July 23, 1940. A. F. STANLEY 2,208,608

APPARATUS FOR TUNNELING

Filed Feb. 13, 1939

Fig. 1

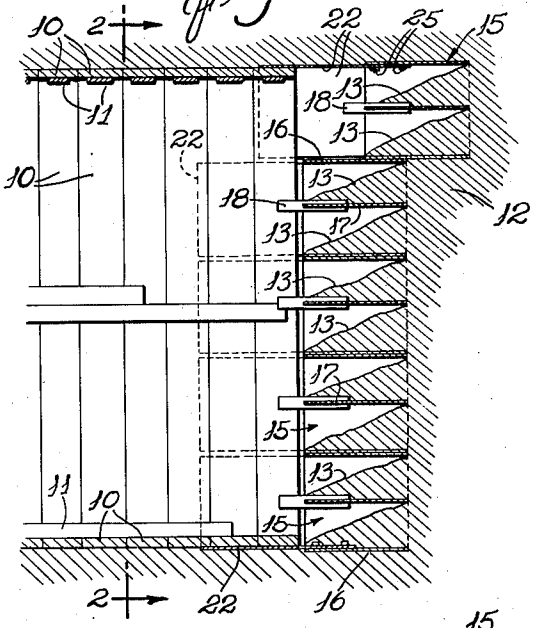


Fig. 2

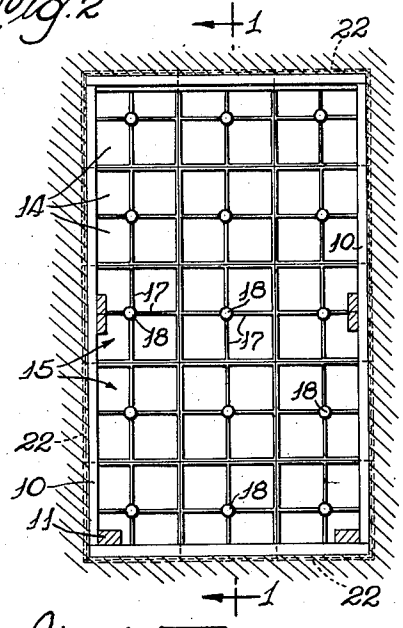


Fig. 3

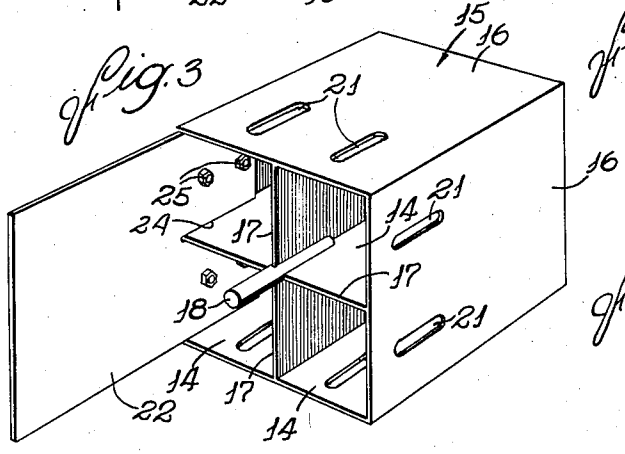


Fig. 5

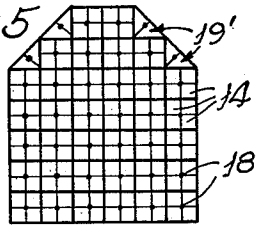


Fig. 6

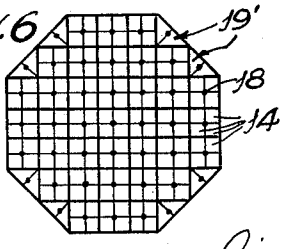


Fig. 4

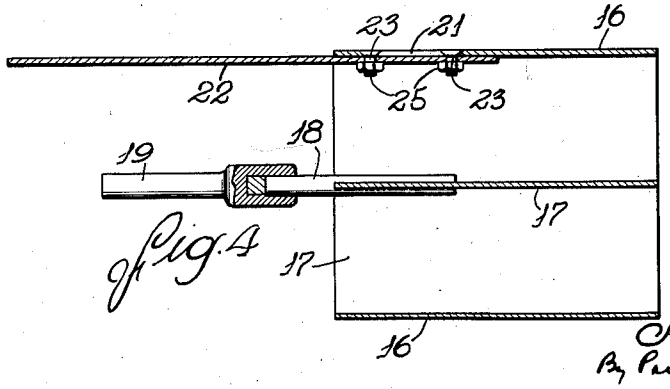
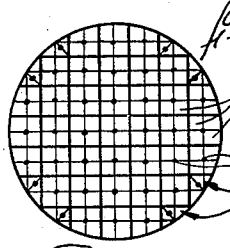


Fig. 7



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APPARATUS FOR TUNNELING

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6 Claims. (Cl. 61—85)

This invention relates to the construction of tunnels and more particularly to tunneling through material which is sufficiently wet or unstable to flow by gravity and require the use of a framework at the end and around the sides of the tunnel to hold the material back during the building of tunnel sheathing. The common practice is to provide removable face boards at the end of the tunnel and poling boards along the sides within which the sheathing is built. This method is inefficient and costly not only because the facework must be built up and torn down repeatedly to permit of material removal but also because the poling boards and much other timber is covered by the sheathing and cannot be reused.

The primary object is to provide a novel method of and apparatus for tunneling by which the foregoing difficulties may be overcome and the cost of tunnel constructions reduced materially while providing proper safety for the workman.

Another object is to split up the line of repose of the wet earth at the face of a tunnel into increments so that the facework, although open, effectually holds the earth and defines a substantially vertical face for the tunnel.

A more detailed object is to split up the line of repose by a facework comprising a multiplicity of tubular cells which may be driven forward individually.

A further object is to provide rearward extensions on the peripheral cells of the facework which extensions advance with the facework and close the space between the latter and the previously built sheathing.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawing, in which

Figure 1 is a fragmentary cross sectional view of a tunnel construction illustrating the present invention, the section being taken along the line 1—1 of Fig. 2.

Fig. 2 is a transverse sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a perspective view of a part of the tunnel facework.

Fig. 4 is a longitudinal section of the part shown in Fig. 3.

Figs. 5, 6, and 7 are cross-sectional views of the facework for different shapes of tunnels.

In the drawing, the invention is illustrated in connection with the construction of a tunnel of rectangular cross-section which is lined around all four sides with sheathing 10 and other framework 11. To hold back the earth 12 which tends to assume an angle of repose corresponding to its degree of stability, the invention contemplates dividing up this angle into a multiplicity of relatively small increments 13 arranged one above the other so as to define at the closed end of the tunnel a substantially vertical face which can be advanced readily along the tunnel to facilitate extension of the sheathing 10.

Division of the line of repose into the increments 13 is effected through the use of a multiplicity of cells 14 of small vertical height arranged side by side and one above the other and preferably adapted for movement individually or in groups to advance the increments, the cells being open at opposite ends to facilitate such movement and permit the wet material which is to be removed to flow through the cells into the tunnel. In the present instance, the cells are arranged in groups which are defined by open ended metal boxes or tubes 15 having side walls 16 defining a square which is divided by intersecting partitions 17 so that each box forms four cells. The walls and partitions may be welded together at the joints. Inasmuch as tunnel sizes usually vary in one foot increments, it is convenient to employ boxes approximately one foot square. The individual cells, being of smaller dimensions, will effect proper division of the angle of repose even when the material is very wet.

In the tunnel, the tubes 15 are stacked together one above the other and side by side to form an open framework equal to or slightly larger than the cross-sectional area of the tunnel to be formed. Being open at opposite ends, the tubes may readily be driven forwardly to advance the facework causing the material to flow through the cells into the tunnel preparatory to removal therefrom before extending the sheathing. To facilitate driving of the boxes, a pin 18 slotted to straddle the joint of intersection of the partitions 17 is welded to the partitions so as to project axially from the rear end of the box. A socketed tool 19 may be fitted over the pin and driving of the box forwardly may be effected by a suitable hammer or jack. It will be observed that the driving force is applied substantially along the longitudinal axis of the tube thereby facilitating straight driving. Also, each tube while being driven forwardly is guided by the then stationary walls of the adjacent tubes.

Where the tunnel is of rectangular or square

cross-section, all of the boxes used may usually be of the same size and shape. For tunnels of other shape as illustrated in Figs. 5, 6, and 7, some or all of the boxes at the periphery of the facework will be of different shape. For example, triangular boxes as indicated at 19' would be used in an octagonal tunnel (Fig. 6). Or, one wall may be of arcuate shape as is indicated at 20 for a circular tunnel.

Ordinarily, it will be found unnecessary to connect the tubes 15 together. However, when such connection is desirable in order to maintain the desired shape of the facework, a suitable lost motion connection may be employed so as to enable the boxes to be driven forward individually. To this end, the side walls 16 may be formed with elongated slots 21 through which bolts, one for each slot, may be entered to join the adjacent boxes while permitting each to be shifted longitudinally of the other. Or, in tunneling through very soft material, it may be desirable to clamp the adjacent tubes rigidly together, this being accomplished by properly tightening the connecting bolts.

To close the sides of the tunnel between the sheathing and the facework as the cells of the latter are driven forwardly, the tubes 15, at the periphery of the facework, are equipped with rearward extensions or tail pieces 22 each projecting along the outer wall of a tube parallel to the tube axis and beyond the trailing end of the tube. The extensions of the adjacent tubes are disposed edge to edge and thus form a peripheral closure or liner which encircles the entire tunnel and can be advanced piece by piece along with the facework. Thus, the extensions perform the function of the poling boards used in prior methods of tunneling and in addition are usable over and over again throughout the tunneling operation.

In order that the tubes 15 may be more or less standardized, it is preferred to make the extensions 22 as separate plates slotted as indicated at 24 to fit inside of the tube. Each plate is fastened to the box wall by bolts 25 extending through slots 21 in the wall 16 and holes 23 in the plate with their heads seated in the countersunk outer ends of the plate holes. Of course, the plates 22 project rearwardly from the tubes 15 distances substantially greater than the width of one sheathing board 10 so as to overlap the last board after being driven a substantial distance ahead of the other boxes as is illustrated in Fig. 1.

During the construction of a tunnel in accordance with the present method, let it be assumed that the sheathing 10 has been built up as shown in Fig. 1 to a point overlapping the extensions 22 and as close as possible to the rear ends of the tubes 15. Then, the tubes are driven forwardly one by one through a distance such that the trailing end of the tube extension 22 will still overlap the sheathing. During such advance, the wet material will flow through the cells 14 onto the floor of the tunnel. After removal of the material, the sheathing is extended within the extensions 22. This process is repeated intermittently. It will thus be apparent that the same facework is used throughout the construction of a tunnel. The same is true of the extensions 22. There is no building up or tearing down of the facework and the operations involved in repositioning the facework are simple and easily performed. Moreover, the use of timbers such as face and poling boards is eliminated thereby greatly reducing material costs, particularly in view of the simple and standardized construction of the cellular units.

The cellular facework construction may also be used to advantage in tunneling under conditions where it is necessary to employ air pressure in holding back the wet material at the end of the tunnel. In such a case, the cellular facework reduces the tendency of the wet material to flow into the tunnel and enables this flow to be controlled at a lower air pressure within the tunnel than has been possible heretofore.

I claim as my invention:

1. A facework for a tunnel comprising a plurality of tubes open at opposite ends and disposed side by side, said tubes being adapted to be driven in an endwise direction into the face of the tunnel, and tail plates carried by the peripheral tubes and coacting to provide a peripheral closure adjacent said facework.

2. A facework for a tunnel comprising a plurality of tubes open at opposite ends and disposed side by side, said tubes being adapted to be driven individually and in an endwise direction into the face of the tunnel, and extensions carried by and projecting rearwardly from the outer wall of the peripheral tubes and coacting to define a tubular liner for the tunnel adjacent the facework.

3. A facework for a tunnel comprising a plurality of tubes open at opposite ends and disposed side by side, said tubes being adapted to be driven individually and in an endwise direction into the face of the tunnel, cross members rigid with the trailing ends of said tubes, and drive pins rigid with said cross members and projecting from the trailing ends of said tubes substantially centrally thereof.

4. For use in a cellular facework for tunnels, a metal tube of polygonal cross-section, a partition disposed within and extending longitudinally of said member and dividing its cross-section into a plurality of cells, and a drive pin rigid with said partition and projecting axially from one end of said member near the longitudinal axis thereof.

5. For use in a cellular facework for tunnels, a metal tube of polygonal cross-section, a partition disposed within and extending longitudinally of said member and dividing its cross section into a plurality of cells, and a drive pin rigid with said partition and projecting parallel to the axis thereof.

6. A facework for a tunnel comprising a plurality of tubes of substantially polygonal cross-section disposed side by side and dividing the line of repose of the material at the face of the tunnel into a multiplicity of vertically spaced increments, said tubes being adapted to be driven individually and in an endwise direction into the face of the tunnel, and means rigid with and disposed within each of said tubes and dividing the latter into a plurality of vertically spaced open ended cells whereby to further subdivide said line of repose of the material within each tube.

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