

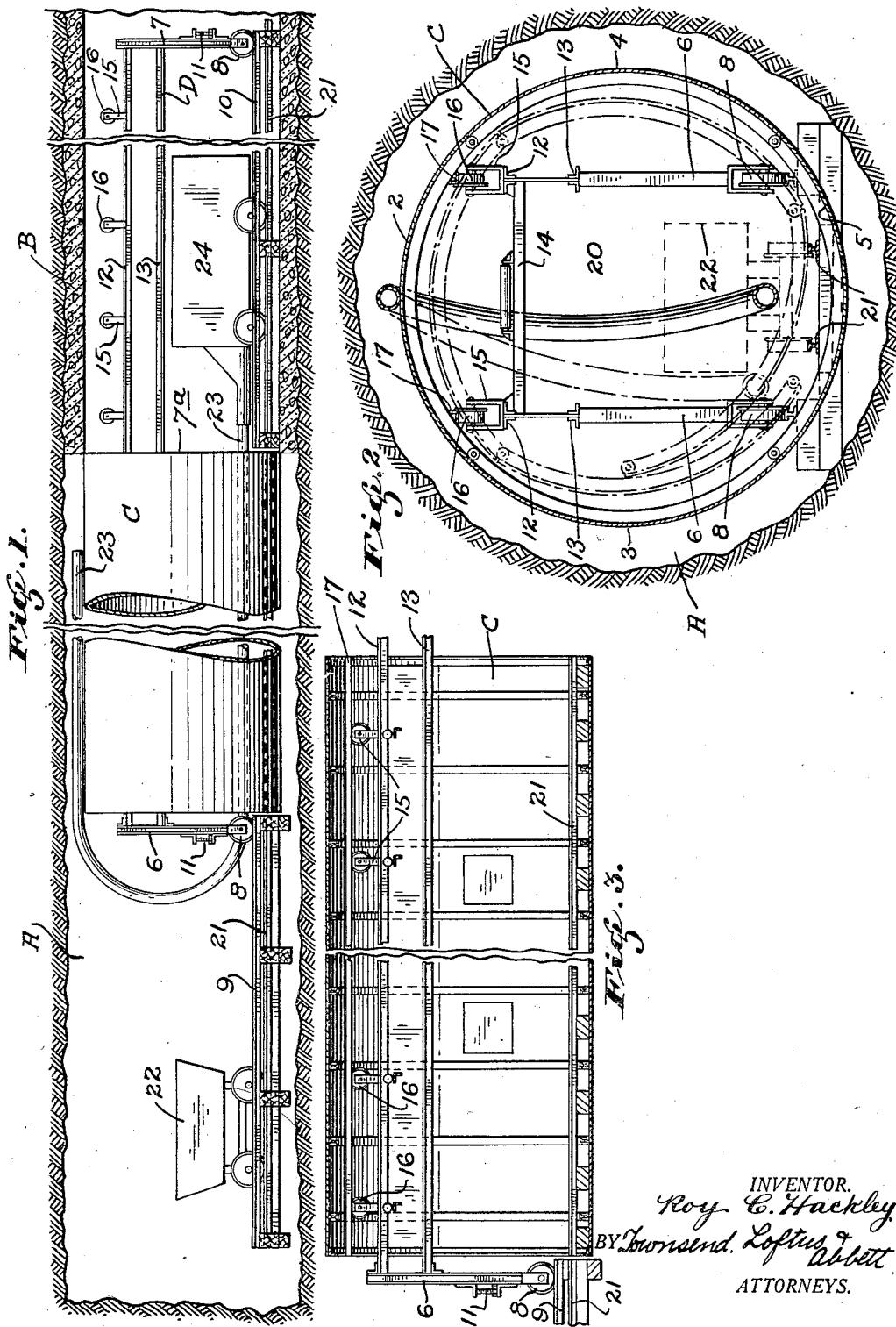
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METHOD OF LINING TUNNELS WITH CONCRETE AND APPARATUS THEREFOR

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METHOD OF LINING TUNNELS WITH CONCRETE AND APPARATUS THEREFOR

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This invention relates to a method of lining tunnels with concrete, and apparatus therefor, and especially to improvements on the method and apparatus disclosed in my co-pending application entitled "Method of lining tunnels with concrete and apparatus therefor", filed February 14, 1927, Serial Number 167,934.

The invention disclosed in my co-pending application embodies the forming of a base and concrete footings at each side of a tunnel; the use of a trackway between the footings; the setting of anchor bolts in the concrete footings; the use of collapsible forms which are adaptable to be supported by the concrete footings and secured by the anchor bolts; the use of a portable carriage movable on the trackway whereby the forms may be raised into position and similarly stripped and lowered after use; a concrete gun with an extended discharge pipe for delivering concrete to the forms when in place; and a portable carriage for the gun and discharge pipe which is movable on the trackway independently of the forms and the carriage cooperating therewith. The method and apparatus disclosed requires two separate operations. First, the pouring and setting of the concrete forming the base and footing of the tunnel, and secondly the pouring and setting of the sides and arch. The work cannot be carried on as a continuous operation as the first section of concrete when poured must be given time to set before the forms for the sides and arch can be placed in position. Furthermore the forms, the supports, and the apparatus heretofore employed practically fill and block the tunnel, thus interfering with, and stopping the work of excavating and mucking as the tunnel is being driven.

The object of the present invention is to generally improve and simplify the method and apparatus heretofore referred to; to provide a method whereby the bottom or invert sides and arch may be poured simultaneously as a single integral unit, and further to provide a method and apparatus which will permit lining of the tunnel with concrete without blocking the tunnel or interfering with the

excavation and mucking operations while the driving of the tunnel is in progress.

The construction of the apparatus employed, and the method of setting the forms, together with the means for delivering the concrete thereto will be described in detail. Having reference to the accompanying specifications and drawings:

Fig. 1 is a longitudinal section of a tunnel showing the forms in place and the concrete gun in position to deliver concrete thereto,

Fig. 2 is an enlarged cross section of the tunnel showing the form in position, said view also showing the carriage and trackway whereby the form is supported,

Fig. 3 is a longitudinal section of the form, said view also showing a portion of the carriage whereby it is supported.

The present invention embodies two main features, first a method which permits a simultaneous pouring of the bottom, sides and arch of the tunnel so as to form a complete integral unit or lining, and secondly it embodies the provision of a mould and a support therefor which will leave a clear, unobstructed passage for the free entrance and exit of mucking cars so as to permit driving and mucking of the tunnel to proceed at the same time as the tunnel is being lined.

The manner in which this is accomplished can best be explained by referring to Figs. 1 and 2 of the drawings. In these drawings A indicates in general the tunnel which is being driven, and B the concrete lining which is placed therein. The tunnel disclosed is circular in cross section, but obviously practically any shape or cross section desired may be obtained with the same method and apparatus, as the only change required would be the shaping of the mould or form to suit varying cross sections.

The mould employed in this instance is circular and is generally indicated at C. It consists of a plurality of sections such as shown at 2, 3, 4 and 5, and these sections are pivotally connected to permit the mould to be collapsed after the concrete has been poured and set. The mould is supported in the present instance by a carriage, generally indicated at D. This carriage consists of

end sections or uprights, such as shown at 6 and 7. These uprights are supported by wheels 8, and these are in turn supported by trackways indicated at 9 and 10. The uprights 6 and 7 are vertically adjustable, as indicated at 11, and the function of this vertical adjustment will hereinafter be described. The end sections 6 and 7 are connected by longitudinally extending beams 12 and 13 and these beams are tied across the top by cross bars or beams 14. The upper beams 12 carry fork-shaped bearings 15, in which are supported rollers 16. These in turn engage single bars or trackways, 17 secured to the form section 2. The form or mould, as shown in Figs. 1 and 2, is supported by the rollers 16, or in other words, the carriage D, and as the rollers engage the trackways 17 it is also possible to move the form as a whole longitudinally of the carriage as will hereinafter be described. Conversely it is possible to move the carriage longitudinally with relation to the form.

In actual operation, with the form in the position shown in Figs. 1 and 2, it is possible to pour the concrete and at the same time to permit the driving and mucking of the tunnel to progress. This is due to the fact that two crews of men are employed, one crew handling the concreting apparatus while the other crew is driving and mucking at a point in advance thereof. It is furthermore due to the fact that the carriage D is substantially U-shaped in construction, (see Fig. 2) as it consists of the uprights 6 and the cross bars or beams 14. A clear, unobstructed central passage generally indicated at 20 is thus formed through which entrance or exit may be had at all times.

A pair of rails, such as indicated at 21 is laid continuously throughout the tunnel and the form and these rails support mucking cars, such as shown at 22. These are extended through the carriage D and the form C up to the face of the tunnel where the driving or excavating is taking place, and the driving and mucking crew can thus continue their work without interfering with the work which is being done by the concreting crew.

The concrete is applied or delivered to the space formed between the tunnel proper and the form in any suitable manner, or as here illustrated by a pipe 23 which is connected with a concrete gun or pneumatic concrete discharging apparatus, such as shown at 24. This apparatus is not described in detail as it has already been fully described and illustrated in my former patent entitled "Apparatus for lining tunnels with concrete," issued March 1, 1927, Patent Number 1,619,297. Suffice it to say that the gun shown at 24 is filled with concrete, air pressure is applied and this pressure forces the concrete out through the discharge pipe 23 which in turn delivers it to the space formed between the

tunnel and the form. The concrete thus delivered drops downwardly over the sides of the form, and thus fills the bottom or invert and the sides of the tunnel and as it builds up the arch or top is also formed. The pipe 23, when the pouring operation starts, assumes the position shown in Fig. 1 but as the filling progresses the gun 24, together with the pipe 23 is gradually advanced until the filling operation has been completed. The pipe and gun may then be removed, as they are portably mounted on the mucking track 21. During the actual period required to discharge the gun, the mucking cars shown at 22 are not able to pass through, but the time required is comparatively short so the mucking operation is only interfered with momentarily. The moment the gun is removed for refilling the mucking cars can pass through as the passage is clear.

After the concrete is set the carriage D is advanced until the end 7 thereof assumes the position adjacent the forward end 7^a of the form. The carriage proper is then slightly lowered by means of the adjustable mechanism indicated at 11 and the forms are then collapsed and stripped with relation to the concrete. In the collapsed form they are again advanced on the rollers indicated at 16, until the forward end of the form assumes the position shown in Fig. 1. The carriage D is then raised by the mechanism indicated at 11 and the form is expanded and placed in position, when it is again ready for the pouring of the next section of the tunnel.

From the foregoing it should be apparent that the two crews can work entirely independently of each other, without any interference whatsoever, the only period that the mucking operation is stopped being that period when the gun is discharging. This, however, represents such a small proportion of the total time that for all intents and purposes both crews are working entirely independently of each other, and without any interference.

Furthermore, a continuous integral concrete lining is obtained as the base, sides and arch are poured with one operation.

Having thus described by invention, what I claim and desire to secure by Letters Patent is:

1. An apparatus for lining tunnels with concrete comprising an elongated carriage, a pair of longitudinally separated trackways within the tunnel, one trackway supporting the side and the other trackway supporting the rear end of the carriage, a form supported by the carriage between the trackways, and longitudinally movable from end to end of the carriage.

2. An apparatus for lining tunnels with concrete comprising an elongated carriage, a pair of longitudinally separated trackways

within the tunnel, one trackway supporting the side and the other trackway supporting the rear end of the carriage, a roller track on the carriage and a form supported by the roller track and longitudinally movable thereon from end to end of the carriage.

3. An apparatus for lining tunnels with concrete comprising an elongated carriage, a pair of longitudinally separated trackways within the tunnel, one trackway supporting the side and the other trackway supporting the rear end of the carriage, a roller track on the carriage, a form supported by the roller track and longitudinally movable thereon from end to end of the carriage, and means for raising and lowering the roller track of the form with relation to the carriage.

4. An apparatus for lining a tunnel with concrete comprising an elongated carriage, a trackway within the tunnel upon which the carriage is longitudinally movable, a form supported by the carriage, and longitudinally and vertically movable with relation to the carriage, and a second trackway extending through the form and the carriage.

5. An apparatus for lining tunnels with concrete comprising an elongated carriage, a pair of longitudinally separated trackways within the tunnel, one track supporting the forward end and the other track supporting the rear end of a carriage, a roller track on the carriage, a form supported by the roller track, said form completely surrounding the roller track and the carriage, said form and carriage having a central unobstructed passage formed therethrough, and a second trackway extending through the tunnel, the carriage and the form.

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