June 3, 1958 A. R. BIEDESS 2,837,325

ROTARY TYPE TUNNELING MACHINE

Filed Aug. 10, 1955 4 Sheets-Sheet 1

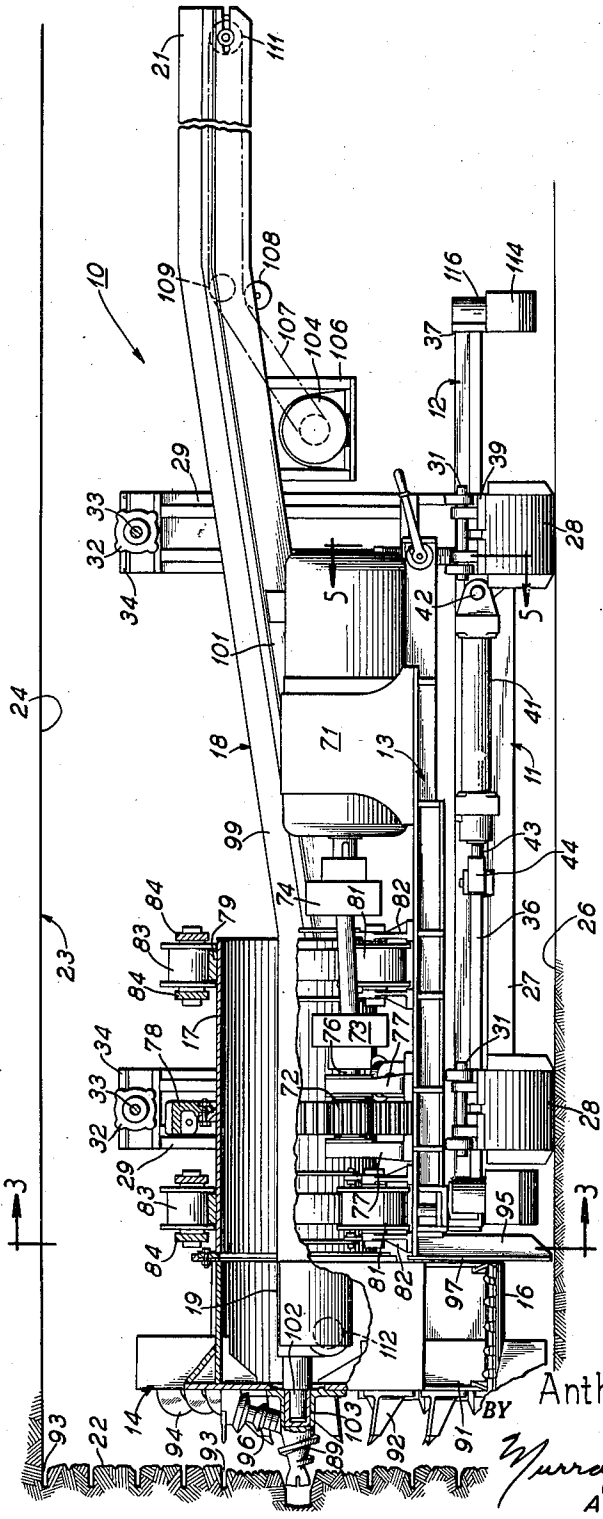


Fig. 1

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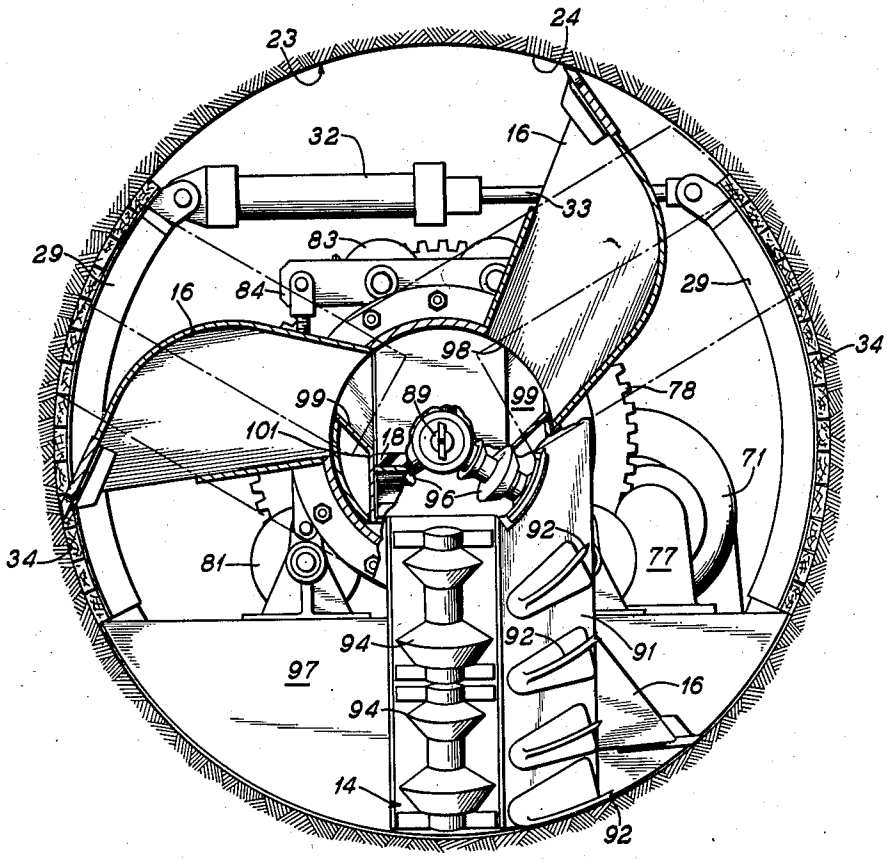


Fig. 2

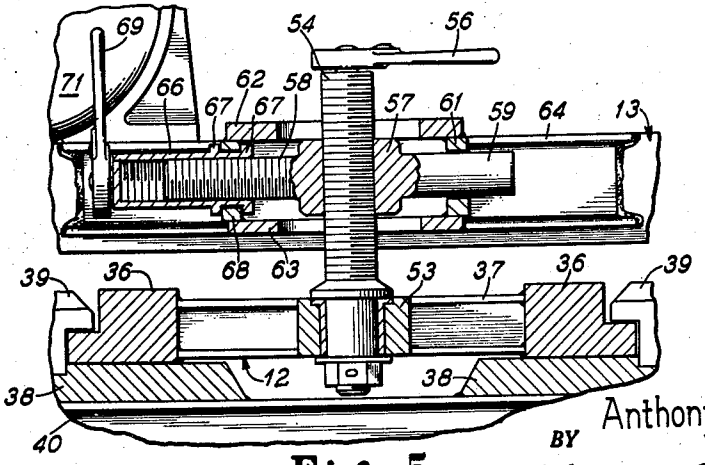


Fig. 5

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ROTARY TYPE TUNNELING MACHINE

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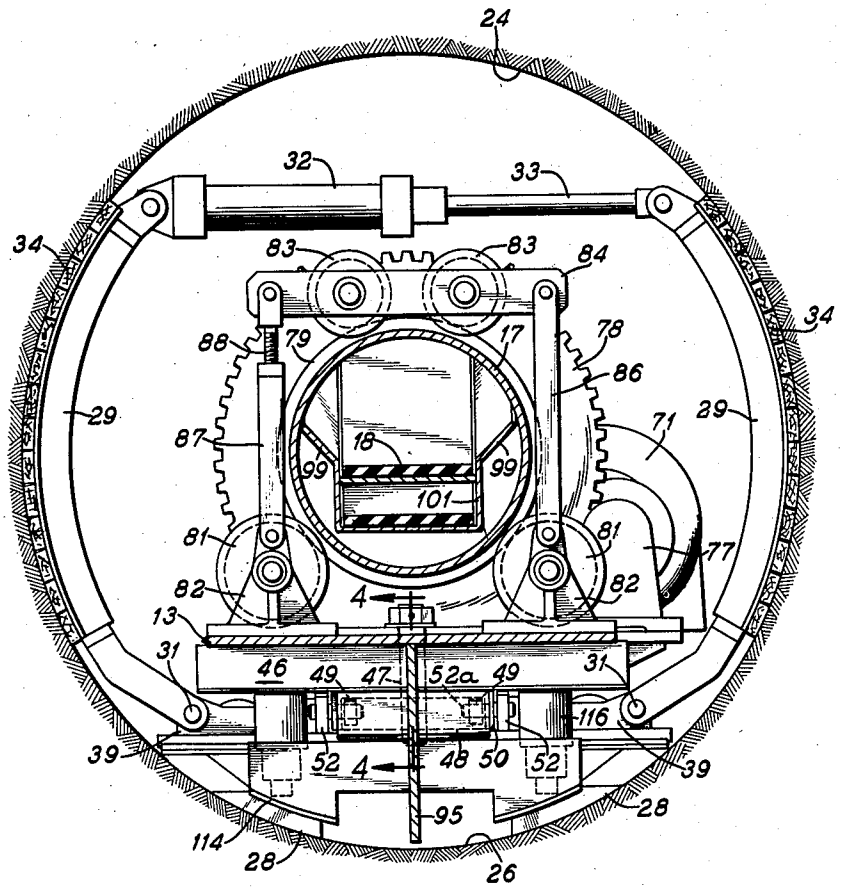


Fig. 3

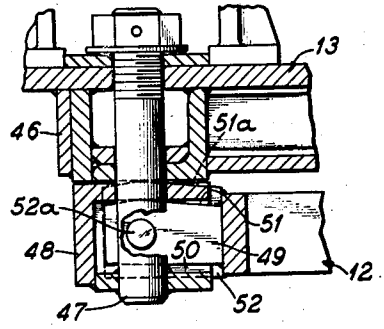


Fig. 4

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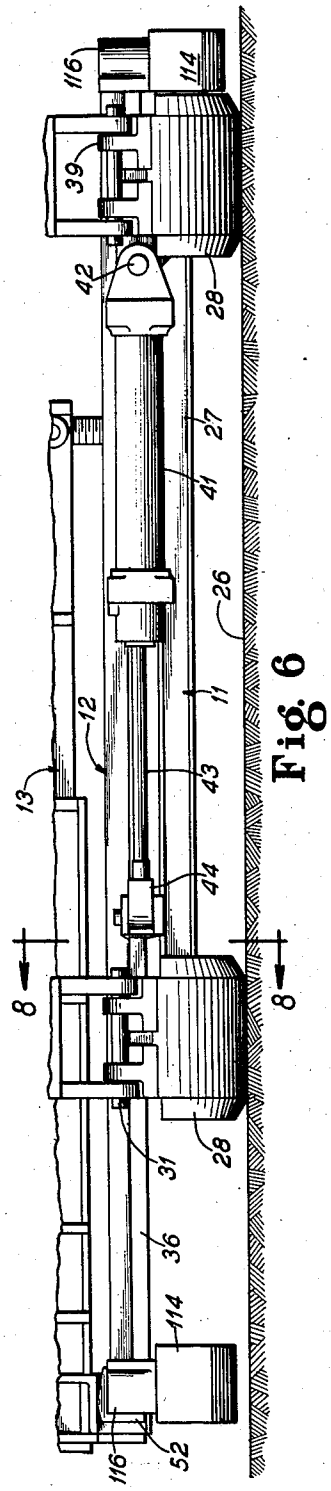


Fig. 6

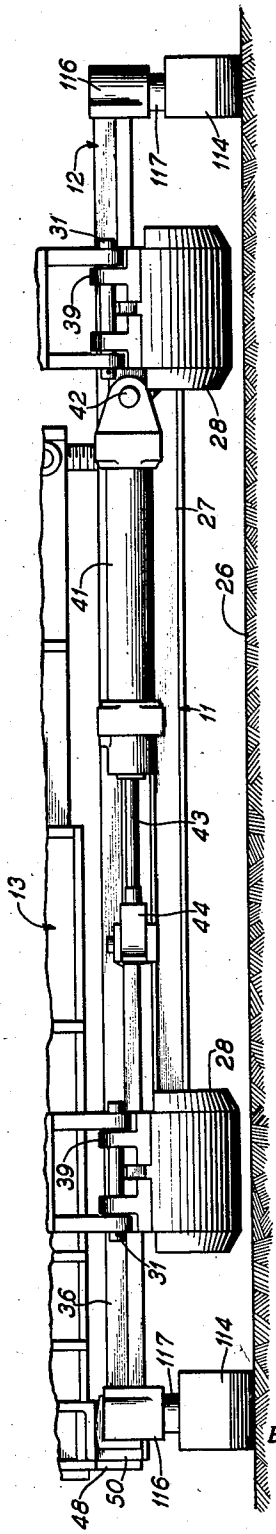


Fig. 7

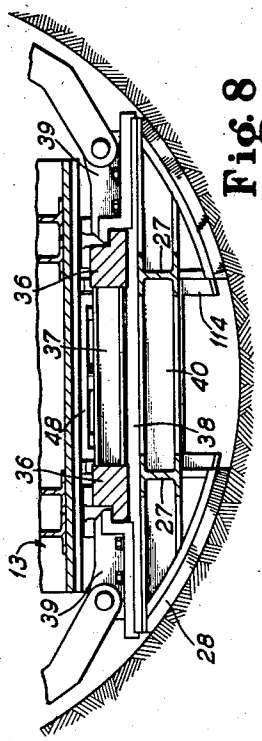


Fig. 8

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ROTARY TYPE TUNNELING MACHINE

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Application August 10, 1955, Serial No. 527,471

2 Claims. (Cl. 262—7)

This invention relates generally to tunneling machines for boring a tunnel from solid rock without the need of explosives, and more particularly to an improved machine characterized by being steered in both vertical and horizontal directions as desired.

One of the principal objects of this invention is to provide a tunneling machine capable of boring a tunnel of large diameter without the need of blasting and also capable of being operated as desired so as to make a tunnel of changing gradient and alignment.

Another object is to provide a tunneling machine of such lengthwise dimension that the tunnel lining operation may closely follow the boring operation.

Yet another object comprehends a tunnel machine characterized by the provision of mechanism for transmitting the reactive forces from the tunneling operation into the sides of the tunnel bore, and also characterized by mechanism whereby the points of reactive effort may be readily changed or shifted as desired in accordance with the rate of tunnel advance.

Other objects and important features of the invention will become apparent from a study of the specification following taken with the drawings which together describe and illustrate a preferred embodiment of the invention, and what is now considered to be the best mode of practicing the principles thereof. Other embodiments of the invention may be suggested to those having the benefit of the teachings herein, and it is therefore intended that the scope of the invention not be limited by the precise embodiment herein shown, such other embodiments being intended to be reserved especially as they fall within the scope and purview of the appended claims.

In the drawings:

Fig. 1 is a side elevation view of a tunneling machine having the improvements according to the present invention embodied therein;

Fig. 2 is a front elevation view of the machine seen in Fig. 1, certain parts being shown in section, said view being taken in a direction looking from the left to the right in Fig. 1, and showing details of the boring head of such machine;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1 and looking in the direction of the arrows, showing details of mechanism for taking the reactive force of the machine during the tunneling operation, and showing also details of an endless conveyor for removing cuttings resulting from the operation of the boring head shown in Figs. 1 and 2;

Fig. 4 is an enlarged detailed view of a swivel connection between the boring head and a support frame of such machine;

Fig. 5 is a partly elevational, partly sectional view taken substantially along the line 5—5 of Fig. 1 and looking in the direction of the arrows, showing means for effecting movement of the cutting head in both vertical and horizontal directions with respect to the support frame;

Fig. 6 is an enlarged side elevation view of the main frame seen in Fig. 1, and showing means for shifting the auxiliary frame and the boring head with respect to the main frame while the main frame is taking the reaction of the forces against the boring head;

Fig. 7 is a view similar to Fig. 6, but showing the auxiliary frame with ground engaging members extending therefrom and in engagement with the invert of the tunnel being bored, the main frame in such position being raised from contact with the invert of the tunnel and being in a position for movement with respect to the auxiliary frame whilst the auxiliary frame is in the aforesaid position; and

Fig. 8 is an elevational view taken substantially along the line 8—8 of Fig. 6 and looking in the direction of the arrows.

Referring now particularly to Fig. 1 of the drawings the improved tunneling machine according to the present invention is indicated generally by the reference numeral 10, and includes a main frame 11 supporting an auxiliary frame 12 movable with respect thereto under conditions as will appear, said main frame 11 being also arranged to be moved with respect to the auxiliary frame 12 whilst the auxiliary frame 12 is held in stationary position under other conditions as will appear. The auxiliary frame 12 supports a third frame 13, which provides a platform for a boring head indicated generally by the reference numeral 14 and including sweep members 16 carried thereby.

The boring head 14 and the sweep members 16 are mounted upon a hollow drum 17 which is arranged to rotate upon the platform 13, the cuttings from the boring head 14 being raised by the sweep member 16 to be discharged interiorly of the hollow drum 17 to be deposited upon an endless conveyor 18 having its inby end 19 within the hollow drum 17 and having its outby or discharge end 21 at the rear of the machine 10.

The main frame 11 is arranged to take the reactive effort from the boring head 14 in operating against a working face 22 to cut a bore 23 from solid rock, said bore having an arch 24 and an invert 26 as seen in Figs. 1 and 3 particularly. The main frame 11 consists of two laterally spaced frame members 27, which are connected at their ends to feet 28, 28 arranged to rest upon the invert of the bore 23 as seen in Fig. 3. The feet 28, 28 also afford points of anchorage for shoes 29, 29, each being pivoted at 31 to the feet 28 and connected at their upper ends through the medium of an hydraulic cylinder 32 and a piston rod 33, each of the shoes 29 having lagging 34 thereon for engagement with the sides of the bore 23. The cylinders 32 and the pistons 33 are arranged to be actuated to force the shoes 29 outwardly, firmly to engage the sides of the bore 23 in the manner as seen in Figs. 2 and 3.

The auxiliary frame 12 consists of a pair of slides 36, 36 which are spaced laterally of each other as seen in Fig. 5 and joined at each end by a cross member 37, see also Fig. 1. The two slides 36 are arranged to slide upon wear plates 38 resting upon transverse members 40 connecting the frame members 27 of the main frame 11, and are restrained against lateral shifting by means of guides 39 seen in Fig. 5.

A pair of hydraulic cylinders 41, are each pivotally connected at 42 to one of the pairs of feet 28, and are provided with piston rods 43 which are connected at 44 to the slides 36. The two cylinders 41, 41 when actuated move the auxiliary frame 12 relative to the main frame 11.

The frame 13 provides a platform for support of the endless conveyor 18 and the boring head 14. It is arranged to be moved in both horizontal and vertical directions with respect to the auxiliary frame 12, and is piv-

oted at its forward end to the auxiliary frame 12. As seen in Fig. 4, the frame 13 is stiffened at its forward end by a transverse member 46, which forms a point of support for the frame 13 upon the auxiliary frame 12. The auxiliary frame 12 underlying the frame 13 is pivotally connected thereto through the medium of a pin 47. A load transfer shoe 48 is arranged to be received upon a pair of tongue-like extensions 49 from the frame 12. The load transfer shoe 48 has end walls 50 which flank the tongue-like extensions 49. Similar tongue-like extensions 52 from the frame 12 underlie the frame 13, and the extensions 52 and 49 and the end wall 50 are pin connected by a pin 52*a*. The shoe 48 together with the pin 47 and the frame 13 is arranged to rock on an upper surface 51 of the extensions 49 and the extension 52 has a similar surface 51*a* upon which the frame 13 rocks.

The shoe 48 is pin-connected at 52 on each side of the pin 47, so that the shoe 48 together with the frame 13 may rock about an axis extending laterally of the machine 10. It will be noted that the frame 13 is also enabled to pivot about the pin 47 with respect to the auxiliary frame 12.

Means are provided for raising the frame 13 in a vertical direction and for shifting the position thereof in horizontal directions so that the tunnel bore may change both its gradient and horizontal alignment as desired. To this end the other end of the frame 13 is provided with a thrust bearing welded or otherwise secured to the transverse member 37 of the auxiliary frame 12, as seen more particularly in Fig. 5. A screw member 54 is supported on the thrust bearing 53 and is arranged to be turned by a ratchet type operating handle 56. The screw 54 cooperates with a nut 57 having a threaded extension 58 and a cylindrical extension 59 which extends through a guide 61, said guide in turn being supported by upper and lower plates 62 and 63 and welded to a transverse member 64 of the frame 13. The threaded extension 58 cooperates with a nut 66 having flanges 67 straddling a guide 68 similar to the guide 61, the guide 68 being also welded to the upper and lower plates 62 and 63. The nut 66 is arranged to be turned by a ratchet operating handle 69.

It will be apparent that turning of the screw 54 will raise or lower the frame 13 with respect to the auxiliary frame 12 depending upon its direction of rotation, while rotation of the nut 66 will cause the frame 13 to shift in a horizontal direction either to left or right depending upon the direction of rotation of the nut 66. The frame 13, as has been explained, is pivotally connected, see Fig. 4, to the forward end of the auxiliary frame 12, and the frame 13 may thus be adjusted in its position with respect to the auxiliary frame 12 to vary the direction of the tunnel bore 23.

Referring now to Figs. 1 and 3 particularly, the hollow drum 17 of the boring head 14 is arranged to be driven by a drive motor 71 mounted upon the frame or platform 13. A driving pinion 72 is connected to the motor 71 through the medium of flexible couplings 73 and 74, and is mounted to turn with a shaft 76 in shaft supports 77. The driving pinion 72 meshes with a ring gear 78 secured to the outer side of the hollow drum 17.

As seen in Fig. 3, the hollow drum 17 has a pair of annular ribs 79 which turn with the drum 17 upon idler rollers 81, each mounted upon the platform 13 upon roller support brackets 82.

The drum 17 is restrained against lifting from the idler support rollers 81 by means of upper idler rollers 83 bearing against the annular ribs 79 and journaled in arms 84, one end of the arms 84 being connected by hold down arms 86 to one of the standards 82 as seen in Fig. 3. The other end of the arms 84 are connected by hold down arms 87 connected at their lower end to the other support bracket 82, and the hold down arms 87 may be adjusted in their length by means of screws 88.

Referring now to Figs. 1 and 2 of the drawings, the boring head 14 has a pilot cutter 89 assisting in guiding the boring head 14. The boring head 14 includes boring arms 91, see Fig. 2, the forward face of which is provided with cutter elements 92 arranged to cut a series of concentric kerfs or grooves 93 in the face 22. The boring arms 91 also support tapered rollers 94 which are arranged to wedge the rock from between the annular grooves 93. The pilot cutter 89 likewise has tapered rollers 96 for a similar purpose.

The cuttings resulting from the action of the boring head 14 fall to the invert 26 of the tunnel 23 against a semi-circular shield or pusher plate 97 mounted at the forward end of the frame 13, see also Fig. 1. The pusher plate 97 bears against a vertical stiffener 95, see Fig. 3, depending from the forward end of the frame 13. The cuttings are thus maintained in a position close to the face 22 whence they are lifted by means of the sweep arms 16. The arms 16 are arranged to pick material from the invert 26, and upon rotation thereof to the position seen in Fig. 2, the cuttings carried thereby drop through openings 98 in the hollow drum 17 onto the endless conveyor 18.

As seen in Figs. 1 and 2 the endless conveyor 18 has flared sides 99 which extend upward from a frame 101 thereof. The inby end of the frame 101 has a cylindrical extension 102 which is supported within a hub 103 of the boring head 14.

Power for driving the endless conveyor 18 is had by a driving motor 104 suspended by brackets 106 beneath the endless conveyor 18. The motor 104 drives an endless chain 107 which is guided about idler sprockets 108 and 109, the endless chain driving a pulley 111 for the endless conveyor 18, the inby end 19 thereof having an idler pulley 112.

Referring now to Figs. 6 and 7 of the drawings, the auxiliary frame 12 is provided at each end with shoes 114 arranged to engage the invert 26 of the tunnel bore. These shoes are movable into invert engaging position by means of actuating cylinders 116 and pistons 117 connected to the shoes 114.

The operation of the machine thus far described is believed apparent from the description foregoing. The frame 11 is clamped in position by means of the bands 29 seen in Fig. 3 so that the frame 11 takes the reaction from the boring head 14. Crowding of the boring head 14 against the face 22 is had by means of crowding cylinders 41 connected between the main frame 11 and the auxiliary frame 12. As the tunneling operation progresses the auxiliary frame 12 will move with respect to the main frame 11 to the position seen in Fig. 6.

At such a time the actuating cylinders 32 for the bands 29 are actuated to collapse the bands 29. The cylinders 116 at the end of the auxiliary frame 12 are then actuated to move the shoes 114 seen in Figs. 6 and 7 to a position of engagement with the invert 26 of the tunnel 23. The main frame 11 together with its invert engaging shoes 28 is lifted by the cylinders 116, and the cylinders 41 are then operated in such a fashion as to cause the main frame 11 to move to the left until it takes a position once more as seen in Fig. 1.

When the main frame 11 has resumed its new position the cylinders 116 are relieved of their pressure fluid to cause the engaging shoes 28 of the frame 11 once more to engage the invert 26 of the tunnel 23. The cylinders 32, see Fig. 3 are once more actuated to cause the bands 29 to engage the tunnel side, and the tunneling operation is resumed as before.

It is possible according to the apparatus described to carry on the tunnel lining operations at a point close to the working face, thereby minimizing danger of rock falls and the like. By the provision of the movement of the frame 13 with respect to the auxiliary frame 12 it is possible for the machine to follow desired changes in gradient and horizontal alignment.

The machine according to the present invention is

also readily movable within the tunnel away from the working face by a reverse set of movements of the auxiliary frame and the main frame from that previously described.

While the invention has been described in terms of a preferred embodiment thereof its scope is intended to be limited only by the terms here appended.

I claim as my invention:

1. A tunneling machine comprising a main frame having ground engaging feet, an auxiliary frame, means acting between said main and auxiliary frames for causing relative movement therebetween, a boring head supported by said auxiliary frame adapted to cut a circular bore and comprising a rotatable hollow drum supporting boring arms at one end thereof, an endless conveyor mounted within said drum, and adapted to convey cuttings resulting from the action of said boring head, sweep members supported by said hollow drum arranged to lift cuttings from the invert of said bore and discharge same on said conveyor, means for maintaining said main frame in position whilst said auxiliary frame and said boring head move with respect thereto including a pair of curved shoes conforming to said circular bore, each being pivoted at its lower end to said main frame and extending around said hollow drum, means acting between the upper ends of said curved shoes and extending over said hollow drum to force said shoes against the wall of said bore, means acting between said auxiliary frame and the invert of said bore to raise the main frame from engagement with the ground whilst said curved shoes are released from engagement with the wall of said bore to enable the first named means to move the main frame to a new position with respect to said auxiliary frame.

2. The invention as defined in claim 1 wherein means are provided between said boring head and said auxiliary frame for moving them relatively in both horizontal and vertical directions.

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