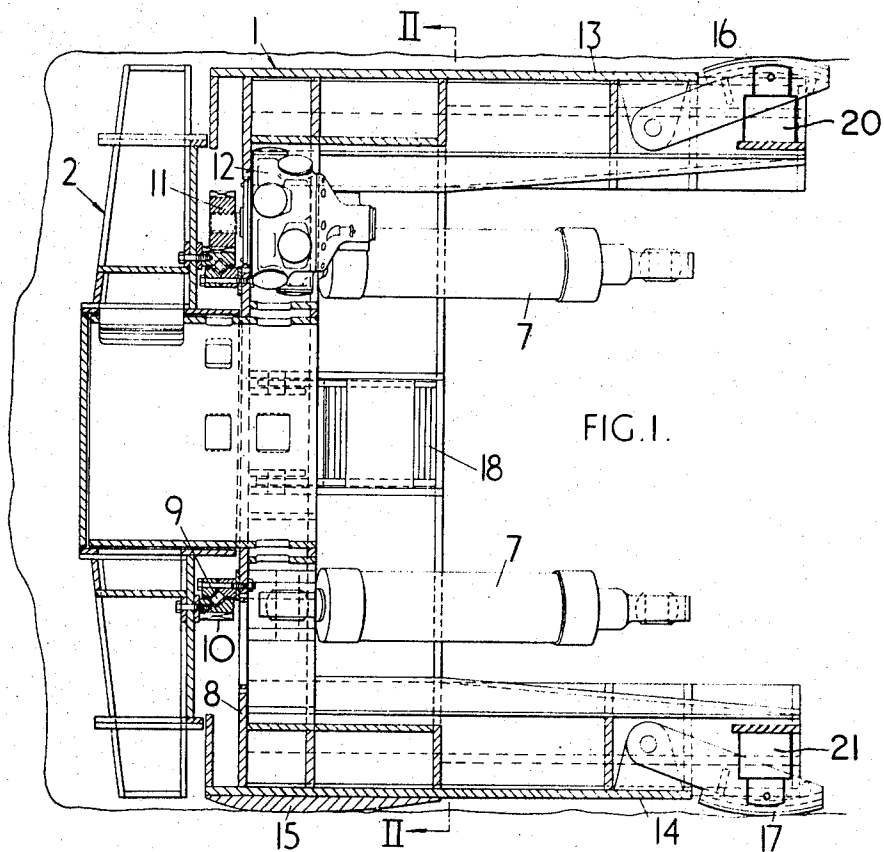
[52] U.S. Cl. **299/31,**
175/76, 299/33

[51] Int. Cl. **E01g 3/04**

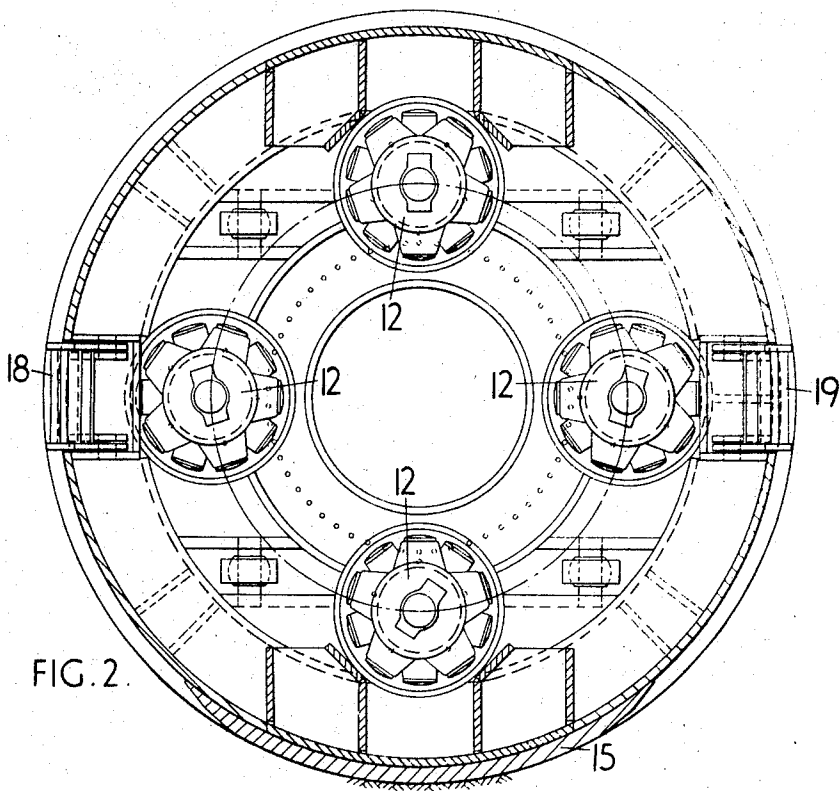
[50] Field of Search **299/11, 31,**
33; 175/61, 76; 61/85

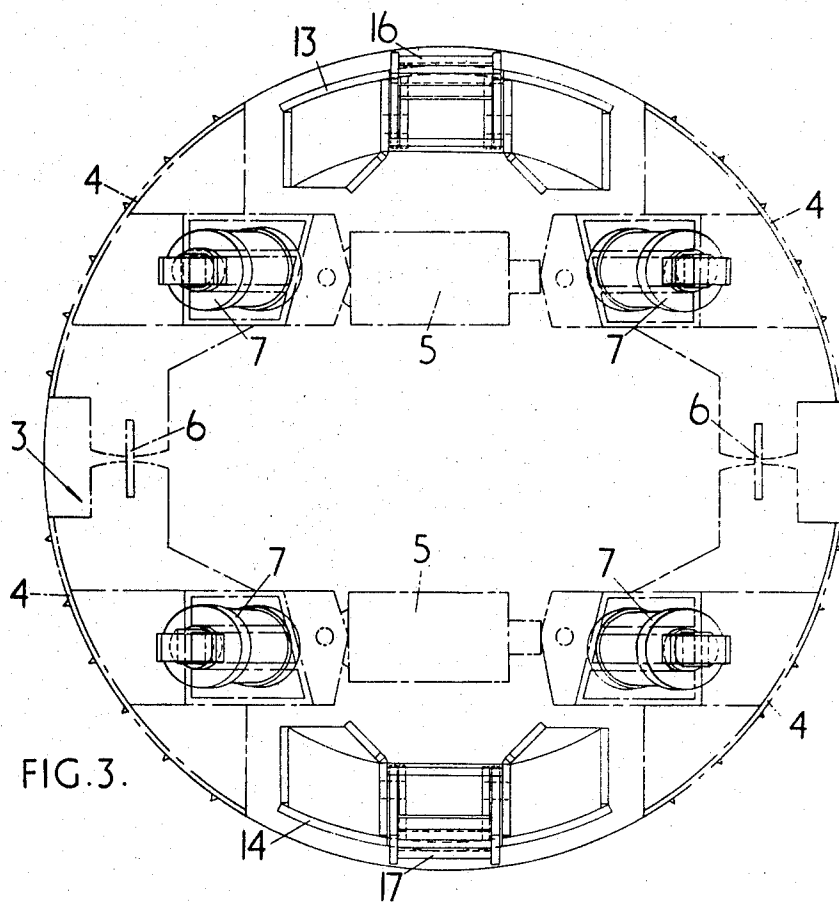
ABSTRACT: A tunneling machine, primarily for use in tunneling through hard ground. A digging assembly of conventional nature is mounted on a shield, but contrary to normal practice, the shield is smaller in radius than the tunnel cut by the digging assembly. At the forward end of the underside the shield is provided with a rocking pad on which the whole shield and digging assembly is bodily rockable to steer the machine. The rocking is achieved by pressing members, e.g. in the form of jacks, mounted in the shield and adapted to press against the tunnel wall.





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TUNNELING MACHINE WITH STEERING SHIELD

This invention relates to tunneling machines and more particularly, but not solely, to machines for tunneling in hard ground.

Tunneling machines conventionally comprise a digging arrangement mounted for rotation on the forward end of a shield and means for advancing the shield by pressing back on a reaction. In soft ground, in which a lining has to be inserted as the machine advances, the reaction may be provided by the lining, while in hard or rocky ground, where lining may not be necessary immediately or at all, the reaction may be provided by means of anchor pads pressed outwardly against the tunnel wall. The pressing may be done by hydraulic jacks, and by using differential extensions of the jacks it is theoretically possible to obtain universal steering of the tunneling machine within the limits required. However, with the machine shield fitting quite snugly in the tunnel made by the digging arrangement, accurate control of the steering is not always achievable in practice without constant monitoring, and the minimum radii of curvature obtainable are excessively large.

According to the present invention, a tunneling machine comprises a digging assembly mounted on a shield which is smaller in radius than the tunnel cut by the digging assembly, the shield further having a rocking pad on the forward part of its underside adapted to contact the lower surface of the tunnel to provide at least limited rocking movement for the shield, and pressing members mounted on the shield for pressing against the tunnel wall to provide positive steering of the shield by rocking or pivoting it about the rocking pad.

By having the pad under the forward part of the underside, the tunneling machine may be given a slight tendency to drive upwardly of the horizontal, which counteracts the inherent tendency of tunneling machines to nose down.

Preferably the pressing members are in the form of pressing pads actuated by hydraulic jacks, and they may be four in number so that one acts vertically upward, one vertically downward and one acts in each lateral horizontal direction. The variations of position of the jacks may be used in such combinations as are necessary to achieve the desired steering.

In a preferred form, the upper and lower central portions of the shield extend rearwardly between main thrust anchor pads. The central portions referred to are connected together by the main body of the shield at the front end only, thus allowing the anchor pads to pass beyond the termination of the upper and lower central portions when operating, but at the same time maintaining partial register between them in order to prevent undesirable rotation of the body section of the machine as a result of the cutting torque transmitted from the head.

The vertically acting pressing pads may be mounted in the rearward extensions of the shield, while the horizontally acting pads may be located only slightly to the rear of the rocking pad.

By operating with a clearance round most of the shield it is possible for the shield to be drawn back from the face. This enables access to the face to be gained more easily than with conventional equipment.

Also, the forward wall of the shield may be provided with removable portions providing extensions of the central aperture for withdrawal of the bearing supporting the digging assembly.

The invention will be further described in a preferred embodiment with reference to the accompanying drawings, in which:

FIG. 1 is a somewhat diagrammatical axial section through a shield and digging assembly of a tunneling machine forming a preferred embodiment of the present invention;

FIG. 2 is a section on the line II—II of FIG. 1; and

FIG. 3 is a rear end elevation, in the direction of arrow III in FIG. 1, and also including a diagrammatic showing of anchor pads.

The tunneling machine illustrated comprises a shield generally indicated by the reference numeral 1, a digging as-

sembly indicated by 2 and a reaction device 3, shown only in FIG. 3, and comprising anchor pads 4 pressed against the lateral part of the wall of the tunnel by hydraulic jacks 5. The anchor pads 4 on each side are hinged together for limited relative movement by means of hinge plates 6, so that the anchor pads as a whole may conform to the contour of the tunnel wall. The tunneling machine advances by means of hydraulic jacks 7 which are pivoted at their rear ends to the reaction device 3 and at their forward ends on the shield 1. These jacks are preferably double acting, so that they may also be used for withdrawing the shield and advancing the reaction device 3.

The digging assembly 2 illustrated is of wholly conventional design, and the details of it do not form part of the present invention, except insofar as it can be seen as extending radially somewhat beyond the radial extent of the shield 1, so that the shield operates in the tunnel with an appreciable clearance. The digging assembly is mounted for rotation on a forward wall 8 of the shield by means of a bearing 9, and it carries a gear 10 which meshes with drive pinions 11 which are driven by hydraulic motors 12 mounted in the shield 1.

The shield is provided with a pair of rearward extensions 13 and 14 which pass respectively between the upper and lower pairs of anchor pads 4.

On its underside, the shield 1 also has a rocking pad 15 which engages the lower part of the tunnel wall and enables the shield to be positively steered with respect thereto. This steering is carried out by means of four steering pads 16, 17, 18 and 19, which are each actuated by individual hydraulic jacks two of which, for example, are shown by jacks 20 and 21 in FIG. 1 associated with pads 16 and 17. Similar jacks are associated with pads 18 and 19. As illustrated, each steering pad is pivotally mounted on the shield, with the pads 16 and 17 acting against the upper and lower walls respectively and mounted in the extension 13 and 14, while the pads 18 and 19 are mounted in the main body of the shield so as to act against opposed lateral parts of the tunnel wall.

In order to make the shield nose downwardly, the pad 17 is pressed against the tunnel wall so as to lift the rear end of the shield which rocks about the pad 15. For an upward deviation, the pad 16 is pressed against the upper wall of the tunnel. Purely lateral deviations are achieved by pressing the respective pad 18 or 19 against the appropriate wall, and composite movements may be obtained by combination of movement of one of the pads 16 or 17 and one of the pads 18 or 19.

It would be appreciated that the shape of the rocking pad 15 is such as to provide considerable ground-engaging surfaces for support of the tunneling machine, and if the ground is in fact a little softer the pad merely settles in a little further and then presents a much greater area and therefore provides greater support.

The rearward extension 13 of the shield 1 provides for considerable overhead protection.

It will be appreciated that the jacks 7 may be used for pulling back the shield from the face, and this may be done after detachment of the digging assembly if necessary. This enables access to the face to be had through the central aperture in the forward wall 8. Further, should the bearing 9 fail, it may be replaced by withdrawing the shield from the digging assembly, removing two removable panels (not shown) so as locally to enlarge the diameter of the central aperture, and then releasing the bearing from the shield forwardly and rotating it about a diametral axis so that it may be withdrawn through the enlarged part of the central aperture. A fresh bearing may then be installed by a reverse procedure.

Means is provided, as is conventional, for preventing, so far as is possible, the access to the bearing of debris arising from the digging operation. Such protection will be provided by minimizing the clearances between adjacent parts of the digging assembly and shield, and also by the provision of one or more lip seals (not shown) at appropriate points.

Various modifications may be made within the scope of the invention.

We claim:

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1. In a tunneling machine comprising a shield and a digging assembly mounted on a forward end of the shield to cut a tunnel of a predetermined radius, the improvement that the shield is smaller in radius than the tunnel cut by the digging assembly and that the shield has a rocking pad mounted on a forward zone of its underside to contact the lower surface of the tunnel to provide at least limited rocking movement for the shield and digging assembly, the shield further comprises a plurality of pressing members mounted thereon for pressing against the tunnel wall to provide positive steering of the shield and digging assembly by rocking them about the rocking pad.

2. A tunneling machine as claimed in claim 1, in which the shield comprises main thrust anchor pads, an upper central portion and a lower central portion, said central portions extending rearwardly between the main thrust anchor pads.

3. A tunneling machine as claimed in claim 1, wherein the

pressing members comprising pressing pads and hydraulic jacks adapted to actuate the pressing pads.

4. A tunneling machine as claimed in claim 3, in which the pressing pads are four in number and are mounted on the shield such that one acts vertically upward, one acts vertically downward and the other two act one in each lateral direction.

5. A tunneling machine as claimed in claim 4, in which the shield comprises main thrust anchor pads, an upper central portion and a lower central portion, said central portions extending rearwardly between the main thrust anchor pads, the vertically acting pressing pads being mounted on the respective rearward extensions of the shield.

6. A tunneling machine as claimed in claim 4, in which the horizontally and laterally acting pressing pads are mounted slightly rearwardly of the rocking pad.

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