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Lobbe

[11] **3,800,549**

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[54] **TUNNELLING APPARATUS**

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[73] Assignee: **Gewerkschaft Eisenhutte Westfalia,** Westfalia, Germany

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Sept. 8, 1971 Germany 2144862

[52] **U.S. Cl.** **61/85,** 61/42

[51] **Int. Cl.** **E01g 3/02**

[58] **Field of Search** ..... 61/84, 85, 45 D, 45 R, 61/42; 299/31, 33

[56] **References Cited**

UNITED STATES PATENTS

3,355,215	11/1967	Haspert et al.	299/31 X
3,379,024	4/1968	Wohlmeyer	61/85
3,411,826	11/1968	Wallers et al.	299/33 X
3,613,384	10/1971	Jacobs	61/85
3,672,726	6/1972	House	299/31

FOREIGN PATENTS OR APPLICATIONS

1,109,630	6/1961	Germany	61/45 D

Primary Examiner—Dennis L. Taylor

Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

A tunnelling apparatus composed of a plurality of elongate planks arranged side-by-side on a circumferential path to form a shield of circular configuration. The planks are separated into two relatively movable groups with the individual members alternately staggered so that a member of one group is disposed between two members of another group. Each group of planks is supported on three axially spaced expandible ring devices used to selectively brace the planks against the tunnel wall. Rams are provided between the rear support device of one group and a central support device of the other group so that the groups can be alternately advanced with the planks of said one group forming a forward support and the planks of said other group forming a rear support.

A frame rotatably supporting a drivable cutting head is slidably mounted on the support devices for the forward support and further rams are provided for advancing the frame and cutting head outwardly of the forward support.

14 Claims, 4 Drawing Figures

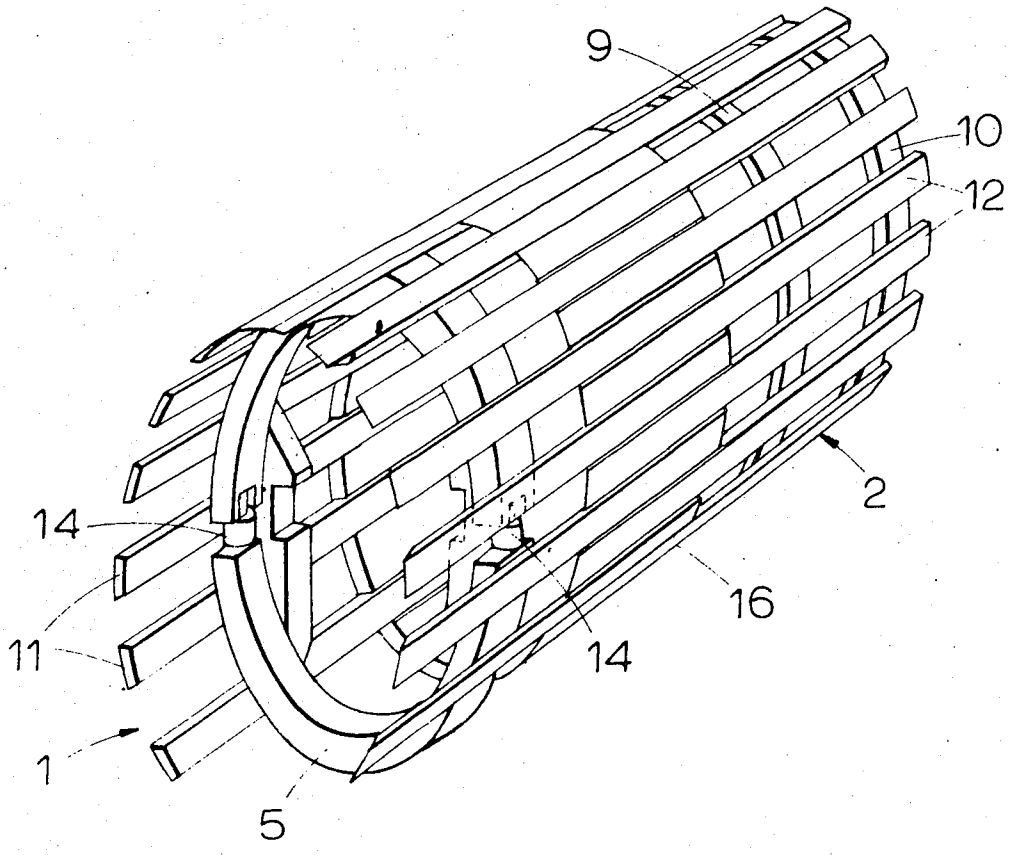

Fig. 1.

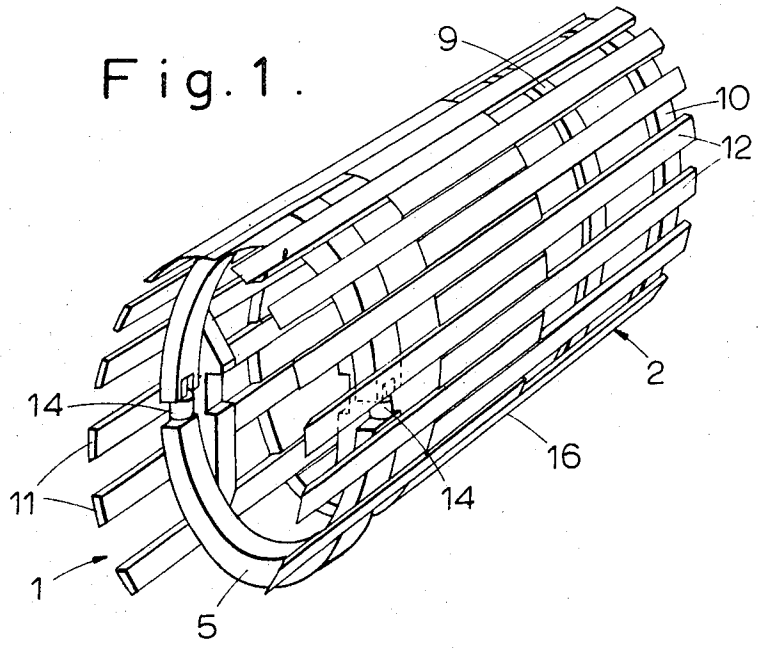
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Fig. 3.

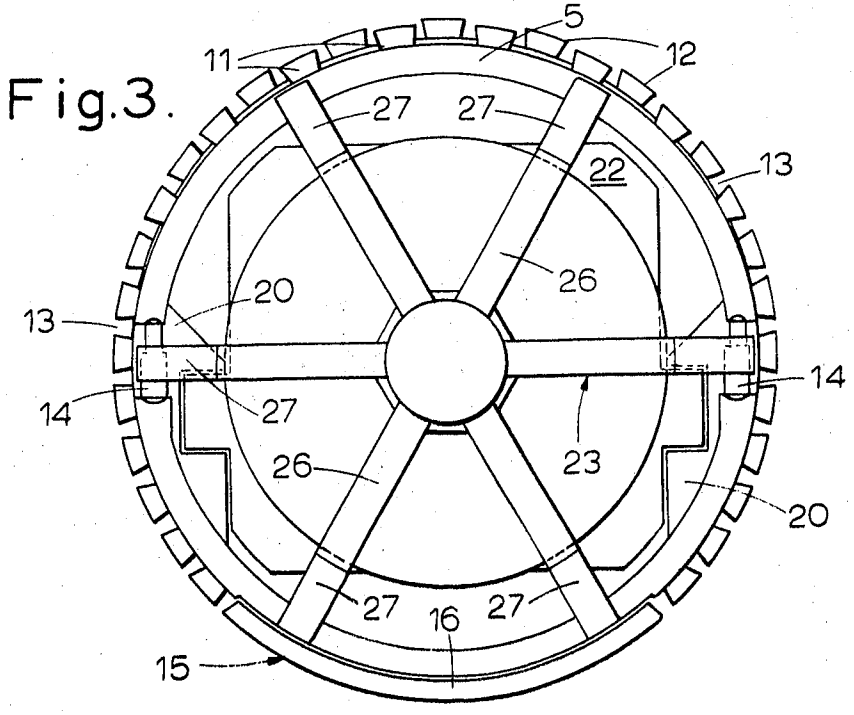
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Fig. 2.

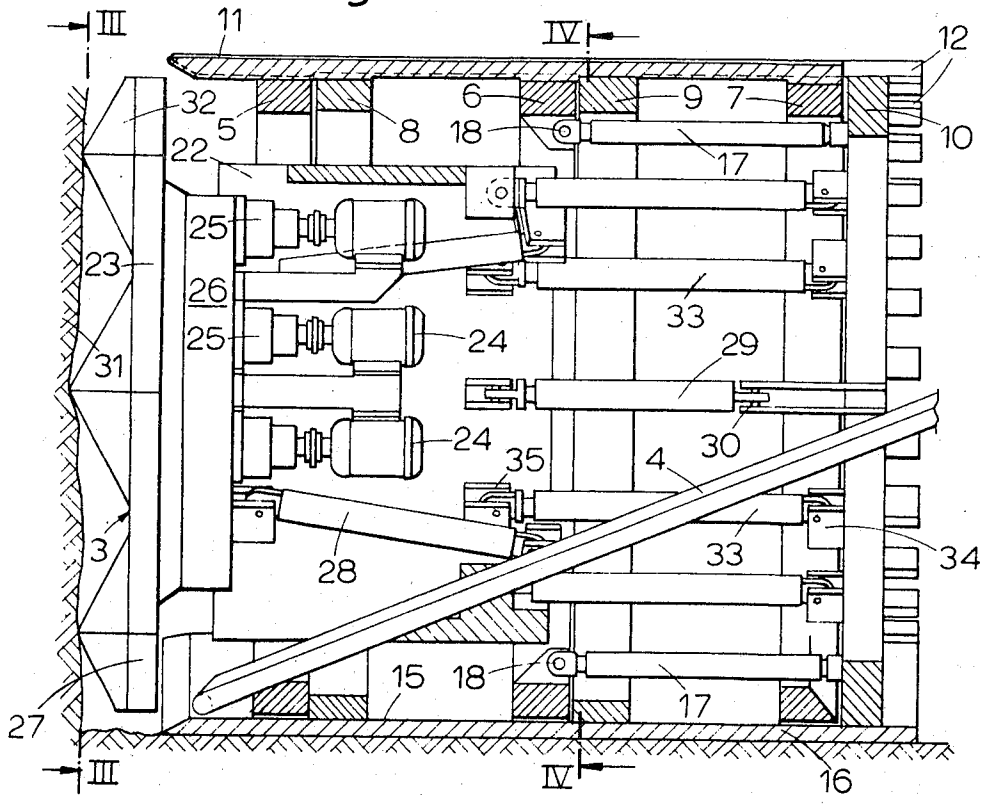
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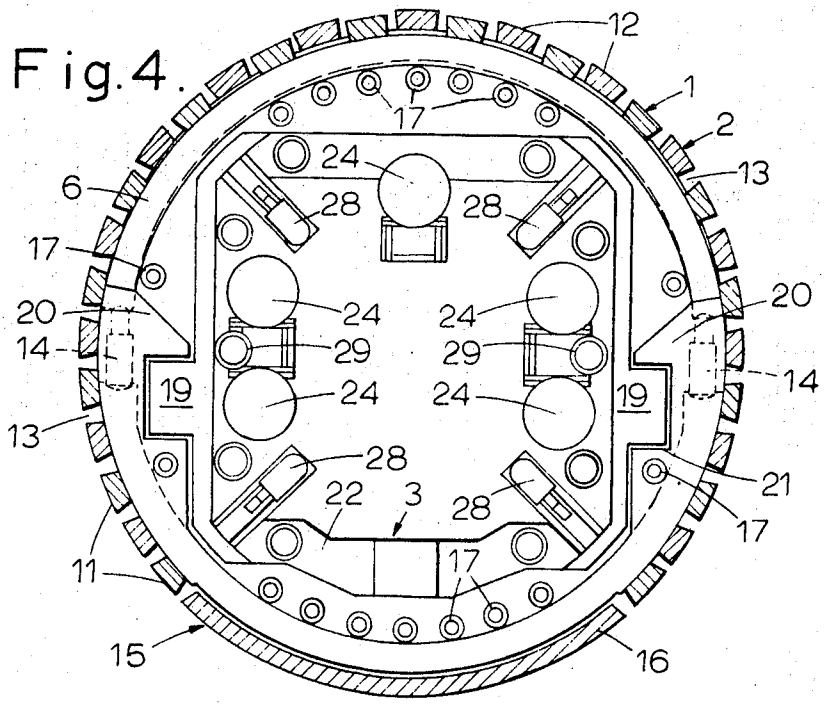
Fig. 4.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TUNNELLING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for use in driving underground tunnels and to a method of driving tunnels using such an apparatus.

In the driving of underground tunnels it is known to support the wall surface of the tunnel at the head of the tunnel with a shield of circular configuration composed of a plurality of separate plank-like members. These members are carried on a frame and advanced individually by means of piston and cylinder units. At the front end of the shield is a cutting head which removes material from the face and at the rear end of the shield there are provided tunnel lining sections for permanently supporting the tunnel wall. Generally with such an apparatus the supporting and driving operations must be performed alternately and this consequently reduces the overall rate at which the tunnel can be driven.

A general object of this invention is to provide an improved apparatus for, and method of, driving tunnels.

SUMMARY OF THE INVENTION

According to the invention there is provided an apparatus for use in driving underground tunnels; said apparatus including a shield wall with relatively movable components, each component being composed of a plurality of substantially parallel elongate members, wherein the elongate members of one wall component are interspersed with the elongate members of the other wall component and the elongate members of each wall component are supported by at least one device adapted to brace said members against the wall of a tunnel.

Further according to the invention there is provided a method of driving a tunnel comprising bracing a plurality of elongate members forming a rear shield wall component against the surface of the tunnel, advancing a further plurality of elongate members forming a complementary forward shield wall component longitudinally outwardly of said braced wall component, advancing a cutting appliance longitudinally outwardly from said further plurality of members to remove material from a face, bracing said further plurality of members against the surface of the tunnel, relieving said first-mentioned plurality of members from the surface of the tunnel drawing up the first-mentioned plurality of members between the further plurality of members and re-bracing said first-mentioned plurality of members against the surface of the tunnel.

Preferably the elongate members of the wall components are arranged to lie on a common circumferential path with each of at least some of the elongate members of one of the wall components being disposed between two of the elongate members of the other wall component. The members are thus alternately staggered in the circumferential direction and small gaps may be left between the sides of the individual members.

In accordance with the invention the wall components can be alternately advanced, while providing an adequate continuous shield, with each component being alternately braced against the tunnel wall to form a thrust abutment for the advance of the other component. The outer faces of the elongate members of one of the wall components may be disposed outwardly relative to the outer faces of the elongate members of the other forward wall components. This one component can then form the rear support of the shield which is alternately braced and moved up to the wall component forming the front support.

In a preferred embodiment the elongate members of each wall component are supported on three support devices spaced apart axially of said members. Each support device may take the form of two half-rings interconnected by piston and cylinder units, operable to move the half-rings together or apart to thereby contract or expand the device to relieve or brace the members of the associated wall component. The devices may conveniently be arranged in pairs with each device associated with the elongate members of one of the wall components being located adjacent one of the devices associated with the elongate members of the other of the wall components.

So far as the actual elongate members is concerned preference is given to a design where each member has a trapezoidal cross-section with its greater width lying outermost. The front end of each member preferably has a knife-edge to assist in penetrating the layers of material around the tunnel wall.

Double-acting piston and cylinder units can be connected between the rear terminal support device of the rear wall component and the central support device for the forward wall component. These units can then be used to effect relative movement between the wall components when one or other of the wall components is braced against the tunnel wall with its associated support devices.

The floor part of each wall component may be formed by a continuous arcuate section and the arcuate section of the rear component may be covered by a floor plate. A conveyor for removing the debris from the face can be installed inside the wall components to transfer material rearwardly.

The apparatus preferably has a cutting appliance with a frame supported for sliding within the forward wall component. For example, the frame has guide members which engage in recesses defined by brackets attached to the, or some of the, support devices for said forward wall component. Piston and cylinder units are preferably used for moving the frame and the units may comprise a group of units for advancing the frame and a group of units for retracting the frame. The retraction units preferably have some form of displaceable mounting so that they do not interfere with the advancing operation and the advancing units preferably have detachable connections enabling them to be disconnected and moved during any retraction operation. The advancing and retraction units are conveniently connectible between the frame and the rear support device of the rear wall component.

The cutting appliance may have a rotatable cutting head supported on the frame and composed of a number of radial arms each having removable end pieces supporting cutters. The head may be driven via motors and gearing carried by the frame and further piston and cylinder units, operable to align the head, may be connected between the support means for the head and the frame.

The invention may be understood more readily and various other features of the invention may become more apparent from consideration of the following description.

BRIEF DESCRIPTION OF DRAWINGS

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic representation of an apparatus made in accordance with the invention;

FIG. 2 is a part sectional side view of the apparatus shown in FIG. 1;

FIG. 3 is a cross-sectional view of the apparatus, the view being taken along the line III—III of FIG. 2; and

FIG. 4 is a cross-sectional view of the apparatus, the view being taken along the line IV—IV of FIG. 2.

DESCRIPTION OF PREFERRED EMBODIMENT

As shown in the drawings, the apparatus is composed of a multi-part outer wall **1, 2**, having a cutting appliance **3** at its forward end, and accommodating therein, inter-alia, a conveyor **4**. The multi-part wall **1, 2** is composed of two relatively movable component parts **1, 2**; each part **1, 2** being in the form of a group of elongate parallel plank-like members **11, 12** respectively. The members **11, 12** are all arranged around a common circumferential path and evenly distributed thereabout with gaps **13** between the individual members **11, 12**. The members **11, 12** are alternately staggered in a circumferential sense with each member **11** disposed between two of the members **12** and vice versa. As shown in FIGS. **3** and **4** the outermost faces of the members **12** forming the rear wall component **2** are disposed slightly radially outwards from the outermost faces of the members **11** forming the forward wall component. The members **11, 12** can also be offset longitudinally (FIGS. **1** and **2**) at certain operational stages so that the members **11**, collectively constituting the forward wall component **1**, are disposed forwardly of the members **12**, collectively constituting the rear wall component **2**. Each component **1, 2** is provided with an arcuate floor section **15** and the section **15** of the rear component **2** is covered by a base plate **16**. The members **11, 12** are each of trapezoidal cross-section with a tapered knife-edge at its forward end. The members **11** are supported on three axially spaced expandible support devices **5, 6, 7** and similarly the members **12** are supported on three axially spaced expandible support devices **8, 9, 10**. The devices **5–10** are arranged in pairs, **5, 8**; **6, 9**; **7, 10**; as shown in FIG. **2**.

Each device **5–10**, is constructed as a pair of matching half-rings interconnected at their adjacent ends with piston and cylinder units **14**. The units **14** can be operated to urge the ends of the half-rings apart or to draw these ends together. In this way the devices **5–10** can be contracted or expanded to brace the members **11, 12** against the surface of a tunnel.

Double-acting piston and cylinder units **17** are used to alternately advance the wall components **1, 2** in the direction of the working face **31** in front of the cutting appliance **3** as described hereinafter. The units **17** are pivotably attached between brackets **18**, secured to the device **6**, and the device **10**.

The cutting appliance **3**, which is designed to remove material from the face **31**, is provided with a cutting head **23** supported for rotation on a frame **22**. The frame **22** bears elongate guide members or bars **19** which extend longitudinally of the wall components **1, 2** at each side of the frame **22**. These bars **19** slidably locate within recesses defined by brackets **20** carried by the devices **5, 6**. A plurality of piston and cylinder units **33** are pivotably connected between brackets **35** attached to the frame **22**. The mountings of the units **33** are displaceable longitudinally and the units **33** are used to retract the frame **22** and thereby the cutting head **23** into the wall component **1**. In addition, piston and cylinder units **29** are also connected between the device **10** and the frame **22**. These units **29** have detachable plug-like end connections **30** enabling them to be removed from the device **10**. The units **29** are used to advance the head **23** from the wall component **1** towards the face **31**.

The head **23** is driven by means of motors **24** carried by the frame **22**. The motors **24** are coupled to the head **23** via gearing **25** which meshes with a toothed ring. The head **23** has a number of radial arms **26** with removable end pieces **27** acting as holders for cutters **32**. Means, in the form of piston and cylinder units **28**, is provided for aligning the cutting head **23**. The units **28** are connected between the support means for the head **23** and the frame **22**.

The operation of the apparatus is as follows

Assume that the units **14** of the devices **8, 9, 10** are operated to expand the devices **8, 9, 10** and thereby brace the rear wall component **2** against the tunnel surface. The rear wall component **2** then forms an abutment whereby the forward wall component **1** can be advanced. To this end, the units **14** of the devices **5, 6, 7** are relieved and the units **17** and **29** are extended to advance the forward wall component **1** and the cutting appliance **3** towards the face **31**. The head **23** is thus urged towards the face **31** and is operated by the motors **24** to detach material from the face **31**. This material is transferred rearwardly of the apparatus by the conveyor **4**. When this advance is completed the units **14** of the devices **5, 6, 7** are operated to expand the devices **5, 6, 7** and brace the forward wall component **1** against the tunnel surface. The units **14** of the devices **8, 9, 10** can now be relieved and the units **17** operated to draw up the rear wall component **2** which is then re-braced. This cycle can then be repeated to progressively lengthen the tunnel.

From time to time it may be desirable to move the appliance **3** back into the wall component **1**, as for example where some manual operation is to be effected on the face **31**. In this event the units **29** are disconnected and moved into positions where they do not hinder the subsequent operation. With the rear wall component **2** braced against the tunnel the units **33** are now operated to retract the appliance **3** inwardly of the wall component **1**. When the manual operation or the equivalent is completed the units **33** are used to advance the appliance **3** outwardly until the units **29** can be reconnected. Thereafter the units **29** can be operated to continue the outward movement of the appliance **3** as desired.

The apparatus as described may be supplemented by a machine which follows up the apparatus and runs on a track laid in the tunnel. This machine may comprise means for installing tunnel lining sections end-to-end so as to provide a permanent support for the tunnel rearwardly of the apparatus. This rear machine may also be provided with a conveyor which receives material from the conveyor **4** and conveys such material rearwardly of the entire working.

I claim: