

No. 762,655.

PATENTED JUNE 14, 1904.

J. W. RENO.
APPARATUS FOR TUNNEL CONSTRUCTION.

APPLICATION FILED NOV. 30, 1903.

NO MODEL.

2 SHEETS—SHEET 1.

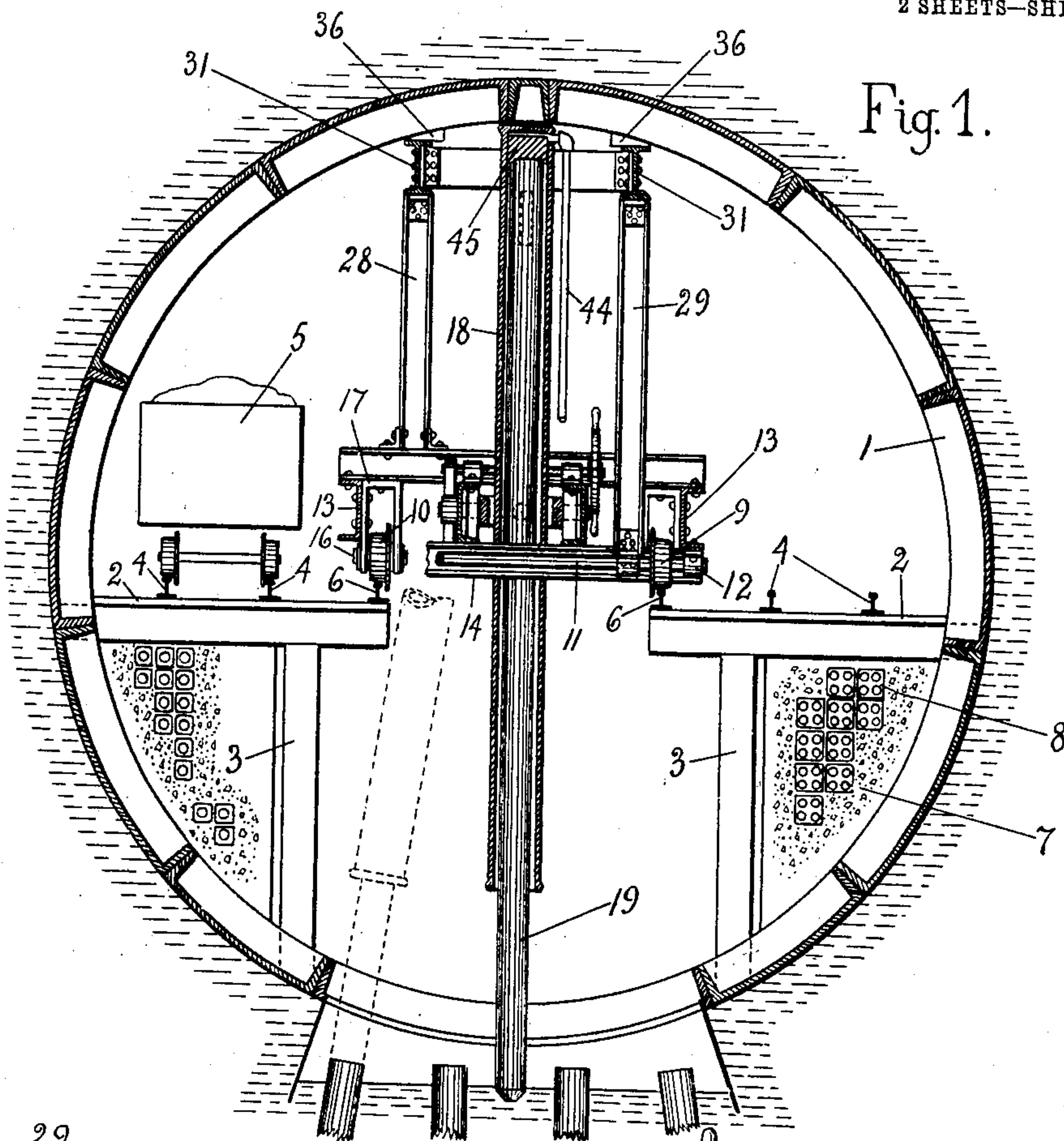


Fig. 1.

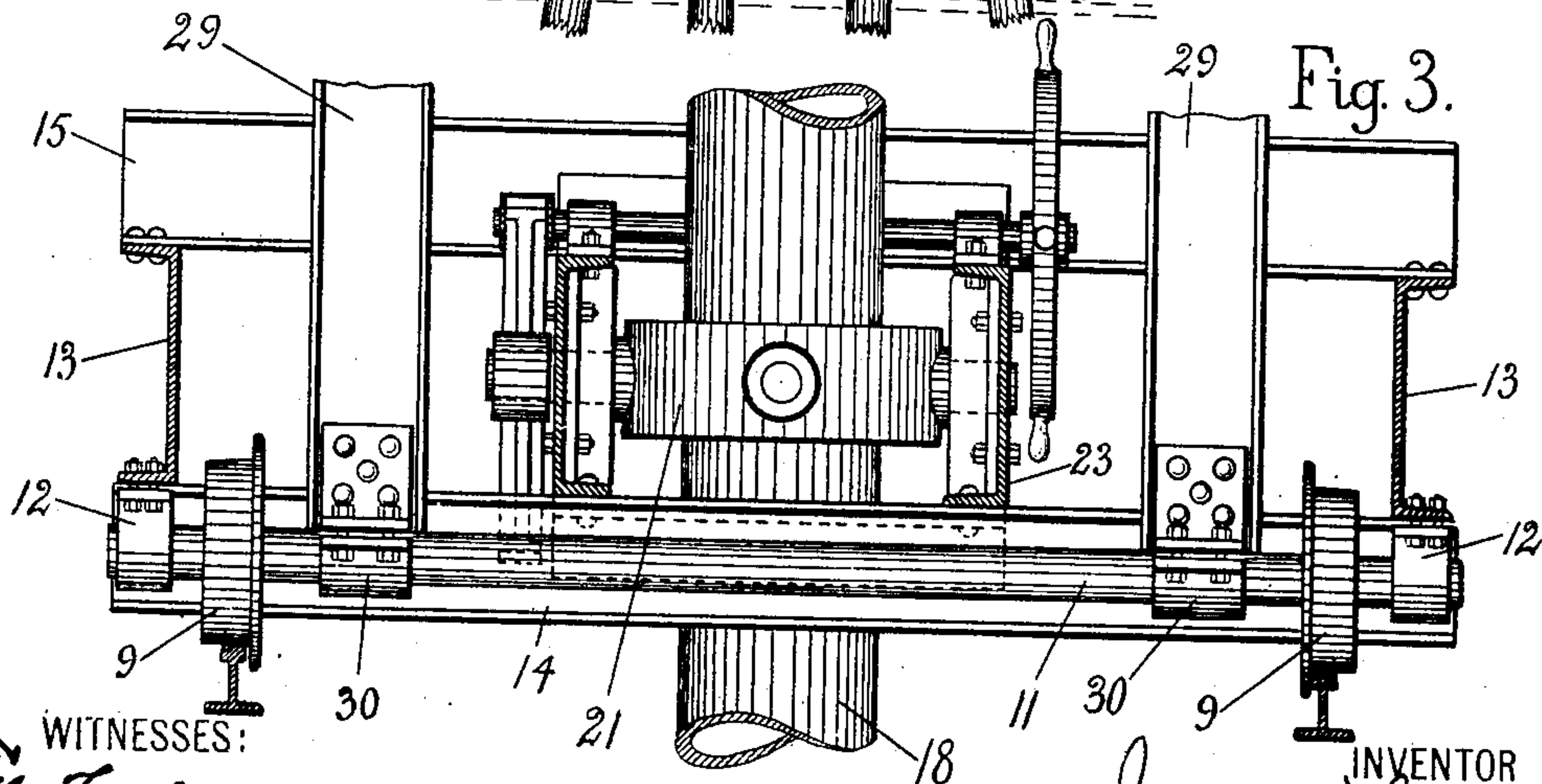


Fig. 3.

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2 SHEETS—SHEET 2.

Fig 2

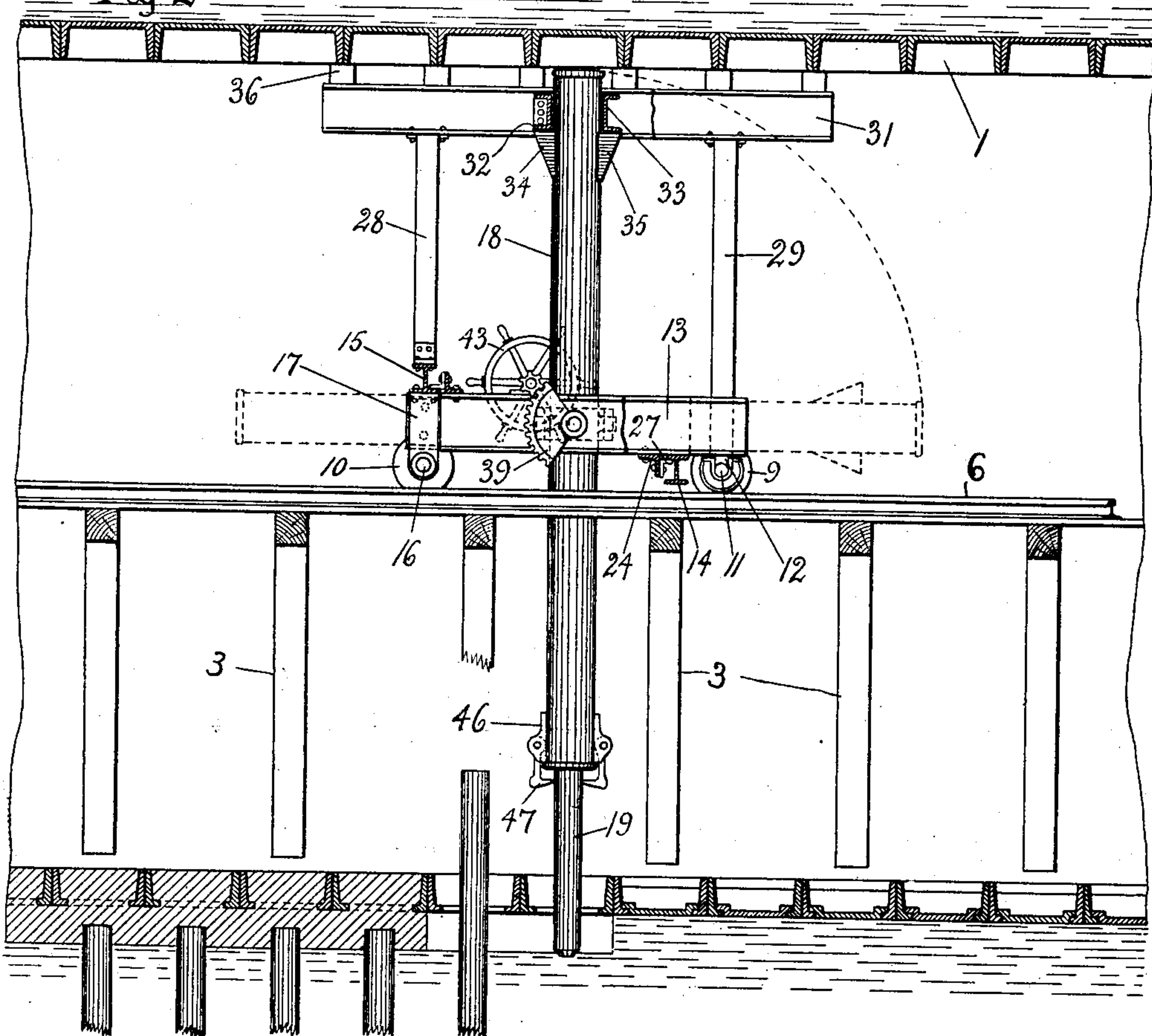
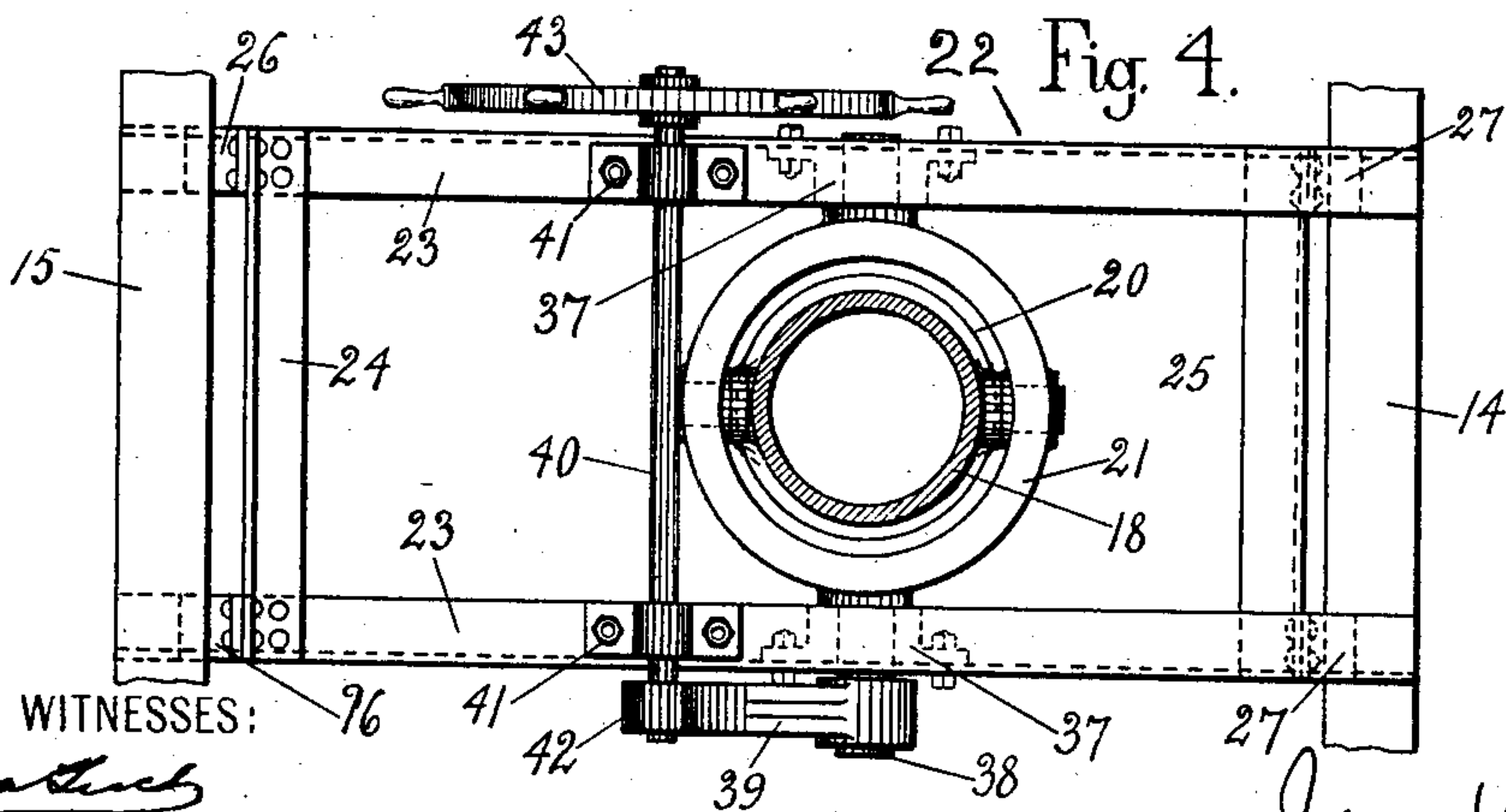


Fig. 4.



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APPARATUS FOR TUNNEL CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 762,655, dated June 14, 1904.

Application filed November 30, 1903. Serial No. 183,124. (No model.)

To all whom it may concern:

Be it known that I, JESSE W. RENO, a citizen of the United States of America, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in Apparatus for Tunnel Construction, of which the following is a specification.

My invention relates to apparatus for tunnel construction, and particularly to apparatus adapted for the tunnel construction and method described by me in my pending application, Serial No. 180,350.

The object of my invention is to provide an apparatus to be used in connection with segmental tunnel construction which shall facilitate and expedite the various operations which follow the forcing forward of the heading or shield, particularly the operations of transporting material to be used in the tunnel to the working points and excavated material from the tunnel and operations which are involved in constructing the tunnel foundation or bed, so that these operations may be carried on with substantially no interference. Tunnels of this class are usually circular in section and consist of a segmental shell which is lined with a wall of cement. The base of a tunnel which supports the railway-tracks is generally formed of concrete, which may be built up entirely within the tunnel-shell, but which I prefer to have extend beneath the tunnel-shell, so as to form a continuous concrete girder of massive size reinforced by longitudinal beams or rods. This concrete construction forming the base of the tunnel may be still further reinforced and strengthened by driving piles therebeneath, as illustrated in my application Serial No. 180,350. While my present application relates to apparatus especially designed for use in connection with the construction described in said application, certain features of it may be used with advantage in other forms of construction.

My invention consists in providing two platforms along the sides of the tunnel, leaving a continuous open space between them and arranging them at substantially the height of the center of the tunnel, in securing the

outer edges of said platforms to the tunnel-shell, and in supporting the inner edges by vertical posts or uprights, in arranging tracks upon each side of said platforms adapted to carry trucks for the transportation of material, and in arranging rails along the inner edges of said platforms adapted to carry portable apparatus to be used in the construction of the base of the tunnel or trucks, or both.

My invention consists, further, in providing a novel means for driving piles down through the base of the tunnel and in other novel features of construction to be hereinafter more fully pointed out and described.

In the drawings accompanying and forming part of this specification, Figure 1 is a transverse section of a tunnel equipped with my apparatus. Fig. 2 is a central longitudinal section. Fig. 3 is an enlarged end view of a portion of the hydraulic pile-driver, and Fig. 4 is a partial plan view.

The reference characters are used in the same sense in all of the drawings and the specification.

Numeral 1 represents the tunnel-shell made up of cast-iron segments bolted together in the usual manner.

2 represents platforms secured at their outer edges to the tunnel-shell and supported, preferably, at a distance somewhat outside of the inner edges of said platforms by upright posts 3, so that the platforms overhang said posts.

4 represents rails mounted to the platforms 2, adapted to support trucks, as 5, for the transportation of material in and out of the tunnel.

6 represents rails laid along the inner edges of said platforms adapted to support any portable apparatus, such as a pile-driver or trucks which may be used for transporting material back and forth along the line of the tunnel. The posts 3 are set back from the inner edges of the platforms in order to give a broader working space between said posts for the construction of the tunnel-base and the road-bed which rests upon it. At the same time a sufficient space 7 is left beneath the platform and outside of the posts 3 to permit the construction of the banquette, which will usually include electrical conduits

8, as shown. It is thus seen that by this arrangement of the platforms 2 and the supports 3 and the tracks upon the platforms three separate lines of tracks are provided for the support and conveyance of portable trucks and apparatus and that the arrangement of these platforms and their supports is such that they may be left in position and used during the entire construction of the banquettes and the tunnel-base and the road-bed within the tunnel.

The particular form of apparatus which I have shown supported upon a track 6 is a pile-driver, by means of which wooden piles of a length substantially equal to or even a little greater than the diameter of the tunnel may be driven down through openings in the base of the tunnel into the earth therebeneath. It is obvious, however, that this arrangement of platforms and tracks is equally advantageous if used in connection with any other form of apparatus used in the various operations in constructing the tunnel.

Numeral 9 represents the rear wheels of the truck supporting the pile-driver mechanism.

10 represents the forward wheels.

The rear wheels are fixed to the axle 11, which runs in the bearings 12, secured to the under side of the longitudinal beams or side members 13. These longitudinal side members are connected at their rear ends by a transverse member or beam 14, located beneath the side members 13, and at their front ends by a transverse member 15, located above the side members, the purpose of this construction being, as will hereinafter appear, to permit the hydraulic cylinder to occupy a horizontal position.

The front wheels 10 of the pile-driver truck are fixed to short shafts or axles 16, which have bearings in the brackets 17.

18 is a hydraulic cylinder closed at one end and having an internal diameter sufficiently large to receive the pile 19 within it and having a length somewhat less than the internal diameter of the tunnel.

The hydraulic cylinder 18 has secured near its center the inner gimbal-joint ring 20, which is pivoted within the outer gimbal-joint ring 21, the outer gimbal-joint 21 being pivotally supported in the frame 22.

The frame 22 is composed of longitudinal members 23 and a front transverse member 24, secured to the upper sides, and a rear transverse member 25, secured to the lower sides of the longitudinal members. The longitudinal members 23 of the frame 22 extend over and rest upon the rear transverse truck member 14 and beneath the forward truck member 15.

26 represents clips riveted to the forward transverse members 24, which engage the flange of the forward transverse truck member 15, and 27 represents clips riveted to the rear transverse frame members 25, which en-

gage the under side of the flange of the transverse truck member 14. It is thus seen that by means of these connections the frame 22, in which the hydraulic cylinder 18 is suspended, is slidable transversely of the truck. The cylinder may therefore be shifted bodily transversely of the truck in either direction for a limited distance, and it may be tilted about its pivotal connections with the frame in any direction.

28 represents uprights secured to the forward transverse member 15, and 29 represents rear uprights, which have secured to their lower ends the bearings 30 on the axle 11. The rear uprights 29 are thus supported directly upon the axle, while the front uprights 28 are supported directly upon the transverse member 15.

31 represents longitudinal I-beams secured to the tops of the upright members 28 and 29, and 32 represents a transverse beam secured to the longitudinal members 31. 33 represents a similar transverse member adapted to engage the two longitudinal members 31, the transverse member 33 being removable for the purpose of permitting the cylinder 18 to swing down to a horizontal position.

The transverse members 32 and 33 engage, respectively, the lugs 34 and 35, fixed to the cylinder.

The longitudinal members 31 are made to clear by a short space the inner flanges of the segments forming the tunnel-shell.

36 represents wedges or blocks which are inserted between the top face of the longitudinal members 31 and the inner faces of the segments of the tunnel-shell, the purpose of the longitudinal members 31 being to distribute the upward reaction or pressure of the hydraulic cylinder over a plurality of tunnel-segments.

The trunnions of the outer ring 21 of the gimbal-joint are supported in bearings 37, secured to the frame 22. One of the trunnions 38 is elongated, so as to extend outside of the frame, and has secured to its outer end the gear-segment 39.

40 is a shaft mounted in the bearings 41, having secured to its end a pinion 42, which engages the gear-segment 39, and upon its other end the hand-wheel 43. By these means, as will be readily understood, the cylinder 18 may be swung from a vertical to a horizontal position, and vice versa.

46 is a hook pivoted to the lower end of the cylinder 18, having its pointed end 47 adapted to be driven into the pile to hold it in position while the cylinder is being turned from one position to another.

44 is a pipe connecting the end of the cylinder 18 with any convenient means for supplying water under pressure, and 45 is a piston, preferably supplied with the usual cup-packing and adapted to operate in the cylinder and to force the pile down into the earth.

The operation of the apparatus is as follows: The side platforms 2 and the side tracks 4 and central tracks 6 are carried forward as the work in the heading progresses to a point as near as convenient to the heading. The tracks are then immediately available for the purpose of carrying excavated material back and out of the tunnel and carrying material to be used for the construction of the tunnel in to any point where it is to be used. When the base of the tunnel has been made ready for the reception of piles, a pile is inserted in the cylinder and brought into position over the point at which the pile is to be driven. The cylinder will preferably be swung to a horizontal position in order to facilitate the placing of the pile therein and the pile secured by means of the hook 46. The blocks 36 are then inserted between the load-distributing members 31 and the tunnel-shell, and hydraulic pressure is brought to bear upon the piston 45, when the pile is driven down until its upper end will just clear the lower end of the cylinder. If it is desired to drive the pile still farther, a short section of pile may be placed in the cylinder having its lower end brought to bear against the top of the partially-driven pile and then, as before, applying hydraulic pressure to force the pile down to the desired depth. Those piles which are driven near the center of the tunnel will be driven in a substantially vertical direction, while those driven at the side may be inclined, as shown in the drawings, and in order to give the desired inclination to the pile the cylinder may be both shifted and inclined, as will be readily understood.

Additional trucks for the purpose of transporting piles or other articles back and forth to the pile-driver may be mounted on the central track 6, and thus a supply of piles may be kept conveniently near the pile-driver with a minimum amount of handling.

It is thus seen that I have provided a simple and efficient means for transporting material to and from the various working points of the tunnel and for pikes from within the tunnel down through its base as the tunnel-shell has been constructed, and I have provided three sets of tracks so arranged and located that they may be used independently of each other and in a manner which will not in any way interfere with the construction of the banquettes or of the permanent road-bed in the base of the tunnel.

The operations involved in the construction of the base of the tunnel and driving the piles therefor may be carried along as fast as the heading progresses at a relatively short distance behind the heading.

The construction of the permanent road-bed and the laying of rails thereon may be carried on at the same rate and kept only a relatively short distance behind the operations of constructing the tunnel foundation and base, and

the construction of the banquettes may be likewise carried on along with the other operations, none of these operations interfering in any way with any of the others.

Having thus described my invention, what I claim is—

1. In a pile-driver, the combination with a hollow cylinder adapted to receive a pile, of a hydraulic piston adapted to operate in said cylinder and means for holding said cylinder in place.

2. In a pile-driver, the combination with a cylinder adapted to receive a pile, of a piston in said cylinder and means for tilting said cylinder.

3. In a pile-driver, the combination with a hollow cylinder adapted to receive a pile, of a hydraulic piston in said cylinder, a support for said cylinder and means for shifting said cylinder upon said support.

4. In a pile-driver, the combination with a cylinder adapted to receive a pile, of a piston in said cylinder, a support for said cylinder, slidable and pivotal connections between said cylinder and said support.

5. In a pile-driver, the combination with a cylinder adapted to receive a pile, of a piston in said cylinder, a support for said cylinder and connections between said cylinder and said support permitting the tilting of said cylinder in any direction.

6. In a pile-driver, the combination with a cylinder adapted to receive a pile, of a piston in said cylinder and means for taking the upward thrust of said cylinder when hydraulic pressure is exerted upon said piston.

7. In a pile-driver, the combination with a cylinder adapted to receive a pile and a piston adapted to operate in said cylinder, of a truck adapted to support said cylinder and pivotal connections between said cylinder and said truck.

8. In a pile-driver, the combination with a cylinder adapted to receive a pile and a piston adapted to operate in said cylinder, of a truck, a laterally-slidable frame mounted on said truck and pivotal connections between said frame and said cylinder.

9. In a pile-driver, the combination with a cylinder adapted to receive a pile and a piston adapted to operate in said cylinder, of a truck adapted to support said cylinder and universal pivotal connections between said cylinder and said truck.

10. In a pile-driver, the combination with a cylinder adapted to receive a pile and a piston adapted to operate in said cylinder, of a support for said cylinder, pivotal connections between said cylinder and said support and gearing connected with said pivotal connections for operating the same.

11. In a pile-driver, the combination with a cylinder adapted to receive a pile, and a piston adapted to operate in said cylinder, of a frame adapted to support said cylinder and a gim-

bal connection between said frame and said cylinder.

12. In a pile-driver for tunnels, the combination with a truck and a driving and guiding means mounted thereon, of a stress-distributing member mounted on said truck adapted to engage the roof of the tunnel.

13. In a pile-driver for tunnels, the combination with a truck and a pile driving and guiding means mounted on said truck, of a stress-distributing member mounted on said truck adapted to engage the roof of the tunnel, means for tilting said pile driving and guiding means from a horizontal to a vertical position and vice versa, and means for engaging said pile-driving means when it is in operative position with said stress-distributing member.

14. In a pile-driver for tunnels, the combination with a truck, of a cylinder adapted to receive a pile mounted on said truck pivotally connected therewith, a stress-distributing member or frame mounted on said truck adapted to engage the roof of the tunnel, and lugs upon said cylinder adapted to engage said stress-distributing frame when said cylinder is in operative position.

15. In a hydraulic pile-driver truck, the combination with longitudinal side members and a hydraulic cylinder pivotally mounted thereon, of transverse members connecting the ends of said side members, those transverse members on one end being located above and those on the other end below said hydraulic cylinder when said cylinder is in its horizontal position.

16. In an apparatus for tunnel construction, the combination of longitudinal platforms arranged along the sides of said tunnel, tracks upon said platforms, tracks along the inner edges of said platforms and a portable pile-driver mounted on said inner tracks.

17. In an apparatus for constructing tunnels, the combination of platforms arranged along the sides of the tunnel-shell leaving a lon-

gitudinal opening between said platforms, tracks along the inner edges of said longitudinal platforms, a portable hydraulic pile-driver mounted on said tracks and a stress-distributing member mounted on said portable hydraulic pile-driver adapted to engage the roof of said tunnel.

18. In an apparatus for tunnel construction, the combination of platforms arranged along the sides of the tunnel-shell at substantially the height of the center of the tunnel leaving a continuous longitudinal opening therebetween, uprights supporting said platforms located a distance apart greater than the distance between the inner edges of said platforms, tracks upon the inner edges in said platforms and tracks on either side between said tracks and said tunnel-shell and a portable pile-driver upon said inner tracks.

19. In a tunnel-construction apparatus, the combination of platforms arranged along the sides of the tunnel-shell having a central opening therebetween and tracks upon said platforms.

20. In a tunnel-construction apparatus, the combination of platforms arranged along the sides of the tunnel-shell having a central opening therebetween and track-rails fixed along the inner edges of said platforms.

21. In a tunnel-construction apparatus, the combination of platforms arranged along the sides of the tunnel-shell having a central opening therebetween, track-rails fixed along the inner edges of said platforms and a pair of track-rails upon either platform between the inner edge thereof and the tunnel-shell.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JESSE W. RENO.

Witnesses:

ELLA SUCH,
ROGER H. LYON.