PROCESS AND APPARATUS FOR MINING BY RETREAT REAMING

BACKGROUND OF THE INVENTION

This invention relates to the underground mining of a generally horizontally extending coal seam by a boring and reaming process which minimizes dust propagation. The apparatus used in the process may also be used for earth boring and reaming operations of general application. More particularly the invention relates to the underground mining of coal by boring and reaming using an apparatus comprising a spiral or auger conveyor.

Auger mining of coal has been successful and economical in open pits and in hillsides where vertical clearance is available but it has not been used generally where head room is limited.

No art disclosing mining coal underground by boring and reaming has been found.

The U.S. Pat. to Kandle, No. 2,839,271, issued June 17, 1958 shows a tunneling machine comprising an auger which bores a horizontal hole through the earth from one location and then reams the hole by means of a reaming head fastened to the auger at a second location and then moved back to the first location.

Cannon et al., U.S. Pat. No. 3,220,494, issued Nov. 30, 1965 shows making a vertical hole from one gallery of a mine to another by drilling from an upper gallery to a lower one, then attaching a reaming head and reaming upwardly.

Forsyth, U.S. Pat. No. 3,280,416, issued Oct. 25, 1966 shows decoking a tower by drilling upwardly, then expanding reaming cutters in a space above the coke and reaming downwardly.

Wheeler et al., U.S. Pat. No. 732,479, issued June 30, 1903 shows an auger for forming a conical hole, the auger comprising pivoted end sections which are expanded to ream the hole.

Various other patents show reaming apparatus for enlarging the bore of a vertical drilled hole by reaming cutters which are expanded in the hole, and Shook, U.S. Pat. No. 2,847,189, issued Aug. 12, 1958 shows such an apparatus in which the hole is reamed by drawing the reaming cutters upwardly.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to provide for the mining of coal in underground mines with only a small amount of dust propagation.

It is another object to mine a seam of coal by forming a hole in said seam, enlarging the blind end of said hole to approximately the full height of said seam and breaking away the coal from the enlarged space towards the accessible face of the seam while conveying the coal towards said face.

Another object is to provide a reaming and boring tool and auger of spiral conveyor sections of small size whereby the mining operation may be carried out by a small number of men in a confined space.

Another object is to provide for mining coal whereby no men would work at the place where the coal is being removed from the seam and no roof bolting, props or rock dusting would be required at this locating.

Another object is to mine a seam of coal by using a cylindrical drilled hole having a diameter substantially equal to the height of the seam, the arch action of the walls of the drilled hole providing a roof and bottom support which allow mining under weak and tender rock which otherwise could not be mined conventionally.

In order to achieve these and other objects which will become apparent as the description proceeds I provide a drilling and reaming apparatus which may be used for drilling and reaming in the earth for various purposes but particularly for mining a horizontal seam of coal by boring a holes in said seam, conveying the bored coal to the accessible face of said seam by an auger or spiral conveyor, then reaming the blind end of the hole out by spreading reaming wings and continuing the reaming of the coal seam toward the accessible face while conveying the coal to said face with the auger or spiral conveyor. The apparatus comprises a spiral conveyor having the front end thereof enclosed by a cylinder, the front of the cylinder having cutting means and the wall of the cylinder having reaming wings pivoting on longitudinally extending pivot axes. The apparatus is rotated by a shaft which is slidable through the center of the conveyor and connected by links to the reaming wings so that retraction of the shaft will open the wings. Doors on the cylindrical enclosure underneath the reaming wings open by gravity to allow the coal cut by the reaming wings to fall into the conveyor and then close to retain the coal on the conveyor. Spiral ribs on the cylinder engage the coal and urge the apparatus forwardly while the shaft is being rotated and retracted to open the reaming wings and ream the coal. Flanges on the wings retain the cut coal and direct it towards the conveyor. Propellers on the shaft and spiral vanes on the cylinder act as a transition conveyor between the reaming section and spiral conveyor sections attached to the shaft rearwardly of the reaming section.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1*a* is a side elevation of the rear of the apparatus in place in a mine shown in cross section;

FIG. 1*b* is a side elevation of the front of the apparatus in place in a coal seam with the reaming wings expanded;

FIG. 2 is a rear elevation of the apparatus;

FIG. 3 is a plan view of the driving means and cross conveyor with the spiral conveyor sections removed;

FIG. 4 is a side elevation of the front of the apparatus on a larger scale with the reaming wings retracted;

FIG. 5 is a view like FIG. 4 with the reaming wings expanded;

FIG. 6 is a front elevation of the boring head;

FIG. 7 is a cross section taken on the line 7—7 of FIG. 4 in the direction of the arrows;

FIG. 8 is a cross section on an enlarged scale taken on line 8—8 of FIG. 4 in the direction of the arrows;

FIG. 9 is a fragmentary cross section taken on line 9—9 of FIG. 4 in the direction of the arrows;

FIG. 10 is an elevation of FIG. 9 from the right;

FIG. 11 is a cross section taken on line 11—11 of FIG. 5 in the direction of the arrows;

FIG. 12 is a cross section on an enlarged scale taken on line 12—12 of FIG. 5 in the direction of the arrows;

FIG. 13 is a fragmentary section taken on line 13—13 of FIG. 12 in the direction of the arrows;

FIG. 14 is a cross section taken on line 14—14 of FIG. 4 in the direction of the arrows;

FIG. 15 is a cross section taken on line 15—15 of FIG. 5 in the direction of the arrows; and

FIG. 16 is a cross section taken on line 16—16 of FIG. 5 in the direction of the arrows.

DESCRIPTION OF THE INVENTION

The mining apparatus 1 of the invention comprises a driving unit 2, conveyor section 3, a reaming section 4 and an advance mining head or section 5. The apparatus is shown as being used in an underground coal mine for mining a seam 6 of coal by operations conducted from an entry 7 adjacent the accessible face 8 of the coal seam. Conventional bolts 9 are shown as providing supports for the roof of the entry.

The drive unit 2 is a conventional portable-type which may be set up in and readily moved to different locations in the entry 7. The unit 2 comprises a bed 10 carrying rollers 11 supporting a carriage 12 having channels 13 engaging the rollers, whereby the carriage may be moved back and forth over the rollers by an advance and retreat drive 14 comprising a power means 15 mounted on the carriage and driving a drum 16 on which is wound a cable 17 anchored at each end to the bed 10. Also mounted on carriage 12 is a power means 18 for rotating the boring apparatus by means of a driven shaft 19.

The driving unit 2 may be adjusted in elevation by hydraulically operated extensible and retractable legs or jacks 20.

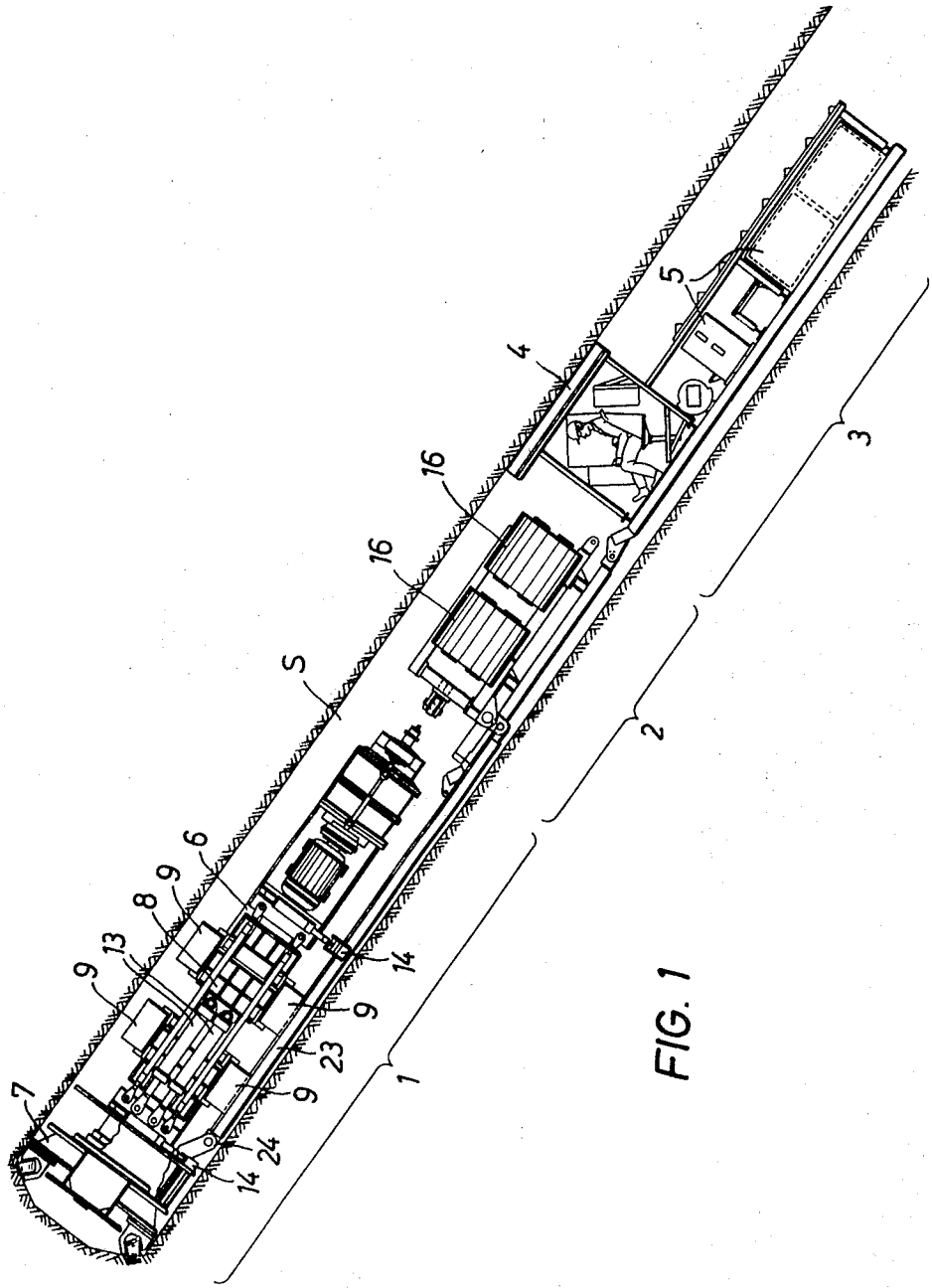


FIG. 1

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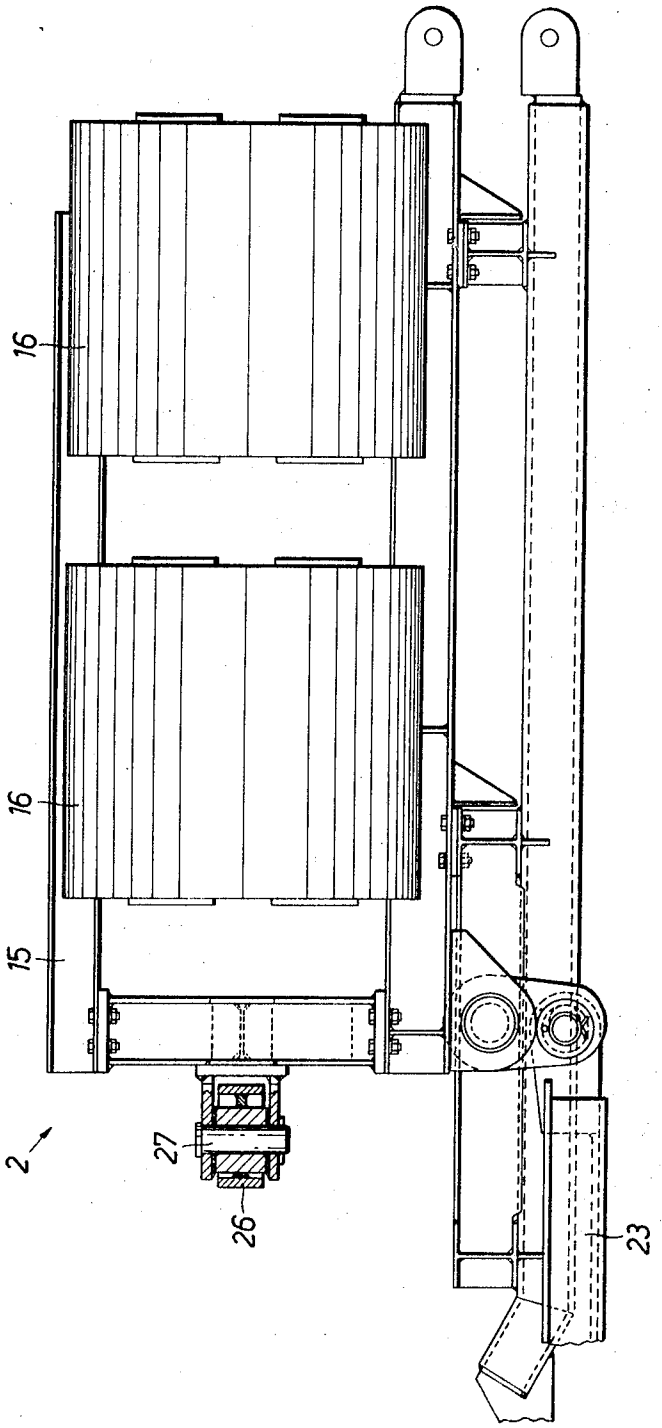


FIG. 2

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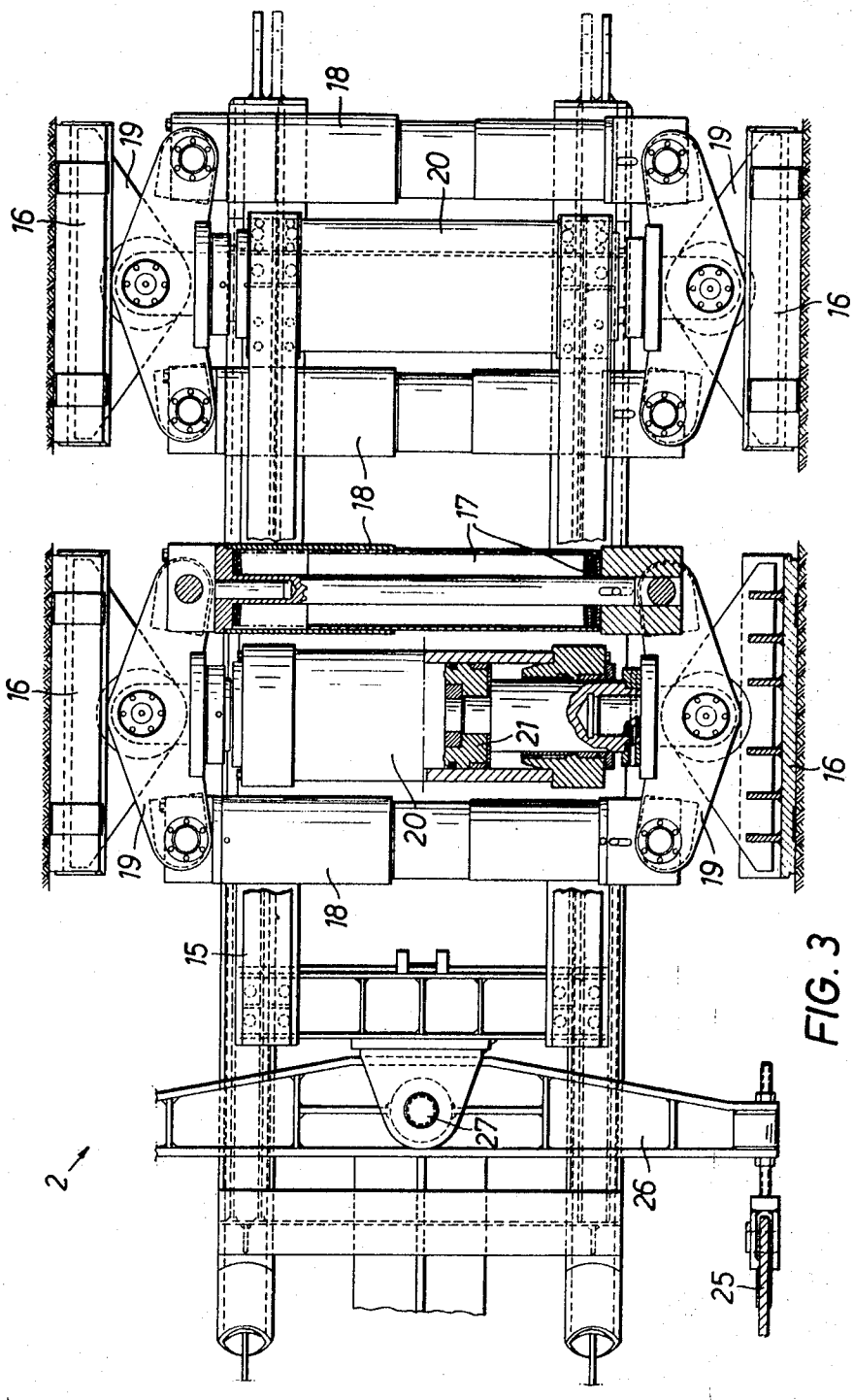


FIG. 3

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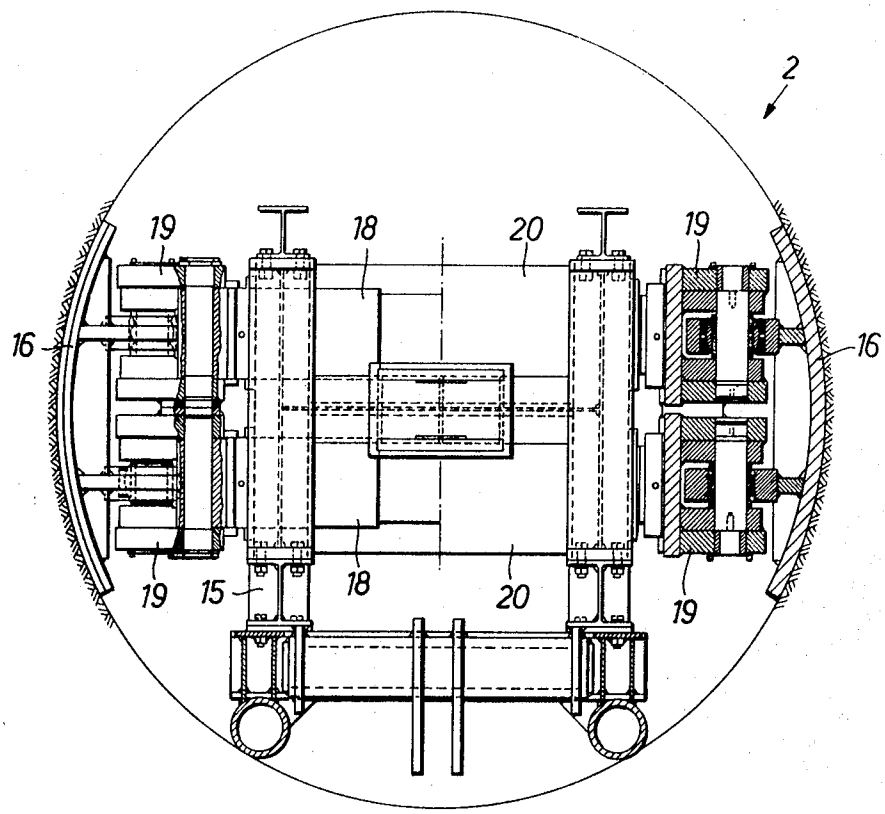


FIG. 4

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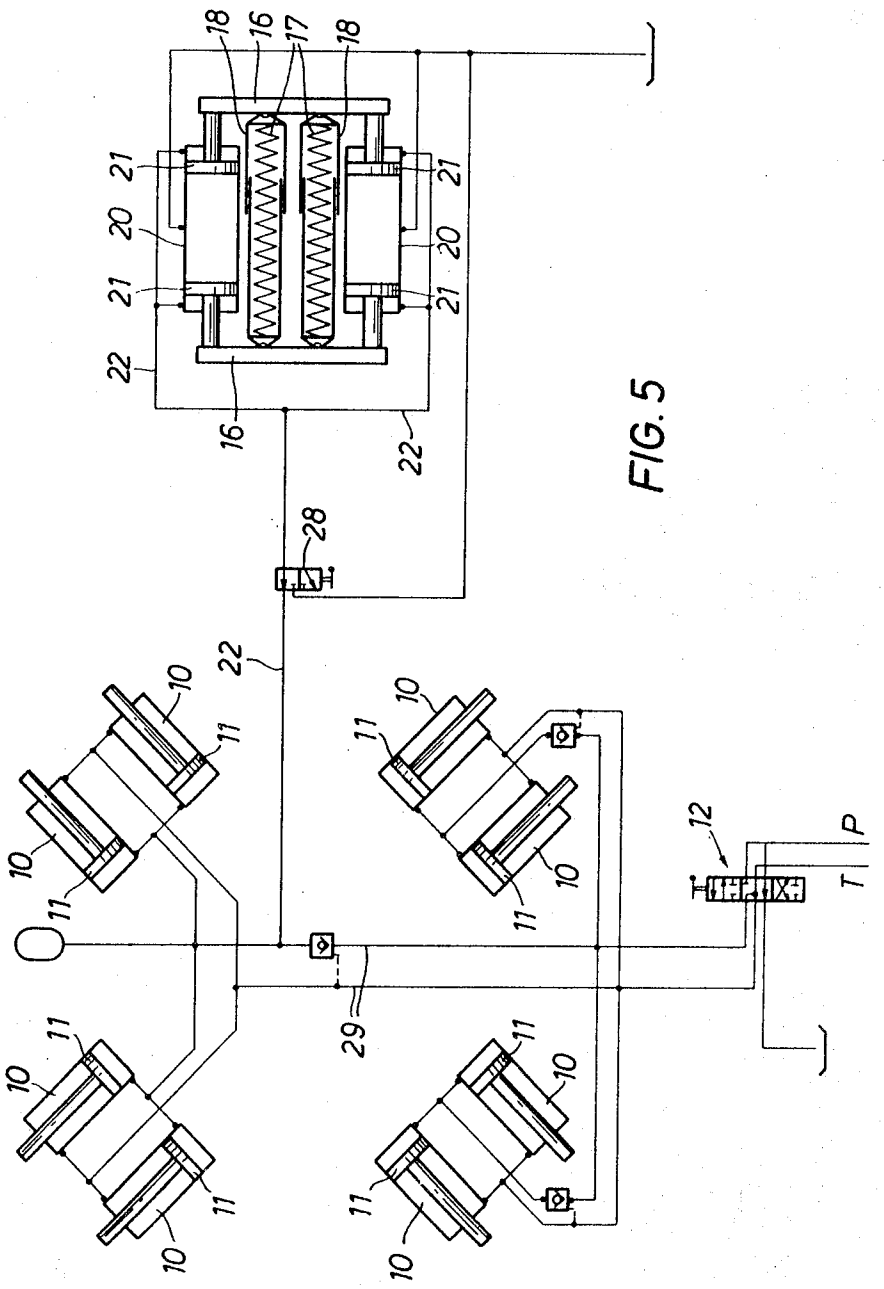


FIG. 5

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STEPPER ADVANCING APPARATUS FOR DRILLING INCLINED TUNNELS

BACKGROUND OF THE INVENTION

Heretofore, conventional excavating equipment has consisted of a drill-mounting frame having hydraulic rams to extend a rotary boring head disposed therein and including extensible clamping plates adapted to engage the tunnel walls to anchor the head as the drill is advanced. Once the stroke of the drill is completed, the drill grips the tunnel walls, the clamping plates on the frame are retracted, and the rams are retracted to advance the frame forwardly, the extent of the stroke and the operation is repeated.

Such excavating equipment has proven satisfactory for drilling substantially horizontal shafts, but is unacceptable for graded and/or vertical shafts gravity would cause the frame to slip when the clamping plates are released to effect movement.

Such driving machines have proved satisfactory for cutting level shafts or the like. In consequence, it would be of great advantage to be able to employ such machines also for driving sloping drifts, galleries etc., so that conventional excavating methods requiring a considerable amount of labor and time.

SUMMARY OF THE INVENTION

The present invention envisions excavating equipment which may be employed to drill sloping shafts, oblique wells and the like.

With the machine according to the invention, the frame clamping plates may be released from the tunnel walls after each advance stroke relative to the machine frame in precisely the same manner as in a horizontal shaft, since a bracing mechanism bears all the forces which tend to move the frame downwards.

Essentially, the invention suggests a bracing mechanism coupled to a conventional drill frame and including clamping plates normally urged into engagement with the tunnel walls by springs. Retracting means on the bracing mechanism overcome the bias of the springs when the mechanism is to be moved in the tunnel. The retracting means and the extensible clamping plate on the drill frame are operatively associated whereby the retracting means are only actuated to overcome the spring bias and thus release the bracing mechanism when the extensible clamping plates of the frame engage the tunnel walls. Conversely, when the extensible clamping plates of the frame are released from the tunnel wall, the retracting means are deactivated and the springs urge the clamping plates into engagement with the tunnel. The bracing mechanism stabilizes the drill frame against vertical movement; the bracing mechanism clamping plates always engage the tunnel walls when the drill frame clamping plates are disengaged from the tunnel. Consequently, should the hydraulic supply to the drill frame fail, the bracing mechanism would prevent gravity from causing vertical movement.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described with reference to the drawings, in which:

FIG. 1 is a side view of the invention in its operating position in an oblique or sloping shaft;

FIG. 2 is a side detail view of the bracing mechanism;

FIG. 3 is a longitudinal cross section view of the bracing mechanism as seen from the top;

FIG. 4 is a transverse cross section view of the bracing mechanism;

FIG. 5 is a schematic diagram of the hydraulic system of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The excavating equipment shown in FIG. 1, illustrates drilling a sloping tunnel S, for example a penstock tunnel for a hydroelectric power plant, and comprises drill frame 1, bracing mechanism 2 and control trailer 3 all interconnected as will be explained fully hereinafter.

The trailer 3 contains the operator control cab 4 as well as hydraulic fluid supply source 5 required for operation of the machine. The drill frame 1 includes machine frame 6, at whose leading extremity is journaled the rotatably drivable cylindrical boring head 7 which mounts the drill. The drill frame clamping mechanism 8, comprises two sets of four arcuate clamping plates 9 which are expanded concurrently radially against the walls of the excavation by hydraulic cylinders 10. Hydraulic fluid input to the cylinders is controlled by valve 12 which receive and distributes the pressurized fluid to the cylinders from pipe P connected in parallel to the cylinders and communicating with source 5. An outlet or drain pipe T permits exhaust of the fluid from the cylinders. It should be appreciated that the concurrent expansion of the plates 9 could be achieved by pneumatic pressure or by electrically controlled solenoids.

When the clamping plates 9 anchor the drill frame, the boring head 7 is displaced forwardly by hydraulic cylinders 13 angularly spaced about the head and pivotally connected to the machine frame 6 to perform the excavating operation on the local cutting face.

At the end of the cutting stroke, the machine frame is set down on hydraulically extensible bearers 14, the clamping plates 9 are retracted and the clamping mechanism 8 advanced by the retraction of the feed cylinders 13. The operation is repeated after the clamping plates 9 have been expanded again to bear on the walls of the excavation.

The bracing mechanism 2 acts in a manner similar to the clamping mechanism 8 and is intended to anchor the machine against the immense forces of gravity imposed on bearers 14 to prevent rearward slip in the sloping drift S. The bracing mechanism thus enables the utilization of the drilling machine of the present invention in a sloping tunnel or shaft.

The bracing mechanism 2 comprises a framework including longitudinal beams 15 for mounting two pairs of diametrically opposed arcuate clamping plates 16. The plates are radially expansible to engage the walls of the excavation to preclude movement of the mechanism relative to the tunnel. The extension and pressing of the plates 16 is achieved by a plurality of compression springs 17 housed in telescopic tubes 18. Each pair of plates 16 is coordinated with four spaced housed springs two each acting on levers 19 hingedly fastened to plates 16 (FIGS. 3 and 4). Between the plate springs 17 are spaced dual-piston cylinders 20 whose pistons 21 are connected at the free end to levers 19.

The pistons are retractable into the cylinder by the injection of hydraulic fluid to the outer faces via conduit 22 connected to the cylinder in parallel. Retraction of the pistons overcomes the bias of the springs 17 and disengages the plates from the tunnel walls.

This operation transpires when the machine is in operation, i.e., when the clamping system 8 is locked to the walls of the excavation by its clamping plates being extended, and the machine frame 6 performs its forward displacement as will be explained hereinafter.

Conversely, if pistons 21 are not retracted, the force of the springs 17 securely anchors the plates 16 in contact with the tunnel walls. This occurs after completion of a forward displacement and the clamping mechanism 8 of the machine is advanced forward again.

The coupling of the boring head 7 and the bracing mechanism 2 consists of two rods 23, one end articulated on the bracing mechanism and the other is articulated on a leading portion of the boring head on rotatable coupling links 24.

The boring head is supported by the rods against bracing mechanism to withstand the weight of machine frame 6 as the latter advanced towards the boring head by retraction of cylinders 13. The control trailer 3 of the machine is coupled to the rear extremity of the bracing mechanism 2. For alternative traction force transmission while performing forward displacement, it is possible, as apparent from FIG. 3, to incor-

porate wire ropes 25 which lead from the machine frame 6 to the bracing mechanism 2, being fastened thereat e.b. to a crossbeam 26 which is journaled on a spindle 27 on the leading side of the bracing device.

As is apparent from the hydraulic diagram according to FIG. 5, the hydraulic pipes 22 connected in parallel to actuating cylinders 20 are connected through a separating valve 28 to the hydraulic system 29 for concurrently feeding and extending cylinders 10. Consequently, extension of cylinders occurs simultaneously with the retraction of piston 21 to overcome springs 17. Accordingly, should the hydraulic system fail and pistons 11 not be extended, the springs 17 would retain plates 16 against the tunnel walls to prevent gravity from causing the excavating equipment to slip.

All the features cited in the foregoing description are given by way of example only; it is apparent that other modifications can be made without departing from the scope of the invention.

What I claim is:

1. Apparatus for drilling tunnels comprising frame means for mounting tunnel boring means, a bracing mechanism, engine-mounting means interposed between said frame means and said bracing mechanism longitudinally extensible, means interconnecting said frame means and said engine-mounting means for varying the distance therebetween, at least one rod interconnecting said frame means and said bracing mechanism, laterally extensible means on said engine-mounting means adapted to engage the tunnel walls whereby said engine-mounting means is anchored against movement, at least one brace plate on said bracing mechanism normally urged to engage the tunnel wall retracting means operatively associated with said laterally extensible means for withdrawing said bracing plate from engagement with the tunnel wall when said laterally extensible means are actuated.

2. Apparatus according to claim 1, wherein said bracing mechanism is provided with a plurality of bracing plates, spring means biasing said plates into engagement with said tunnel walls, said laterally extensible means and said retracting means comprising a plurality of fluid-actuated rams communicating with a common fluid source whereby actuation of said rams cause said extensible means to engage the tunnel walls and said retraction means to overcome the bias of said springs whereby said plates are disengaged from the tunnel walls.

3. Apparatus according to claim 2, wherein a plurality of rods are pivotally connected at each end to said frame means and said bracing means to stabilize both as the distance between said frame means and said engine mounting is contracted by actuation of said reciprocal interconnecting means.

4. Apparatus according to claim 3, wherein said bracing mechanism comprises pairs of arcuate clamp plates disposed on opposite sides thereof urged to engage the tunnel walls.

5. Apparatus according to claim 4, including a control trailer coupled to said bracing mechanism including a control cab, valve means disposed in said cab, said valve means interposed between said common source and said extensible and retracting means.

6. Apparatus according to claim 1, wherein said tunnel boring means includes second laterally extensible means to engaged said tunnel walls when said reciprocal means spreads said frame means and said engine-mounting means.

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