Feb. 7, 1933. G. H. DUNLOP 1,896,439

METHOD AND APPARATUS FOR TUNNEL CONSTRUCTION AND THE LIKE

Filed April 11, 1930 2 Sheets-Sheet 1

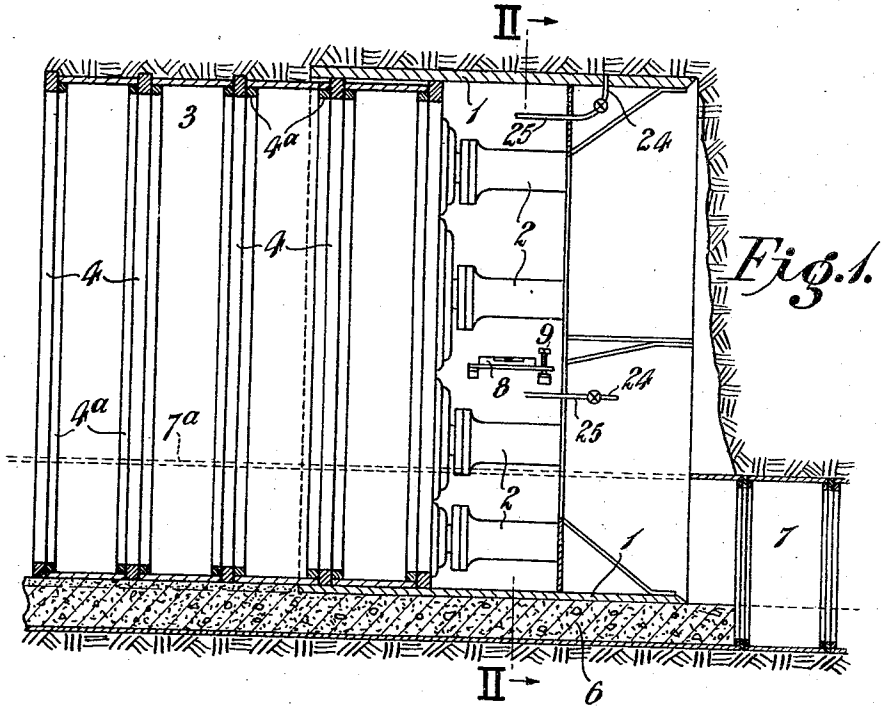


Fig. 1.

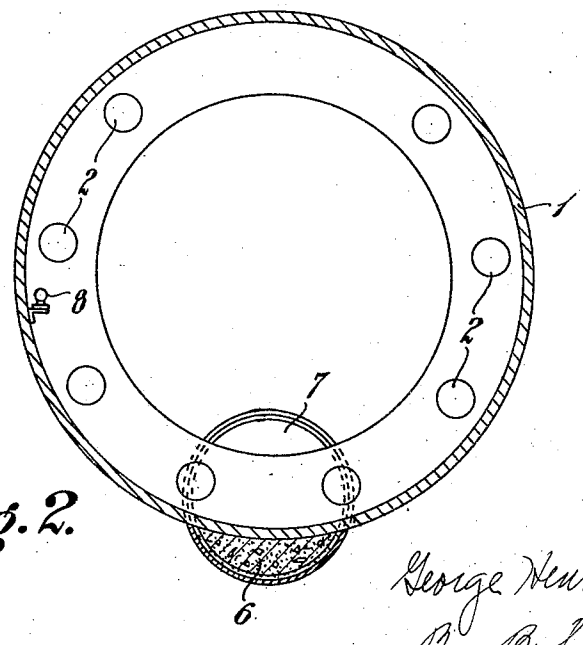


Fig. 2.

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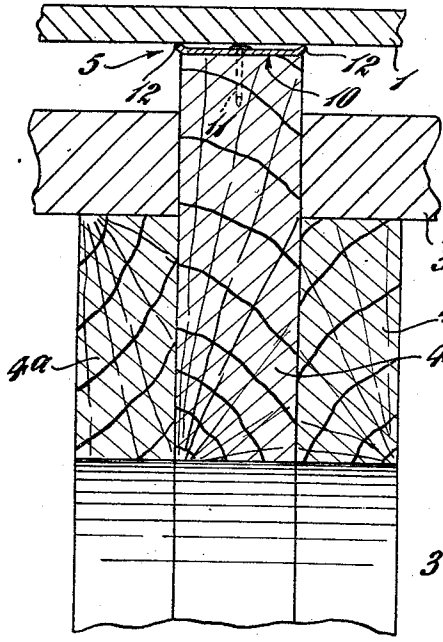


Fig. 3.

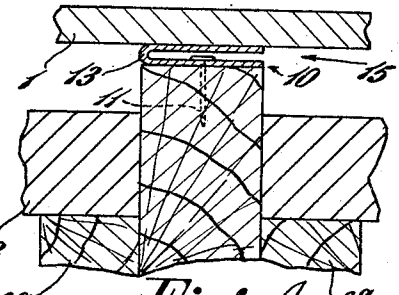


Fig. 4.

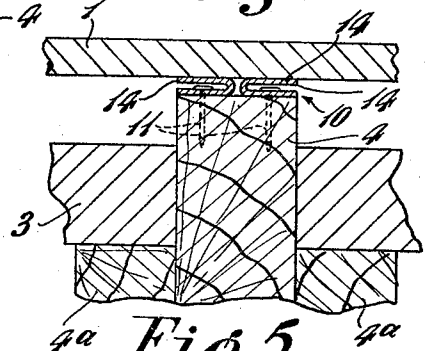


Fig. 5.

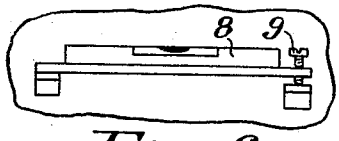


Fig. 6.

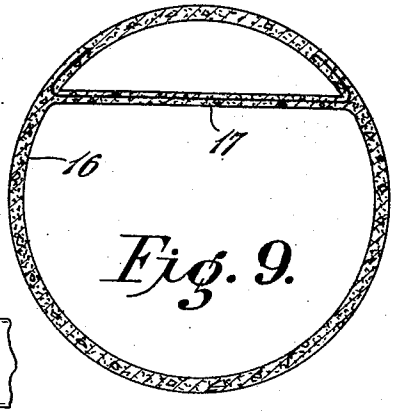


Fig. 9.

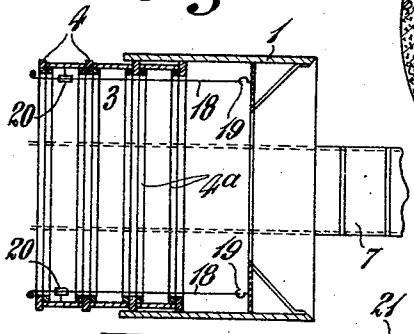
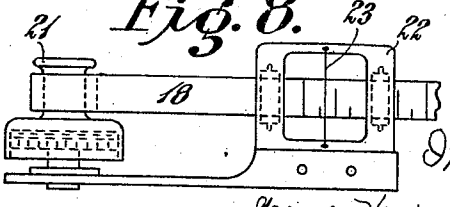


Fig. 7.

Fig. 8.



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Patented Feb. 7, 1933 1,896,439

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR TUNNEL CONSTRUCTION AND THE LIKE

Application filed April 11, 1930, Serial No. 443,535, and in Australia April 13, 1929.

This invention relates to an improved method and apparatus for tunnel construction and the like including shaft construction.

It will be described as used in connection with a shield-driven subaqueous tunnel wherein compressed air is employed.

The improvements constituting the invention include:—

(1) The use of a pilot tunnel the bottom of which is employed as a base for the larger tunnel to be constructed, the object being to facilitate construction.

(2) Packing attachments on the outside of the linings used following the shield to prevent inflow of water or outflow of air.

(3) Subdivision of permanent tunnel linings by transverse partitions to stiffen such tunnel linings against bending stresses.

(4) The use of instruments, as for example spirit levels, fixed within the shield, so that departure from true direction may be noted during movement of the shield and the use of rods or tape measures in connection with lateral direction.

(5) The injection of fluid between the outside of the shell and the ground so as to facilitate movement and act as a lubricant.

In large tunnels a pilot tunnel may be driven for investigation of the ground ahead. This may be placed according to this invention at such level that the shield used for the main work may slide on the suitably constructed invert of the pilot tunnel or base thereof and may thereby be guided both as to line and level and the difficulty of maintaining true direction of the shield will thereby be reduced. The pilot tunnel may be used for transport of earth, etc., during construction.

The packing attachments on the outside of the ribs may be similar to U-leathers in pumps or presses or the like, arranged to act one or both ways, to prevent the passage of fluid, as for examples compressed air or water.

By the use of means such as a spirit level fixed within the shield deviation from true direction during movement can be seen at once and corrected without waiting until it may have become considerable and correction difficult, as for example at the completion of the movement for each ring of lining.

Similarly tapes or rods may be used at the sides during movement of the shield so as to detect initial deviation from true direction.

Fluid such as water may be forced outside of the shield between the shield and the ground so as to act as a lubricant and facilitate movement. This may be of use in steering the shield to facilitate movement of one part of it for altering direction. For this purpose means can be provided to allow space for the fluid, by having the cutting edge slightly larger than the portion behind it.

In large tunnels for traffic there may be divisions and by suitable design in connection with these the outer lining may be stiffened and strengthened.

The accompanying drawings illustrate practical forms of the invention and comprise—

Fig. 1 a vertical section through a tunnel under construction and portion of the pilot tunnel and—

Fig. 2 is a section on line II—II of Fig. 1.

Figs. 3, 4 and 5 are enlarged sectional details illustrating the packing attachments.

Fig. 6 is an enlarged elevation of the spirit level fixed to the side of a portion of the shield.

Fig. 7 is a horizontal section drawn to reduced scale through the main tunnel illustrating the use of the tape measures.

Fig. 8 is an enlarged detail of the reel and dial associated with such tape measure.

Fig. 9 is a vertical section through the lining of a tunnel illustrating the stiffening partition.

Referring particularly to Figs. 1, 2 and 7 the usual hydraulic tunnelling shield 1 is illustrated with hydraulic rams 2 and a tunnel lining 3 progressively constructed as the excavations advance in front of the shield.

The cylindrical lining 3 as illustrated is formed in sections supported by circular ribs comprising outer members 4^a and a central member 4, the periphery of which projects beyond the lining 3 and eventually a lining 16 Fig. 9, usually of concrete is constructed

on the interior of the constructional members of the tunnel.

According to this invention the pilot tunnel 7 is driven in advance of the main tunnel and it is formed in such a position that its bottom is approximately at the level of which the bottom of the main tunnel is required.

The lower portion of the pilot tunnel is filled in with concrete to form a base 6 for the main tunnel and for this purpose the surface of the concrete is curved to the radius of the main tunnel as illustrated in Fig. 2.

It will be understood that the major upper portion of the pilot tunnel 7^a in Fig. 1 is dismantled and removed as the main tunnel is progressively constructed.

The concrete base 6 of the pilot tunnel constitutes a satisfactory slide guide for the main tunnel both as to line and level, thereby facilitating true direction of the shield 1 when being advanced.

A spirit level 8 Figs. 1 and 6 is fixed within the shell of the shield with means such as a screw and nuts 9 for adjusting the spirit level relatively to the shield. In Fig. 2 the shield 1 with rams 22 is shown resting on the concrete base 6 in the pilot tunnel 7, and the spirit level 8 is shown on the left hand side of the shield. In Figs. 3, 4 and 5 there is shown a layer 10 of suitable packing material fixed to the rib member 4 of the tunnel lining which extends out close to the shield at 5; this layer is secured to the rib member 4 by means of nails 11 or the like. In Fig. 3 the edges at each side of the packing material are free to turn up and press tightly against the shell of the shield at 12.12. In Fig. 4 the layer of packing material is in the form of a U piece 13 secured to the part 4 of the lining by nails, which construction is adapted to prevent passage of fluid between the lining and the shield in the direction of the arrow 15. As a further alternative construction two U pieces 14 as shown in Fig. 5 could be used facing opposite ways so as to prevent passage of fluid either way.

In Fig. 7 is shown in sectional plan the shield 1 with the tunnel lining 3 and tape measures 18.18 attached to hooks 19 on part of the bulkhead of the shield 1 at each side and extending back along the inside of the lining to a combined reel and dial or other suitable device at 20.20 so that as the shield moves forward the tapes will be held taut and draw through the devices so as to show continuously at each side during the movement forward of the shield the extent of the advance at each side in order that the shield may be directed. Fig. 8 shows the tape 18 in enlarged detail including a reel at 21 and a dial 22 through which the tape is drawn and read at the mark 23. Each tape measure may be readily attached to and detached from the shield by passing the usual ring at the end of the tape over the hook 19 connected to part of the bulkhead of the shield 1.

It will be evident that measure rods may be used in lieu of tapes.

In Fig. 9 the concrete lining 16 is shown with a transverse partition 17 extending from side to side of the lining. Such partitions have been used in tunnels adapted to form within the tunnel an outlet for the passage of air being withdrawn from the tunnel for the purpose of ventilation; the purpose of the part 17 according to this invention is to make this part strong enough to act as a connection between the upper part of the lining so as to strengthen it against loading on the top of the tunnel.

The aforesaid improvements are designed to render more effective the ordinary tunnelling shield in general use by closer connection between the shield and the lining and at the same time to facilitate the operation of the shield in respect to progress and direction.

In effect there is given to the shield a close fit between the lining and the shield by means which will not prevent the slight changes of direction of the shield relative to the lining necessary for maintaining and correcting the alignment and level of the shield.

The pilot tunnel will serve for preliminary exploration for ascertaining the nature of the ground, will facilitate the transport of the excavated ground forward while work is proceeding in and behind the shield, for example erection of the lining. The pilot tunnel will be constructed of any suitable size and form preferably so that it can be readily dismantled to the extent necessary as the shield is advanced; and will be suitably prepared to assist in supporting and guiding the shield as described.

It will be understood that the pilot tunnel may be used in advance of other known types of tunnel machines as well as with the shield, for example tunnelling machines with rotating cutters used for excavating tunnels in firm clay, soft rock or the like.

The spirit level is used for noting and showing the level of the shield or tunnel machine. It will be set in position relative to said shield or machine so as to show the direction of either of same relative to its true direction.

Tapes are used instead of rods and the like because they will less interfere with work within the shield and tunnel; they can easily be unhooked from the shield and put aside when the shield is not being moved.

The spirit level and tapes will be especially necessary in tunnels, especially small tunnels, where the pilot tunnel may not be used.

Any suitable means may be adopted for injecting fluid between the outside of the shell or other part of the shield where there is movement of the shield relative to the earth;

for example small jets or pipes may extend through the shell 4 or other part of the shield as at 24.24 in Fig. 1 and water may be forced through these pipes from a connected hose or the like 25.

I claim:—

1. In tunnel construction whereby a slidable shield or tunnel machine is employed and a pilot tunnel, smaller than the main tunnel to be constructed is preliminarily formed, the construction whereby the base of said pilot tunnel is located approximately at the prearranged level of the bottom of said main tunnel and the base of said pilot tunnel is utilized to guide and support said slidable shield or tunnel machine and afterwards to support said main tunnel.

2. In tunnel construction as set forth in claim 1, the construction in which the upper part of the pilot tunnel is removed in sections, a filling is placed on the base of the pilot tunnel and the surface of said filling is constructed to correspond to the form of the bottom of the main tunnel.

3. In tunnel construction employing a slidable shield or tunnel machine with independently controllable propelling rams in advance of the tunnel lining, the provision of tape measures attached to said shield or machine and dial attachments fixed on the sides of the main tunnel, said tapes being drawn through said dial attachments so that the relative advance of each side of the shield may be continuously observed and the directional course of said shield may be corrected if necessary by suitable regulation of said rams.

4. In tunnel construction employing a slidable shield or tunnel machine with independently controllable propelling rams in advance of the tunnel lining, level indicating means attached to the shield or machine in combination with tape measures attached to said shield or machine and dial attachments fixed on the sides of the main tunnel being progressively constructed, said tapes being drawn through said dial attachments.

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