Nov. 18, 1941. J. L. DOW ET AL 2,263,352

TUNNEL CONSTRUCTION

Filed May 16, 1939

Fig. 1.

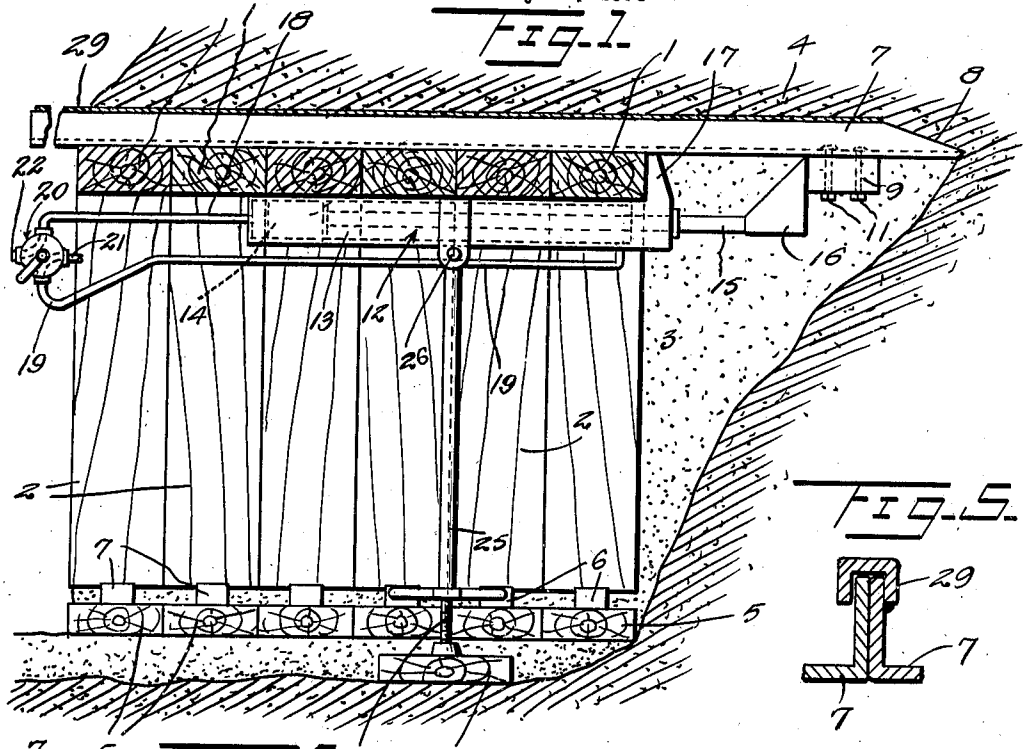


Fig. 5.

Fig. 4.

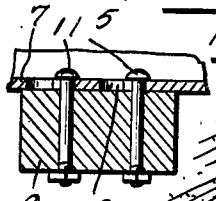
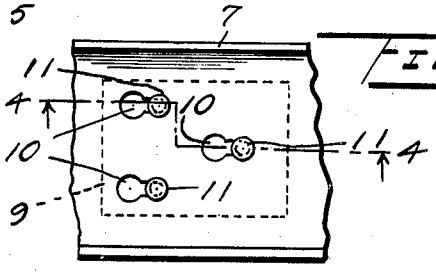


Fig. 2.

Fig. 3.



Inventors

J. L. Dow, A. E. Keller,
J. H. Barth

By Watson E. Coleman
Attorney

Patented Nov. 18, 1941 2,263,352

UNITED STATES PATENT OFFICE

2,263,352

TUNNEL CONSTRUCTION

Jack L. Dow, Sheboygan, and Albert E. Keller and John H. Barth, La Crosse, Wis.

Application May 16, 1939, Serial No. 273,992

4 Claims. (Cl. 61—42)

This invention relates generally to the class of earth engineering and pertains particularly to tunnel construction.

The present invention has for its primary object to provide an improved method of digging tunnels in sub-soils which are not self-supporting, such as sand, clay or the like, so as to avoid the possibility of cave-ins.

Another object of the invention is to provide in tunnel construction a novel means of supporting the earth overhead while removing the earth for the formation of the tunnel so that cap and shoulder beams may be set up conveniently and the possibility of the overhead material caving in before such beams are set up, entirely avoided.

A further object of the invention is to provide in tunnel construction, improvements in poling irons and in means for forcing the same ahead into the earth for the formation of a wall structure from beneath which the earth may be conveniently removed.

The invention will be best understood from a consideration of the following detailed description taken in connection with the accompanying drawing forming part of this specification, with the understanding, however, that the invention is not to be confined to any strict conformity with the showing of the drawing but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawing:

Fig. 1 is a view taken longitudinally of a tunnel at the outer end of the same and illustrating in longitudinal section the mechanism embodying the present invention.

Fig. 2 is a transverse section of the structure shown in Fig. 1 taken rearwardly of the hydraulic jack.

Fig. 3 is a detail view of a portion of a poling iron showing the method of attaching the push block thereto.

Fig. 4 is a sectional view taken substantially on the line 4—4 of Fig. 3.

Fig. 5 is a sectional view taken transversely of the abutting edges of a pair of poling irons showing on a large scale the guiding channel.

Referring now more particularly to the drawing, there is shown a series of cap and shoulder beams 1 and 2, respectively, mounted in position within a tunneled out area 3 in a body of earth 4, these beams forming the bracing wall structure which keeps back the overhead body of earth which would not otherwise remain in position.

As shown, the cap beams and shoulder beams are here arranged to form one-half of a six-sided figure, but it will be readily apparent that these may be so arranged that the shoulder beams will be vertically disposed or perpendicular to the cap beams 1 for the formation of a tunnel of square cross-section.

Each of the shoulder beams 2 is supported by a foot block 5 and between the lower end of each shoulder beam and the foot block supporting it there is driven a wedge 6 by means of which the desired tight engagement between the upper ends of the shoulder beams and the ends of the cap beams is obtained.

Extending longitudinally of the tunnel and transversely of the cap and shoulder beams are the channel irons 7 which will be referred to as poling irons. These channel or poling irons are placed in side by side relation and at their forward ends they have the flanges cut obliquely, as indicated at 8, so that the forward or advancing end of each poling iron is substantially in the form of a blade whereby it may be more readily made to penetrate the earth.

As shown in Fig. 1, the forward or tapered ends of the poling irons project into the earth beyond the innermost ones of the cap and shoulder beams 1 and 2, and these poling irons are made to advance into the earth ahead of the reinforcing cap and shoulder beams in the following manner.

A push block 9 is provided for attachment to the underside of any one of the poling irons 7. This attachment of the push block is accomplished by providing the flat of web portion of each poling iron with one or several longitudinally extending key hole slots 10 and providing the push block with headed bolts 11 corresponding in number to the slots 10 of a poling iron. These bolts extend vertically through the push block with the heads at the upper side and are attached to a poling iron by shifting the bolts so that the heads will be raised above the top of the push block and then extending the heads through the larger ends of the key hole slots and shifting the block so that the shank portions of the bolts will move into the restricted ends of the slots. The block may then be drawn tightly into connection with the poling iron by tightening the nuts 11a which are attached to the lower ends of the bolts.

The numeral 12 generally designates a hydraulic jack which comprises a cylinder 13 hav-

ing within it a piston 14 which is connected with a rod 15 which extends from one end of the jack and which carries a head or push block 16. The forward end of the cylinder is provided with an integral laterally extending bracing foot 17 which is designed to position against the forward edge face of the innermost one of a cap or shoulder beam. For the supplying of the necessary operating fluid to the two ends of the cylinder for the operation of the piston 14, there are provided the two pipes 18 and 19, pipe 18 being connected with the rear end of the cylinder and the pipe 19 with the forward end, as shown. These two pipes are connected with a four-way valve 20 which is provided with the ports 21 and 22 which are connected with a suitable source of fluid supply and pump (not shown). By manipulation of this valve, the necessary operating fluid for the piston may be introduced at one end from the pressure line and carried off from the other end of the cylinder to return to the source of supply and by reversing the valve, the reverse operation may be effected, that is, the fluid may be caused to enter the end of the cylinder from which it previously was exhausted and to be exhausted from the other end of the cylinder so as to reverse the operation of the piston. The interior construction of the valve 20 has not been detailed as the construction of such valves is well known, the rotary member thereof merely containing two separate arcuate passages extending transversely thereof by means of which the desired connections may be established between the pipes 18, 19 and the pipes 21 and 22.

In the carrying out of the present invention there are first set up or placed in position about four sets of the cap and shoulder beams. The poling irons or channel irons 7 are then driven across and over the top of these cap and shoulder beams into the earth and so that the tapered ends 8 of the poling irons will advance into the earth a substantial distance beyond the innermost ones of the beams.

The poling iron push block 9 is then attached to an iron by means of the slots and headed pins described or by any other suitable means and the hydraulic jack is then placed in position horizontally across the inner side or sides of the beams over which extends that poling iron to which the push block 9 has been attached, the foot 17 of the jack being engaged against the forward edge of the innermost beam.

In order that the poling irons may be kept in proper line as they are driven forwardly into the earth, each poling iron has secured over the edge of one side flange a downwardly opening guide channel 29, such channel being secured by one side flange against the inner face of the poling iron flange so that the guide channel is directed oppositely to the channel of the poling iron and projects beyond the attached poling iron flange. By means of this channel, the edge of the side flange of the adjacent poling iron is loosely engaged so that the poling irons may have relative longitudinal movement but cannot shift apart laterally and, therefore, after they have been started upon the proper course, each poling iron as it is advanced will be held on a true path by the adjacent poling irons with which it is connected.

In order to maintain the jack cylinder in position there is provided a supporting post 25, the upper end of which is detachably coupled with the cylinder in a suitable manner, as indicated at 26, while the lower end is provided with a threaded bore to receive a trench jack screw 27 which is mounted upon a base or foot block 28.

After the hydraulic jack has been set up in the manner stated, the fluid control valve 20 is opened to admit fluid to the rear of the cylinder so as to advance the piston and the head 16 carried by the piston rod. This head is brought into contact with the poling iron push block and by the admission of additional fluid behind the piston, the pushing head 16 is forced forwardly so as to force the poling iron ahead into the earth. This procedure is repeated for each poling iron until all of the irons have been advanced a predetermined distance whereupon the underlying earth may be safely removed without danger of cave-in and the cap and shoulder beams may be set up so as to provide a permanent sheeting for the tunnel.

It will, of course, be readily understood that after the jack piston has been advanced the desired distance, its retraction is accomplished by turning the valve 20 to the position where the pipe 19 will be connected with the fluid pressure line which may be either the line 21 or the line 22, and when in this position the pipe 18 will then be connected with the other line which would be the return line for the fluid pressure apparatus, the pressure then operating through the pipe 19 to return the piston to the starting position in which it is shown in Fig. 1.

From the foregoing, it will be readily apparent that there is provided in accordance with the present invention an efficient and safe method and means of penetrating the earth for the formation of tunnels, without danger to working men of a cave-in of the earth where such tunnels are made in sub-soil which does not have in itself sufficient body to stay in place as a tunnel opening is formed therethrough. With this device, it will also be readily apparent that tunneling can be done much more rapidly than by the present method, it being estimated that such tunneling may be advanced from three to six times as done according to present methods.

While it will be readily understood that the rate of advance of the poling irons into the earth will vary somewhat according to the sizes of the irons, jacks, push blocks, etc., under average conditions the poling irons will be driven ahead into the earth by the hydraulic jacks a distance of from two to three feet after which the underlying earth will be removed and the cap and shoulder beams then put into position and then by removing a portion of the earth ahead of the last placed beams, the irons may again be advanced.

Other advantages of the tunneling construction of the present invention are that the equipment is of light character and can, therefore, be readily transported from job to job; it is flexible in regard to line and grade; it can be salvaged on completion of a job; it tightens the timbering and increases the safety factor and speed and is readily adapted to various sizes and shapes of tunnels such as the modified box type, the hexagonal type, the modified hexagonal type, the cap and leg type and the arched type, and the initial cost of the equipment is low. In the use of the equipment of the present tunnel, settlement will be reduced to a minimum and the cost of street repair and shifting of water mains and other sewers directly over or adjacent to the tunnel will be eliminated. The timbering of the tunnel is tight and secure so that no sand or

other non-supporting material can sift through.

The manner of positioning the hydraulic jack will allow for the placing of more timber before advancing the poling irons, thus saving time in moving the jack, and the irons may be placed in position easily by employment of the attached poling iron push blocks after the irons are located in position.

Other features of advantage in the present construction are that the usual needle beam employed for advancing the poling irons is eliminated; the walls of the tunnel are maintained true to line and grade, because the caps and shoulders can be wedged tightly against the poling irons, thereby reducing the amount of concrete required between the inside form and the outside bracing, and the invention is readily adaptable to mining under compressed air, thereby replacing the usual continuous shield.

What is claimed is:

1. In earth tunneling, a plurality of series of earth walling supporting beams in side by side abutting relation to form a solid retaining wall, each series including a transverse cap-beam and two shoulder beams supporting the ends of the cap beam and extending downwardly therefrom, a foot block supporting each shoulder beam, a wedge interposed between each foot block and the supported shoulder beam whereby the latter is urged upwardly against the cap-beam, a plurality of channeled poling irons extending longitudinally of the tunnel and interposed between said beams and the earth wall supported thereby, said irons having the channels thereof directed away from the beams, and means for selectively advancing said channel irons into the earth ahead of the innermost ones of the beams.

2. In earth tunnel construction, a series of wall supporting beams extending transversely of the tunnel, a plurality of channel irons extending longitudinally of the tunnel and disposed in abutting side by side relation upon the outer sides of and extending across said beams, a jack body adapted to be supported against and across the under sides of said beams and including a piston operated rod movable longitudinally of the tunnel, means forming a part of the jack body for engagement with the forward edge of the innermost one of the beams to dispose the body longitudinally of the tunnel against the under sides of the beams, means for coupling said piston rod with a channel iron for effecting the longitudinal advancement of the latter through the medium of the jack, said channel irons having the channel sides thereof directed into the adjacent earth, and a channel bar extending longitudinally of the edge of one flange of each channel iron with its channel side directed toward the bar and receiving and having said flange secured therein along one side thereof, the channel of the bar slidably receiving the edge of the adjacent flange of the adjacent channel iron.

3. In a tunnel construction, a series of wall supporting beams disposed transversely of the tunnel, a plurality of channel irons extending longitudinally of the tunnel in side by side abutting relation upon the outer sides of and extending across said beams, a jack body including a cylinder having at one end an integral laterally extending foot and adapted to be positioned across the under sides of said beams with said foot engaging across the forward face of the innermost one of the beams, said jack body including a piston operated rod extending from the said end of the cylinder, a head carried by said rod and projecting laterally therefrom in the same direction as said foot, said channel irons having their forward ends tapered to a point and each of said channel irons adjacent its pointed end having the web portion thereof provided with a group of keyhole slots, and a push block having headed pins each engageable in a keyhole slot of the group to facilitate attachment of said block to the under side of a channel beam, the push block constituting means for coupling the laterally disposed part of the head of the piston rod with the channel iron to facilitate thrusting said channel iron forward from the beams.

4. In a tunnel construction, a series of wall supporting beams extending transversely of the tunnel, a plurality of channel irons extending longitudinally of the tunnel and disposed in side by side abutting relation upon the outer side of the beams, said beams being in edge abutting relation to form a solid tunnel wall lining, a jack body adapted to be supported across the under sides of said beams longitudinally of the tunnel and including a piston operated rod movable longitudinally of the tunnel, a laterally projecting bracing foot forming a part of the jack body at its forward end and engageable across the forward edge of the innermost one of the beams, a head carried by said rod and projecting laterally from the longitudinal center of the rod in the same direction as said foot toward the adjacent channel iron and alined longitudinally of the jack body with said foot, and a thrust block detachably secured to the channel iron and engaged by said head for facilitating the longitudinal advancement of the channel iron under the action of the jack body.

JACK L. DOW.
ALBERT E. KELLER.
JOHN H. BARTH.