Sept. 29, 1936. W. J. NEWMAN 2,055,876

TUNNELING

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Fig. 1.

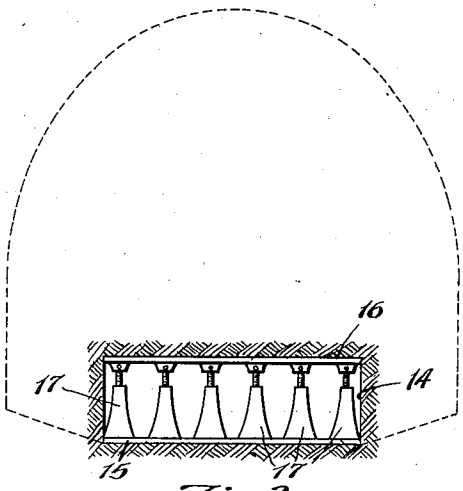


Fig. 2.

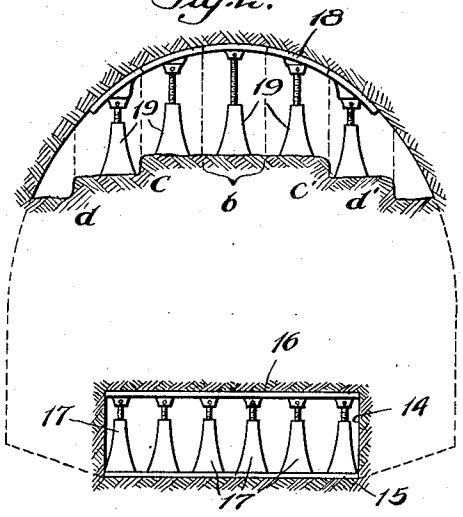


Fig. 3.

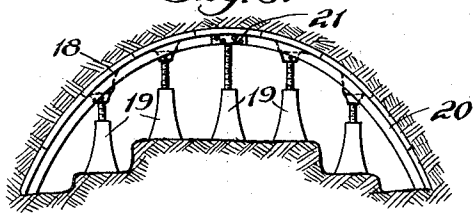


Fig. 12.

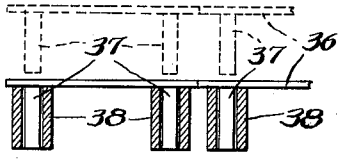


Fig. 4.

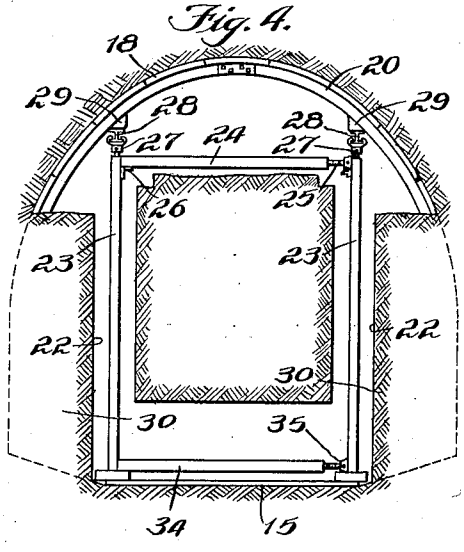
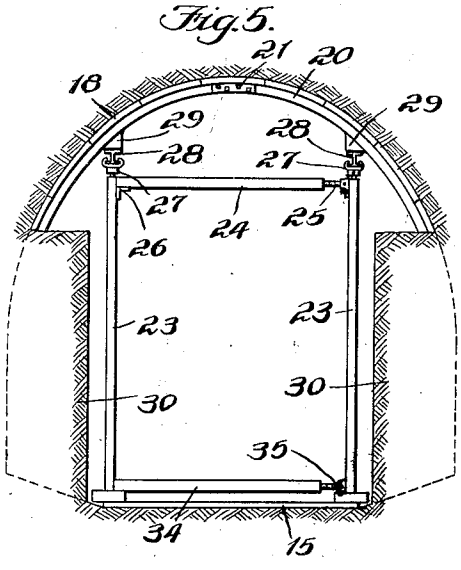


Fig. 5.



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Fig. 6.

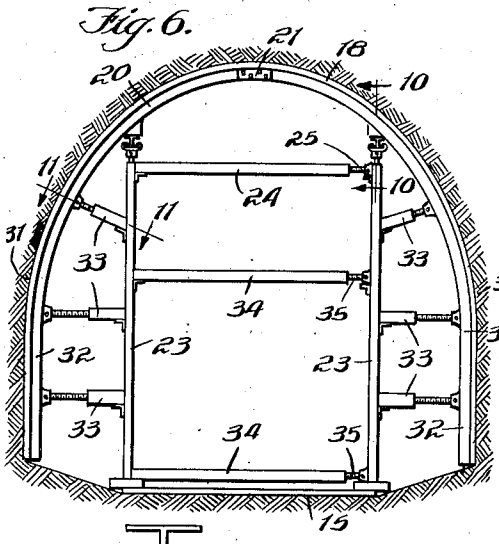


Fig. 7.

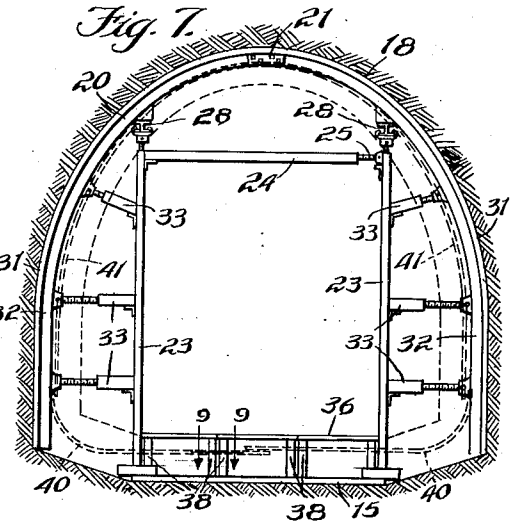


Fig. 10.

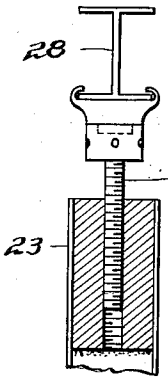


Fig. 9.

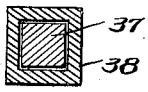
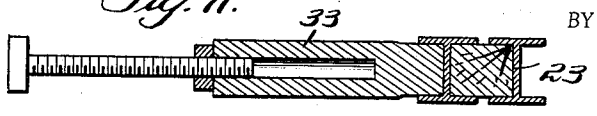


Fig. 8.

Fig. 11.



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2,055,876

TUNNELING

William J. Newman, Chicago, Ill.

Application August 20, 1934, Serial No. 740,595

5 Claims. (Cl. 61—42)

This invention relates to an improved method of tunneling and is particularly intended for use where the tunnel is to be dug through earth or clay as distinguished from tunneling through rock, although some features of my improved method may be applicable to various kinds of tunnels.

The principal object of the invention is to provide an improved method of tunneling through earth, clay, or the like, whereby the operations may be carried on in an economical and safe manner.

Other objects of the invention are to provide means for tunneling whereby the roof and walls may be supported to the fullest extent to prevent caving or leakage; to provide an improved system of tunneling whereby an excavating machine may be freely used for taking out the larger portion of the material; to provide a step by step method of tunneling in which the material will be taken out in different areas and the lining and bracing will be introduced in a novel manner; and to provide such other improvements as will appear from the following description.

In the accompanying drawings illustrating this invention,

Figure 1 is a sectional view illustrating the first step or operation which consists in making an opening at the bottom of the tunnel and inserting suitable supports;

Figure 2 is a view showing the next step or opening at the top of the tunnel and roof supports;

Figure 3 is a detail showing the arrangement at the top of the tunnel for further supporting the roof;

Figure 4 illustrates the next succeeding step which consists in making vertical cuts or channels, preferably by means of a suitable excavating machine and placing supporting members therein;

Figure 5 shows the next step or removal of the core or center part of the tunnel after suitable braces have been placed in position;

Figure 6 shows the tunnel after the sides have been excavated, preferably by hand, and further bracing installed;

Figure 7 is similar to Figure 6, showing the raised temporary flooring and indicating the positioning of the concrete re-inforcing members;

Figure 8 is a longitudinal sectional view of the tunnel showing the excavating machine in position;

Figure 9 is a sectional detail taken on the line 9—9 of Figure 7;

Figure 10 is a sectional detail taken on the line 10—10 of Figure 6;

Figure 11 is a sectional detail taken on the line 11—11 of Figure 6; and

Figure 12 is a detail of the temporary or removable floor.

In these figures some of the parts are shown diagrammatically and other parts may be omitted for convenience in illustration, sufficient detail being supplied so that the invention can be readily understood by those familiar with the art.

As shown in Figure 1, the outline of the excavation for the tunnel is illustrated in dotted lines and it may be assumed that the work is to be begun at an exposed working face. A substantially rectangular hole 14 is dug at the bottom of the tunnel, preferably by means of an excavating machine. The drawings are intended to illustrate a tunnel having an excavation of approximately 21 feet in height and for this size tunnel the hole 14 may conveniently be made about four feet high and twelve feet wide and extending inwardly about five feet. Planking 15 is placed at the bottom of the hole and other planking or plates 16 placed at the top of the hole with jacks 17 arranged as shown for supporting the roof.

The next steps as shown in Figure 2, consist in making a central vertical cut at the top of the tunnel as indicated at *b*, which cut is made by a machine and may be about twenty-two inches wide and four feet deep and four to six feet in height. A liner plate 18 such as usually used for roof support is then placed in position and is held by one or more jacks 19. Additional cuts as indicated at *c*, *c'*, *d*, *d'*, etc. are then made and as each cut is completed a liner plate and supporting jacks is placed therein so that when all of such cuts have been finished the roof of the tunnel will be outlined as shown and will be supported by means of liner plates and jacks which rest on the floor of this upper cut.

When all of these plates have been inserted in the arch or roof portion, curved ribs 20 preferably formed of I-beams are placed in position under the liner plates preparatory to subsequently supporting said plates after the removal of the jacks 19. The ribs 20 may be made in single pieces or may be made in two pieces joined together at the center as shown at 21 in Figure 3.

These ribs may be supported temporarily in any desired manner but are subsequently supported by posts and framework which will presently be described.

The next step as shown in Fig. 4 consists in making two vertical cuts or kerfs, **22**. These cuts are preferably made by means of an excavating machine and may conveniently be made about 22 inches wide and extend back in the same distance as the previous excavations. After these cuts have been made posts or struts, **23**, are placed therein. These posts should be strong and substantial and adapted to withstand lateral as well as vertical pressure. They are preferably formed of two I-beams with a filler of wood as indicated in Fig. 11. The lower ends of these posts are supported on the planking, **15**, and they are connected or braced at the top by cross beams, **24**, having screw jacks, **25**, at the ends for tightening the same. These beams may be connected to the posts by angle irons, **26**, or other suitable connections. The posts are provided at the top with jacks or screws, **27**, as shown in Fig. 10, which support beams, **28**, which extend longitudinally of the tunnel and engage with the ribs, **20**. These beams engage with lugs or bosses **29** on the ribs which provide a suitable bearing for the same. As soon as the beams **28** have been placed securely in position and are pressed up against the ribs, the jacks **19** may be removed and the liner plates **18** and the roof of the tunnel will be securely supported by such posts and framework.

The next step in the operation is shown in Fig. 5 and consists in the removal of the core or center portion of the material which remains between the top and bottom cuts and the side cuts **22**. This material is also preferably all removed by means of the excavating machine, the framing provided by the posts and their connections leaving ample space in which the machine may operate.

The next operations are indicated in Fig. 6, the material **30** remaining at the sides of the tunnel as seen in Fig. 5 may be removed preferably by hand and thus completing the excavation of a section. The side liner plates **31** and ribs **32** are then placed in position and are supported by means of jacks or braces **33** which are inserted between the posts **23** and the ribs **32**. Any suitable number of such jacks or braces may be used depending upon the nature of the material. Additional cross beams **34** may also be inserted between the posts **23**, these beams being preferably provided with screws or jacks **35** so that they may be tightened in position.

When these steps have been completed it will be seen that all of the walls of the tunnel are properly supported and the excavating work can be continued for any reasonable distance ahead of the placing of the concrete or lining of the tunnel. Furthermore, by means of this novel framework and bracing, ample space is left for carrying on both the excavating and the lining of the tunnel.

As shown in Figs. 7, 8, 9 and 12 I provide an elevated removable platform **36** which is preferably made in sections and each section provided with posts **37** which are secured thereto and may be moved with these sections. These posts rest upon the bottom planking and each post is encased in pockets **38**. The platform or planking **36** is preferably about two feet above the bottom of the tunnel and serves as a flooring upon which the excavating machine **39** may run. It also serves as a flooring for tracks for cars or wheelbarrows which may be used for taking out the material excavated at the sides of the tunnel.

This elevation of the platform also serves to provide a suitable space for placing the lower reinforcement rods **40**, as indicated in Fig. 7. These rods may be arranged in any desired manner but ordinarily will be overlapped at the center and extend outwardly and up for a short distance adjacent to the sides of the tunnel. They connect with other reinforcing rods **41** such as ordinarily are used for reinforcing the concrete in the tunnel lining or walls. After the reinforcing rods **40** have been placed in position the concrete may be run in over the flooring **36** and dumped into position at the bottom of the tunnel, and preferably carried up at the sides to about the bottom of the arch. The flooring or platforms **36** may then be removed, together with the legs **37**, while the boxes **38** remain in position in the concrete. In this manner the flooring may be repeatedly used and moved forward as the work progresses. After the concrete has been placed in the bottom of the tunnel, the forms (not shown) for the sides and roof may be placed in position and the concrete work carried on in the usual manner, the liner plates and the ribs ordinarily being left in position in the concrete. It will be noted that sections of the platforms **36** may be removed for placing concrete in the bottom while the other sections remain in position to provide runways for the wheelbarrows or carts. Instead of completely filling in the bottom, a few inches is preferably left at the top to be filled in after the top and sides of the tunnel have been completed, and this final layer will be bonded to the lower filling by the boxes **38** which serve in the nature of reinforcement for the flooring.

The use of a tunneling machine in these operations is illustrated in Fig. 8 which shows a portion of a machine adapted for this purpose in position to make one of the forward cuts. The machine is provided with a swinging boom **42** which carries the excavating buckets and may be driven in any suitable manner, but as the machine forms no part of the present invention further description is unnecessary. In this figure one of the top cross braces **24** is shown as being removed from its original position between the forward posts **23** and lowered a sufficient distance to permit the operation of the cutters at the top of the tunnel. After the cut has been partially completed this brace or frame member may be returned to its original position. Longitudinal beams or frame members **43** are also shown between the posts **23** as indicating any suitable bracing to be used to make the open framework through which the machine may operate. In some methods of tunnel excavation it is common to use a needle beam or central longitudinal beam which serves as a support for the radial props. However when an excavating machine is to be used the use of such needle beam is not practicable as it does not provide for sufficient space for supporting or operating the machine. It will be noted that in accordance with my invention the rectangular framework formed by means of the posts and transverse braces, leaves a clear open space for the excavating machine and such framework tends to protect not only the machine but the workmen, throughout the various operations, and fully supports the entire inner walls of the excavation, thus preventing caving or falling in during the tunneling operations. It will thus be seen that my improved system, which includes such framing to provide a relatively large central passageway, is particularly applicable for use in machine tunneling as distinguished from the previous methods of hand tunneling in which the requirements are substantially different, as will be readily appreciated by those familiar with this work.

While I have shown and described the principal

apparatus used in connection with my tunneling operations and the various steps of the method of carrying out the same, it will be noted that changes may be made in order to adapt the same to different conditions, as for different excavations, or for different shaped tunnels, and therefore I do not wish to be limited to the particular method or apparatus herein shown and described, except as set forth in the following claims in which, I claim:

1. The herein described method of tunneling which includes excavating holes in the face of the tunnel at the bottom and top thereof, providing supports for the roofs of said holes, then making vertical openings at the sides of the tunnel connecting said holes, then placing an open framework in the spaces provided by such excavating and supporting the roof by means of such framework, then removing the remaining material at the face and finally placing the supports for the sides of the tunnel and bracing the same from said framework.

2. The method of excavating a tunnel, which includes digging a hole in the face of the tunnel at the bottom thereof by means of an excavating machine, then placing planking in the bottom of the hole and inserting means to support the ceiling of the hole, then digging a hole at the top of the tunnel of substantially the same depth as the one at the bottom thereof, placing liner plates and jacks in the upper hole to temporarily support the ceiling thereof, then placing transverse ribs in position to support the liner plates, then making vertical cuts by means of an excavating machine adjacent to the sides of the tunnel and connecting said bottom and top holes, then placing posts in said vertical cuts and connecting the same with the ribs to support the roof, then excavating the core at the center of the face by means of an excavating machine, and finally excavating the material at the sides by hand to complete the section.

3. The herein described tunneling method which consists in making an opening in the face at the top thereof with its upper wall conforming to the shape of the tunnel roof, inserting liner plates and jacks for temporarily supporting the roof, then making vertical openings in the face which are spaced apart leaving a center core and placing posts therein with jacks at the top for supporting the roof, then removing the remaining material of the section, and finally placing liner plates at the sides of the tunnel and bracing the same from said posts, said posts being spaced to permit an excavating machine to pass between the same substantially as described.

4. The method of building a tunnel or the like which includes the excavating of a hole in the face at the bottom of the tunnel, placing planking in the bottom of the hole, placing means for temporarily supporting the ceiling of the hole, then excavating a hole in the section at the top of the tunnel, placing means therein for temporarily supporting the ceiling of such hole, then making vertical kerfs at either side of the face and placing posts in said kerfs which are supported on said planking, then placing longitudinal beams above said posts and pressing the same upwardly against the roof supports by means of jacks, then removing the temporary supports from the bottom hole and excavating the remainder of the section, then bracing the posts by transverse bracing and applying liner plates to the sides of the section and bracing said liner plates by means of jacks against the posts, said posts being spaced apart to provide an open entry for machines or the like at the center of the tunnel.

5. The method of tunnel building in clay or the like, which consists in making an entry at the bottom of the tunnel, then shoring up and supporting the roof of the entry; then making an entry in the face at the top thereof and shoring up and temporarily supporting the roof of such entry from the floor thereof; then excavating vertical kerfs extending from the bottom entry to the top entry, leaving a substantially rectangular central mass of material and side shoulders at the outer sides of the kerfs; then placing posts in said kerfs and transverse bracing in the top and bottom entries between the posts and providing longitudinal beams on said posts and supporting the roof of the top entry thereon, then excavating the center mass and side shoulders and introducing liner plates and bracing from said posts to the liner plates to support the walls at the sides of the tunnel; placing a raised platform in the bottom of the tunnel, introducing reinforcing rods under said platform and up along the sides and top of the tunnel, and finally lining the tunnel with concrete in which said reinforcing rods are embedded.

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