Oct. 25, 1938. D. M. HOLLINGSWORTH 2,134,478

TUNNELING MACHINE

Filed May 11, 1938 2 Sheets-Sheet 1

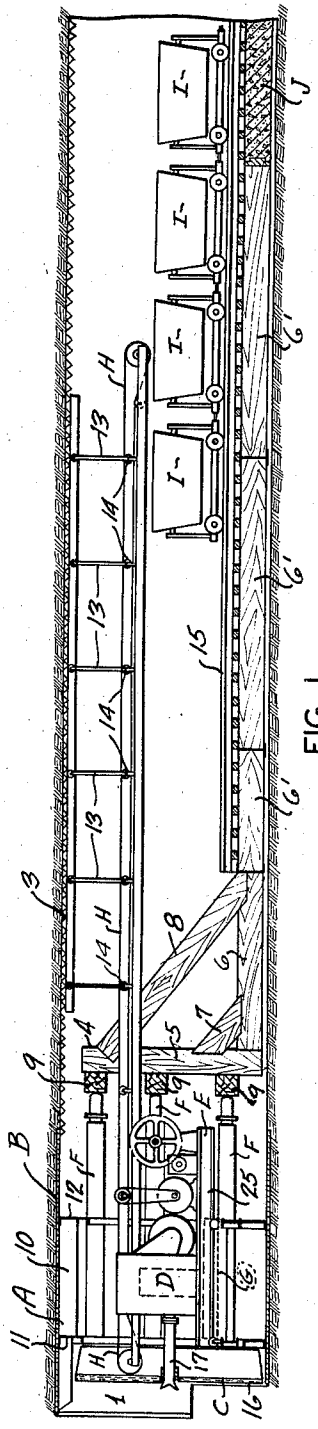


FIG. 1.

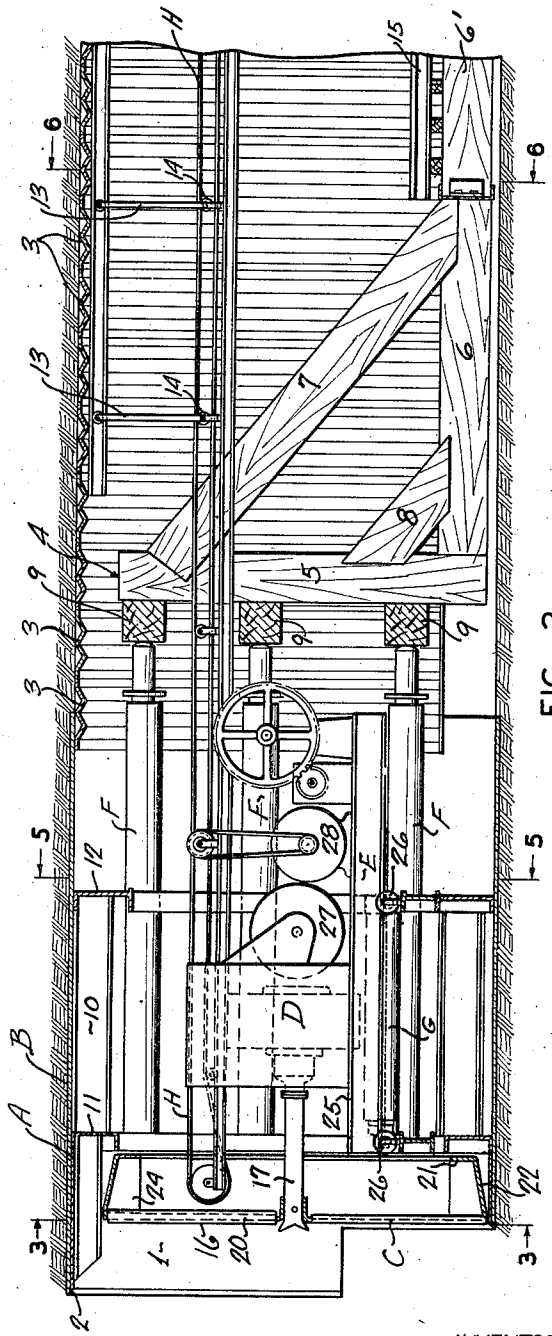


FIG. 2.

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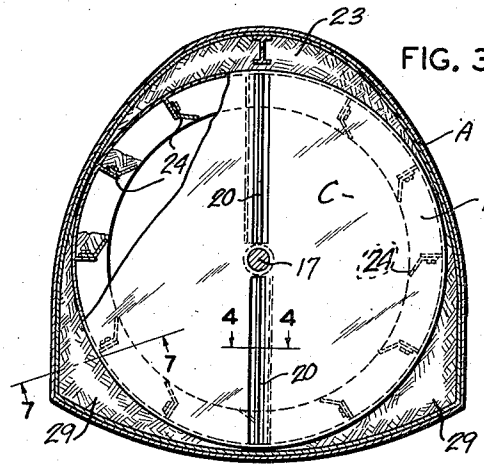


FIG. 3.

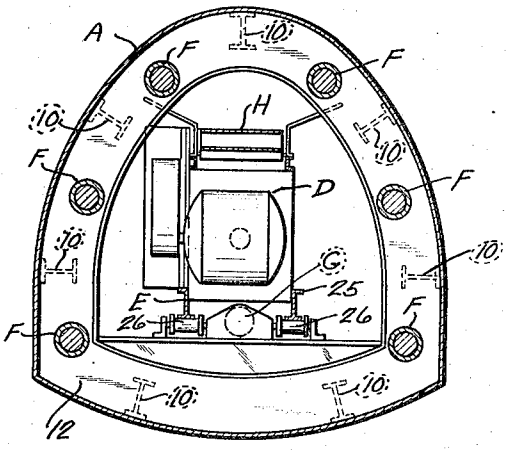


FIG. 5.

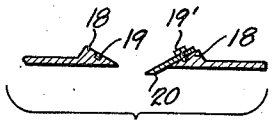
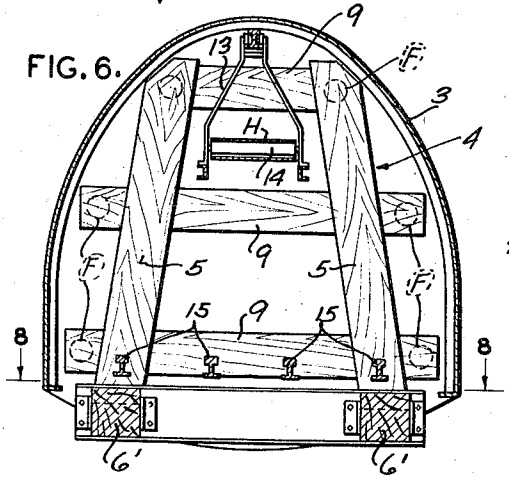


FIG. 4.

FIG. 6.



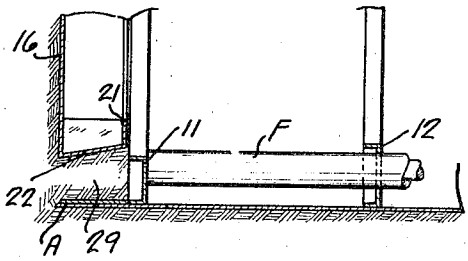


FIG. 7.

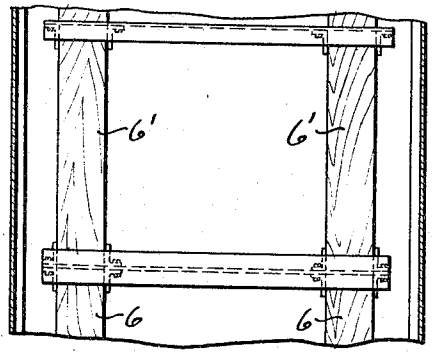


FIG. 8.

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UNITED STATES PATENT OFFICE

2,134,478

TUNNELING MACHINE

Denzil M. Hollingsworth, St. Louis, Mo., assignor to Equipment Rental Corporation, St. Louis, Mo., a corporation of Missouri

Application May 11, 1938, Serial No. 207,257

6 Claims. (Cl. 61—85)

My invention relates to tunneling machines, and has for its principal object to produce such a machine relatively cheaply, and one which is highly efficient in performance. Tunneling, particularly for sewer work and the like, is generally done by manual labor where the earth is of such consistency that it can be removed by pick and shovel. This is necessarily a slow and expensive method. Such efforts to use a machine to replace manual labor of which I have any knowledge have not been particularly successful, due, I believe, to cumbersome mechanical methods and arrangements, and the rather slow advancing movement of such a machine. It is to be understood that where the tunneling is in rocky material my tunneling machine is not usually applicable, for much of such material must be blasted out. My machine is particularly applicable where the earth is clay, marl, shale, or such other material and where men with pick and shovel could most effectively work. By experience I have found that by using my machine I can progress at approximately a speed of one foot per minute while drilling. In sewer construction work such speed in tunneling is highly important and results in a great saving in the cost of constructing a sewer.

By my mechanical set-up the tunnel is advanced and the sewer construction work is likewise progressively carried forward, and when the sewer is completed my mechanism is all subject to withdrawal through the completed sewer without injury or detriment thereto.

An important feature of my invention is that I employ a forwardly movable shield which is advanced by means of hydraulic jacks approximately twenty-four inches ahead of the drilling device, and which defines the upper portion of the sewer. The drill then removes the earth within a cylindrical radius inside said shield, and the earth so removed is carried on a traveling conveyor to cars into which said earth is discharged, and as each car is filled with such earth it may be pulled out of the sewer and dumped.

Horseshoe shaped shields have not been successfully jacked due to their tendency to rotate, therefore a still further important feature of my invention is that if and when the shield tends to rotate during the drilling operation and thus produce a tilted arrangement of said shield, I can reverse the cutting blades on the rotatable drilling member, which causes the shield to rotate in the opposite direction, and thus I can restore said shield to its normal position. If such rotation continues to the detriment of the drilling work, I can again reverse the cutting blades and again restore said shield to its normal position. These cutting blades are readily accessible and can be changed in a relatively short time.

I preferably advance my drill by using one hydraulic jack bearing against a portion of the carriage upon which my drill is mounted. As stated before, all the mechanical equipment which I employ can be dismantled and the several parts freely removed through the completed tunnel.

The shield is kept on line and grade by varying the pressure thereon by different hydraulic jacks which are used to advance said shield. By my invention a minimum amount of manual labor is necessary and only one operator for the machine is required.

Fig. 1 is a longitudinal, sectional view showing the drilling device and loading system.

Fig. 2 is an enlarged section of the drilling portion of the mechanism.

Fig. 3 is a cross-section taken on line 3—3 of Fig. 2 showing the drilling head partly in elevation and partly in section.

Fig. 4 is a detail section taken on line 4—4 of Fig. 3.

Fig. 5 is a cross-section taken on line 5—5 of Fig. 2.

Fig. 6 is a cross-section taken on line 6—6 of Fig. 2.

Fig. 7 is a section taken on line 7—7 of Fig. 3.

Fig. 8 is a horizontal section taken on line 8—8 of Fig. 6, showing the jack-positioning means.

In the drawings A designates a longitudinally movable shield forwardly movable in a tunnel B, so as to penetrate the earth to be removed in the excavation of said tunnel. C is a drilling device operable by a motor D mounted on a carriage E.

The drill never penetrates beyond the top of the shield A, and this tends to prevent falling or caving of soft material. A series of hydraulic jacks F, usually six in number, are used to push the shield A forwardly into the earth. The drilling device C is moved forwardly by a hydraulic jack G. A belt conveyor H is mounted in the upper part of the equipment for carrying back to dump cars I the earth drilled out by the drilling device C.

1 designates a forwardly extending portion of the shield A and is preferably tapered, as at 2, to facilitate the penetration of the earth by said portion 1. This portion 1 preferably extends approximately about two-thirds around the drilling device C and is capable of moving ahead of and independently of said drilling device. In Figs. 1 and 2 the shield A has been advanced about

two feet into the earth ahead of the drilling device C. The shield A extends rearwardly a substantial distance, as shown in Figs. 1 and 2. As the drilling progresses and the tunnel is cleared, corrugated liner plates 3 are placed about the top and sides of said tunnel and serve as supporting means for said tunnel and one face of a wall for concrete with which said tunnel is lined, as shown at J in Fig. 1. The concrete lining is the usual lining employed in tunnel or sewer construction.

The hydraulic jacks F for advancing the shield A bear against an A-frame 4 which is composed of the uprights 5 and rearwardly extending timbers 6 and 6' which extend rearwardly and abut against the forward end of the floor portion of concrete J, which is preferably of quick-setting cement so that a sturdy setting for said jacks is thus provided. Timbers 7 and 8 as supports for the A-frame are set diagonally in contact with one face of the uprights 5 and the rearwardly extending timbers 6. Cross timbers 9 are placed across the A-frame, and it is against these timbers 9 that one end of the hydraulic jacks F pushes. The hydraulic jacks which I employ have a seven foot throw and a capacity of one hundred and fifty tons each.

The shield A is held in its expanded position by seven I-beams 10, which are placed longitudinally of the shield (see Fig. 5), and two circumferentially placed members 11 and 12, one near the front of the shield A and the other approximately two-thirds of the way back (see Figs. 1 and 2). The beams 10 extend longitudinally of the shield between these two members 11 and 12. Preferably the beams 10 and members 11 and 12 are bolted to the inner circumference of the shield A so that when the shield is to be dismantled and removed from the sewer these parts may be removed and the shield collapsed, thus permitting the ready removal of said shield.

The belt conveyor H is supported from the roof of the tunnel by the hangers 13, which have rollers 14 at the lower ends thereof over which the flexible belt conveyor H moves. The dump cars run on the rails 15 placed longitudinally along the floor of the tunnel. One set of said rails 15 may serve to receive another string of dump cars, and the belt conveyor H may be swung so as to discharge first into one string of cars and then into the other string.

The drilling device C consists of a circular plate 16 mounted on a shaft 17 which extends forwardly from the motor D, and is driven by said motor. Radial slots are provided in this plate 16 and are sufficiently wide to admit the earth cut away by the drilling device. At the edge of each side of these openings I provide angular supports 18 which have threaded openings 19 in the outer face thereof to receive threaded bolts 19' for securing the blades 20 in position (see Fig. 4). By this arrangement the blades 20 can cut away the earthy material against which the drilling device A abuts. The plate 16 is supported by a circular member 21, which is supported in any convenient manner and the outer edge of which extends forwardly as at 22 to serve as a support at the forward edge thereof for the plate 16, which plate is revoluble. If and when it is desired to reverse the cutting revolution of the plate 16, the blades 20 are detached from the side to which they have been bolted when the plate 16 was rotating in one direction and placed on the opposite side of the opening and bolted to the angular support 19 located at the side of said opening. If a horseshoe shaped sewer is being tunneled, I cut a circular opening and the earth 23 at the top of the shield A but above the top of the rotating plate 20 drops down and through openings provided in the forwardly extending part 22 of the circular member 21.

A sufficient space between the inner faces of the circular plate 16 and member 21 is provided to permit a series of buckets 24, carried by the circular plate 16, to operate and thus as the earth passes through the radial openings in the plate 16 or drops from the upper, horseshoe portion of the shield A, it is elevated by the buckets 24 and dumped therefrom onto the belt conveyor H, which in turn carries it rearwardly to a point over the dump cars I, into which said earth is discharged by the conveyor H. The forward end of the conveyor H extends into the space between the circular plate 16 and the member 21, as shown in Figs. 1 and 2. It will be understood that the motor D is reversible, but as the motor and its associated parts are no part of my invention, I am not illustrating or describing in detail said motor and its associated parts, as any conventional type motor may be employed.

The drilling device C and motor D and associated parts are mounted on a carriage 25, which is mounted for longitudinal movement upon the rollers 26 appropriately placed on the members 11 and 12. If necessary an appropriate supporting device for the upper portion of the motor D may be supplied.

A hydraulic pump 27 is provided and is operable by a motor 28. This pump supplies the water for the hydraulic jacks. The conveyor H may also be run by said motor 28 operable independently of the motor D.

The earth in the lower corners of the horseshoe as shown at 29 can be removed manually by a shovel and thrown into the buckets 24, and from them discharged onto the belt conveyor H.

The conveyor H is attached to the drill reduction drive driven by the motor D and moves forward with the drilling device as the hydraulic jack G drives the drilling device forwardly to make it dig. The drilling device C is 8 feet in diameter, with two cutting edges which are designed to cut 1 inch of earthy material with each revolution. The device C rotates at approximately 10 revolutions per minute. The peripheral speed of the drilling device C is approximately 250 feet per minute, and the speed of the conveyor belt H is also 250 feet per minute, both being ample to handle approximately 18 inches of drilling per minute. The hydraulic jack G advances the drilling device C approximately 18 inches per minute, and said jack has a pressure up to 40,000 pounds. It will be understood that when the drilling device C reaches the forward end of the shield A, the drilling device is stopped and the shield is advanced forwardly a distance of about 18 inches and stopped. The shield A is adapted to be pushed forwardly by the application of the six jacks F heretofore described.

Workmen are completely enclosed and protected at all times by the shield A. By my device any settlement of adjoining ground is avoided, and only the actual material defined by the shield A is removed from the tunnel.

I claim:

1. A tunneling machine comprising a longitudinally movable shield, means for advancing said shield, a drilling device capable of rotat-

able and longitudinal movement, means for rotating said drilling device and means for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable drilling blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, buckets connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

2. A tunneling machine comprising a longitudinally movable, expansible shield, means for holding said shield in expanded position, a drilling device capable of rotatable and longitudinal movement, means for rotating said drilling device and means for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable drilling blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, buckets connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

3. A tunneling machine comprising a longitudinally movable, expansible shield, longitudinal and circumferential members for holding said shield in expanded position, a drilling device capable of rotatable and longitudinal movement, means for rotating said drilling device and means for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable drilling blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, buckets connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

4. A tunneling machine comprising a longitudinally movable, expansible shield, means for holding said shield in expanded position, a drilling device capable of rotatable and longitudinal movement, means for rotating said drilling device and hydraulic jacks for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable drilling blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, buckets connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

5. A tunneling machine comprising a longitudinally movable, expansible shield, means for holding said shield in expanded position, a drilling device capable of rotatable and longitudinal movement, means for rotating said drilling device and means for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable drilling blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, a rear supporting element for supporting said face member of said drilling device spaced apart from said face member, buckets carried by said face member and located in the space between said face member and said rear supporting element connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

6. A tunneling machine comprising a longitudinally movable, expansible shield having a forwardly projecting hood and side portions for penetrating the earthy material, means for holding said shield in expanded position, means for advancing said shield, a drilling device capable of rotatable and longitudinal movement, means for rotating said drilling device and means for advancing said drilling device longitudinally, the face member of said drilling device being provided with radial slots, detachable blades for attachment to either side of said slots depending upon the direction of rotation of said drilling device, buckets connected to said drilling device for receiving earth removed during the operation of said drilling device, and a traveling conveyor adapted to receive said earth from said buckets for conveying said earth rearwardly away from said drilling device.

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