No. 626,063. Patented May 30, 1899.

C. G. HASTINGS.

TUNNELING SHIELD.

(Application filed Mar. 30, 1898.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1

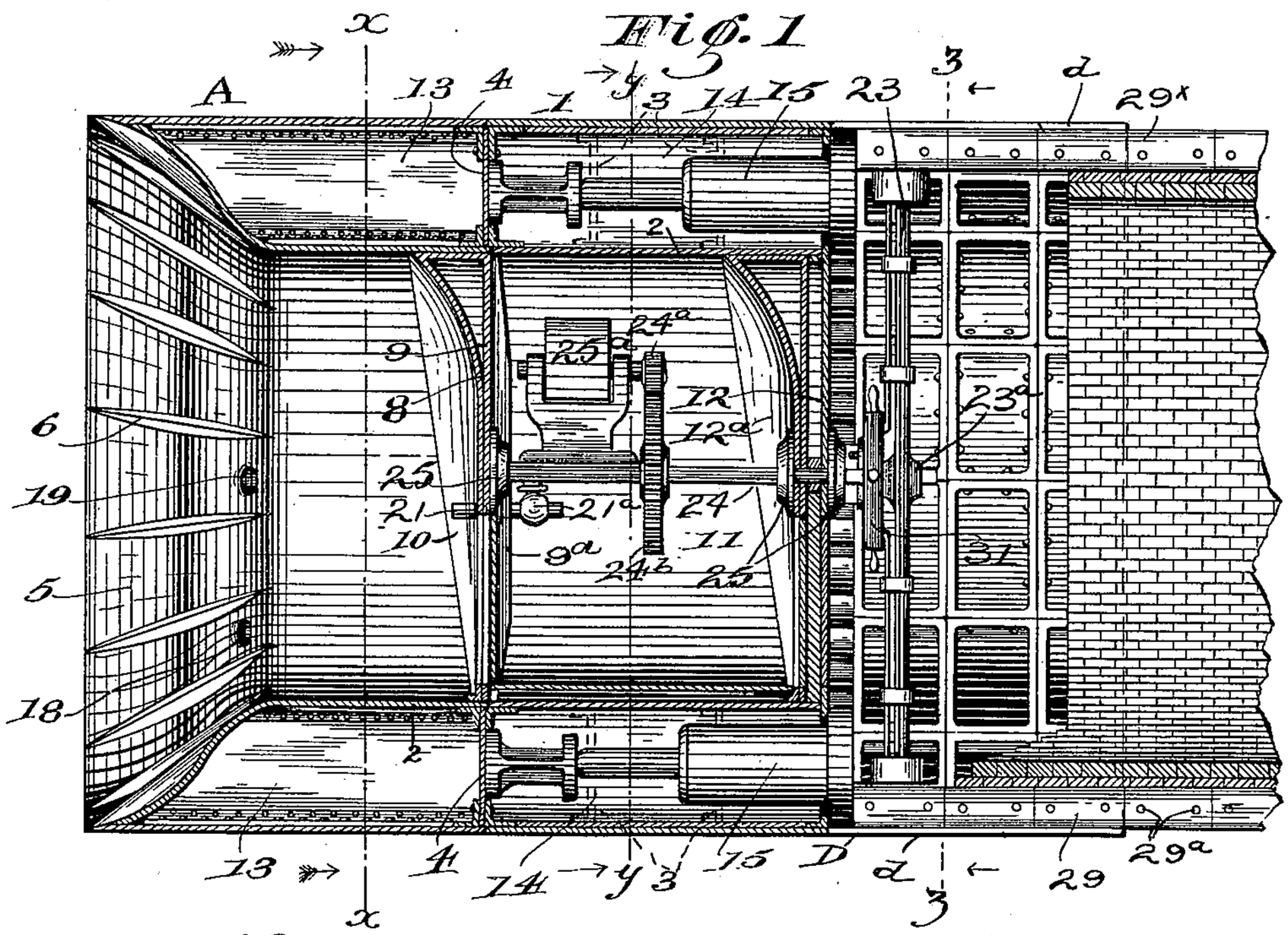


Fig. 10

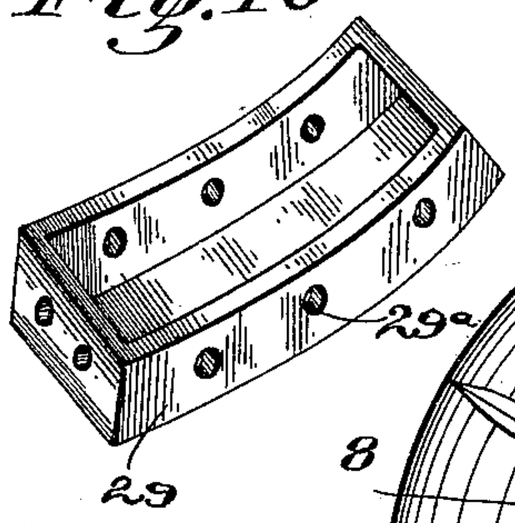


Fig. 2

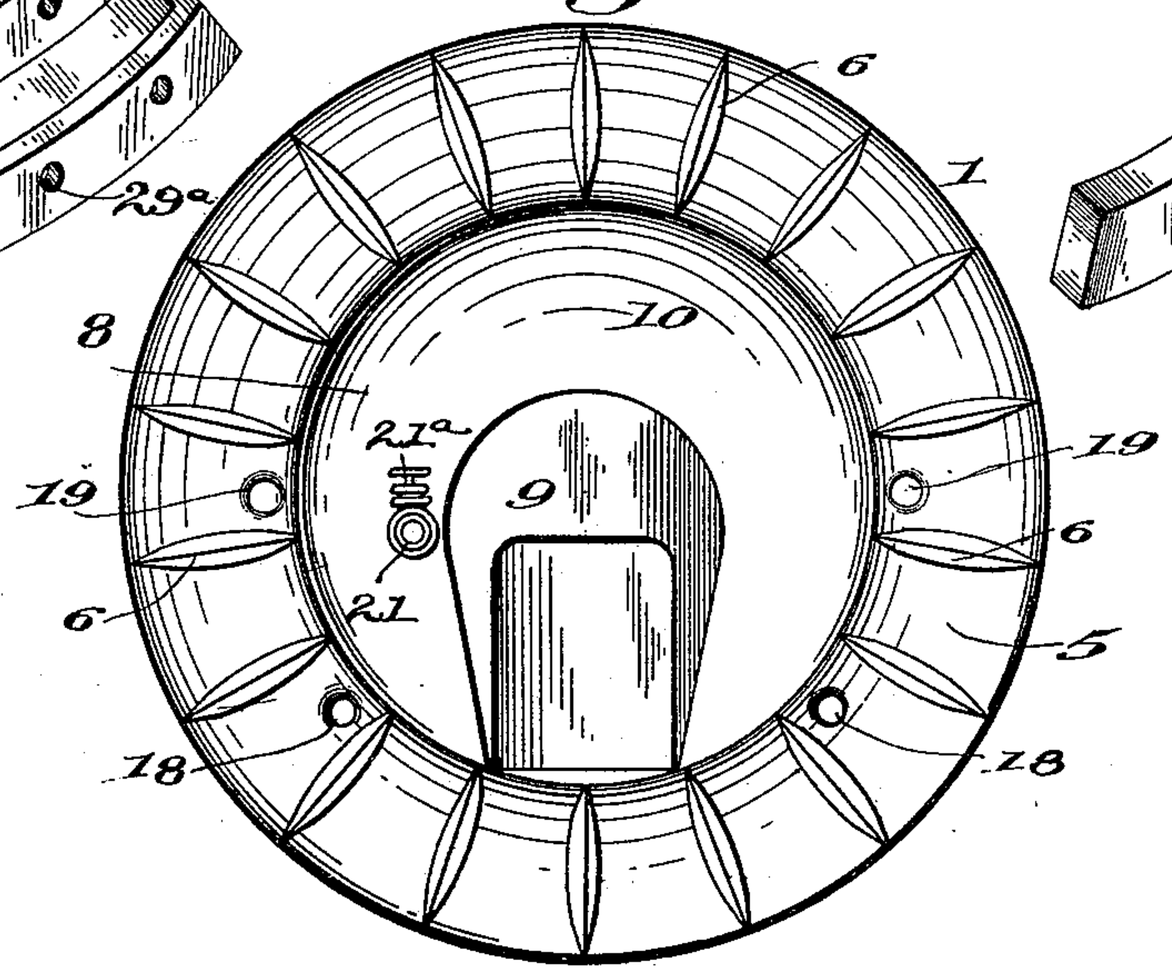
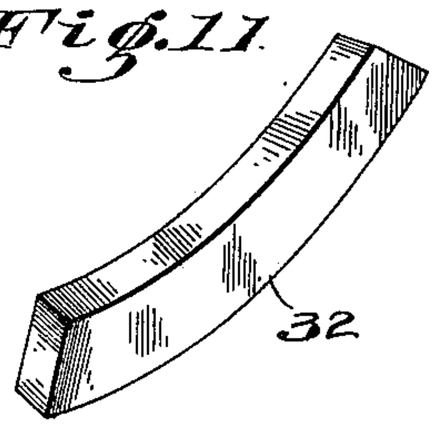


Fig. 11.



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3 Sheets—Sheet 2.

Fig. 3

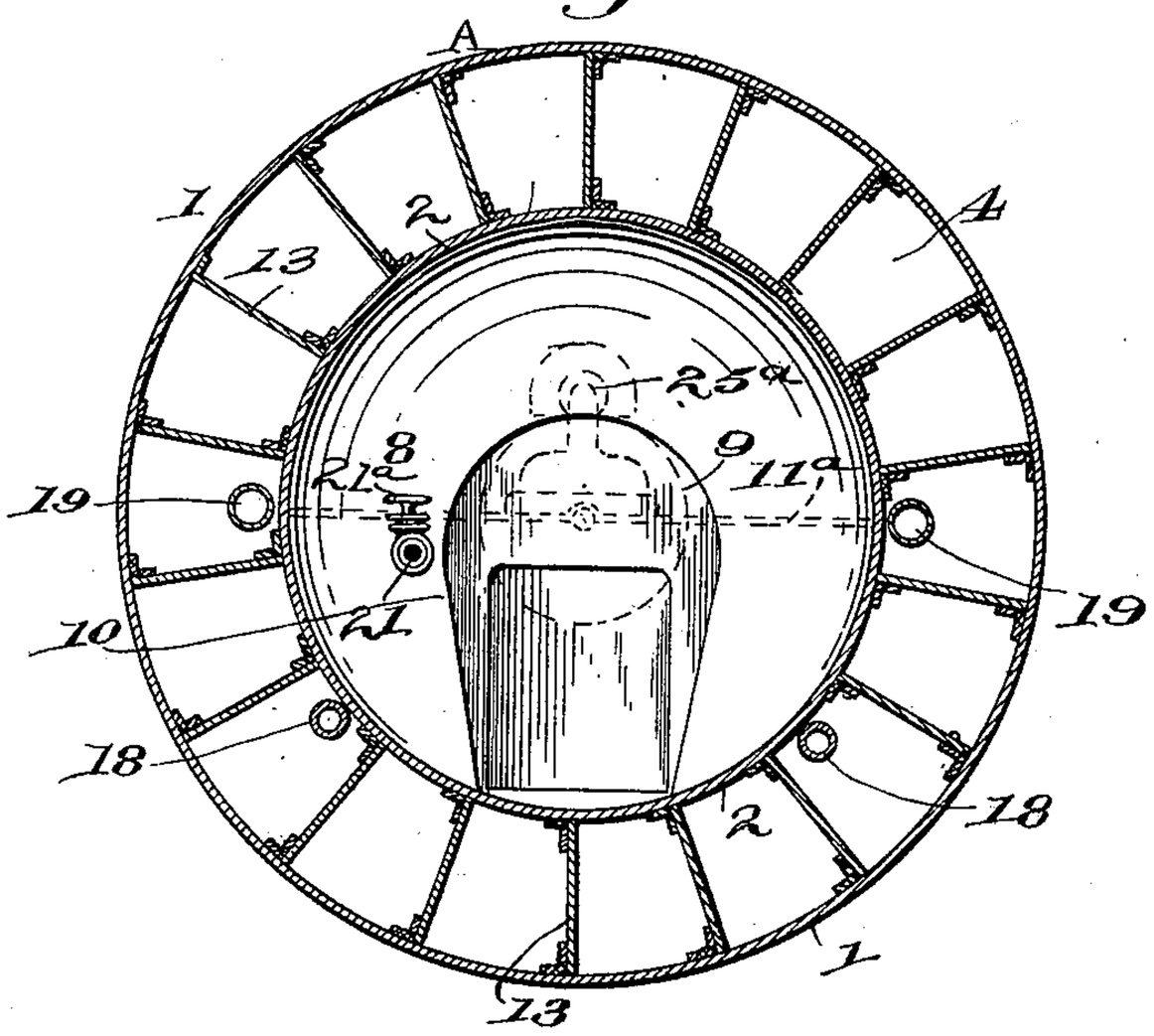
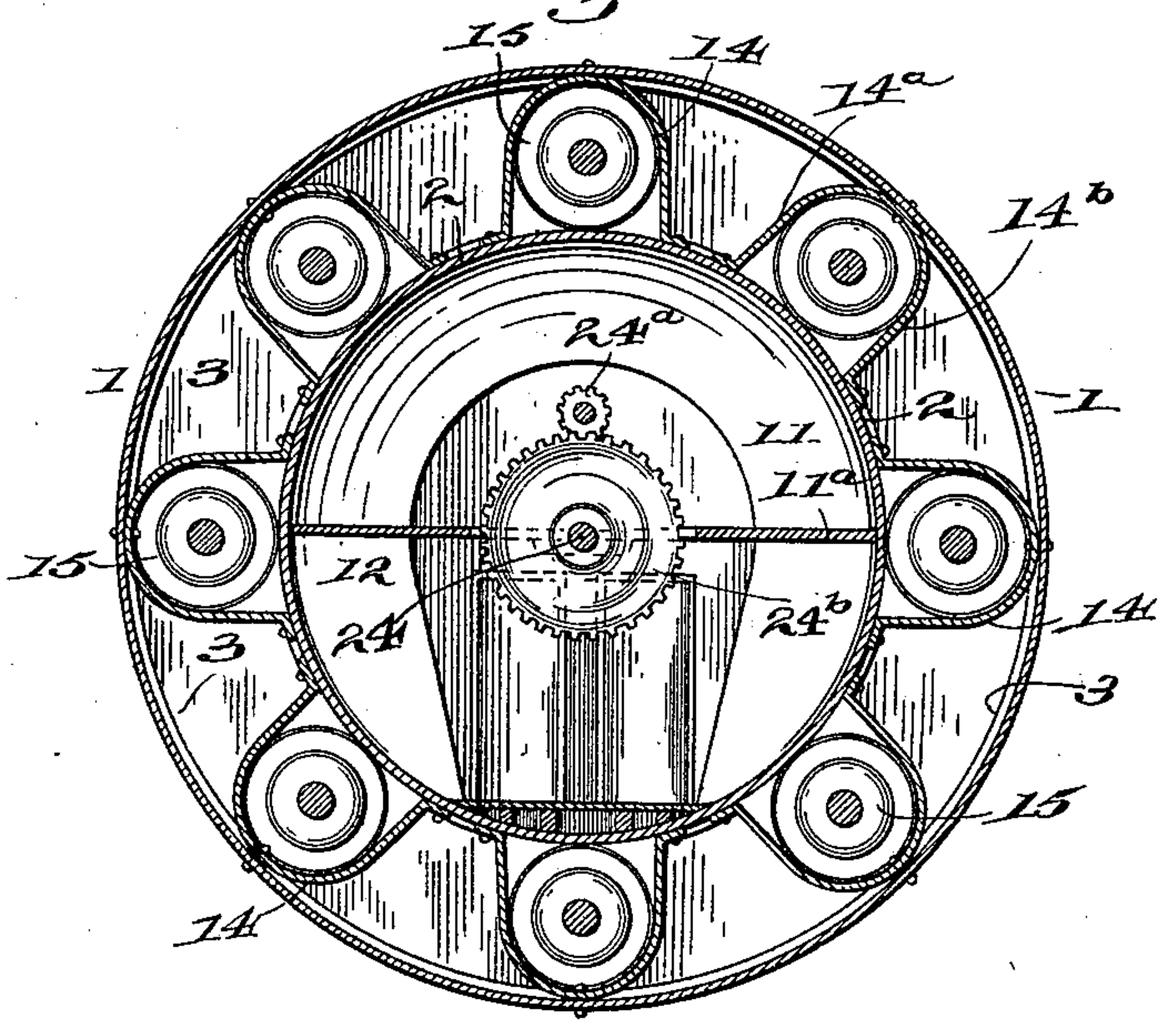


Fig. 4



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TUNNELING SHIELD.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 7

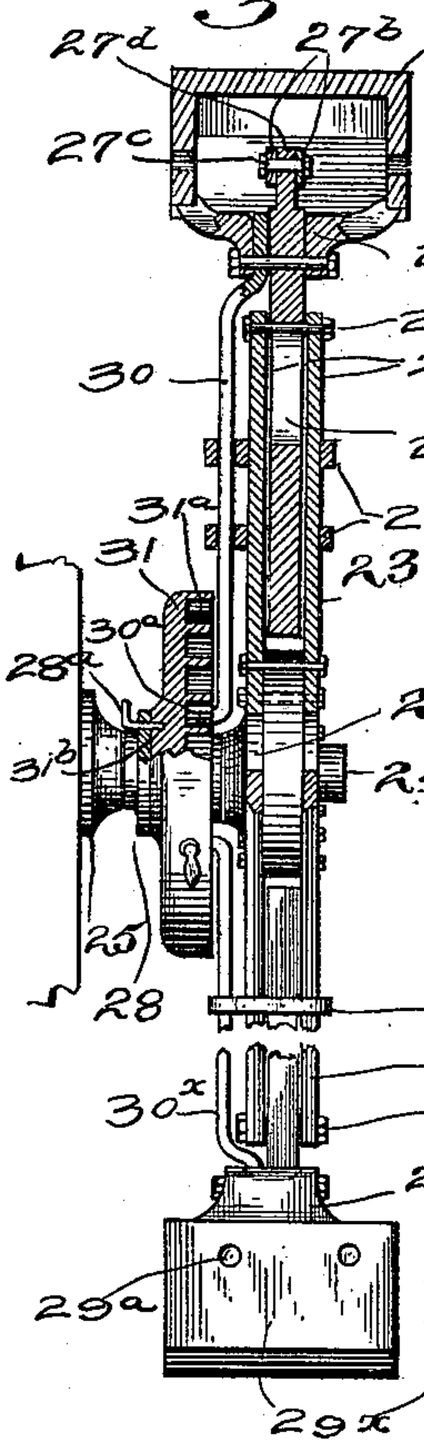


Fig. 8

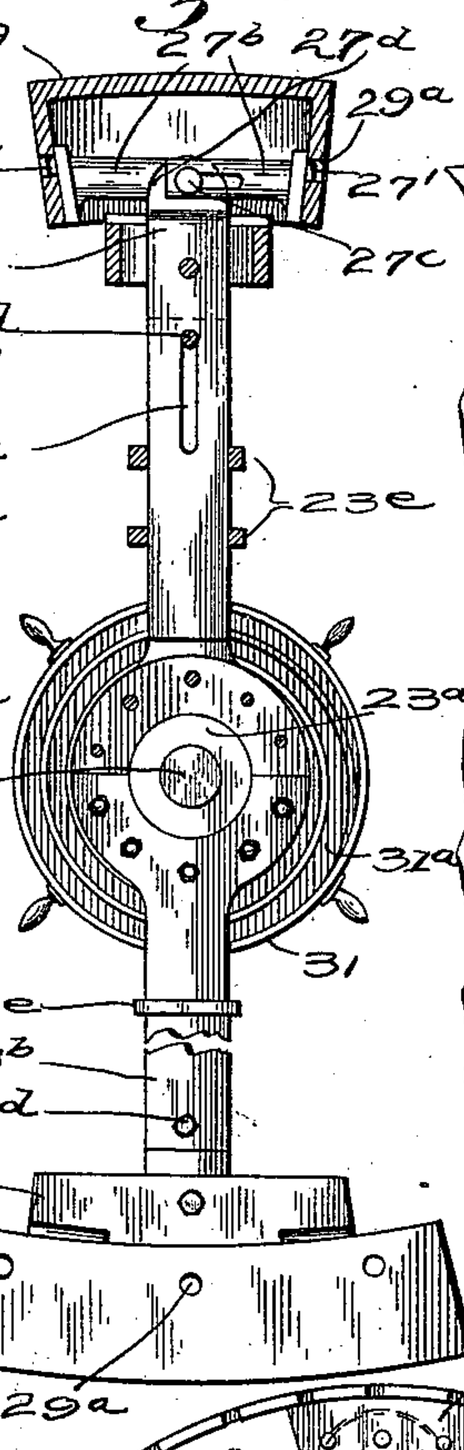


Fig. 5

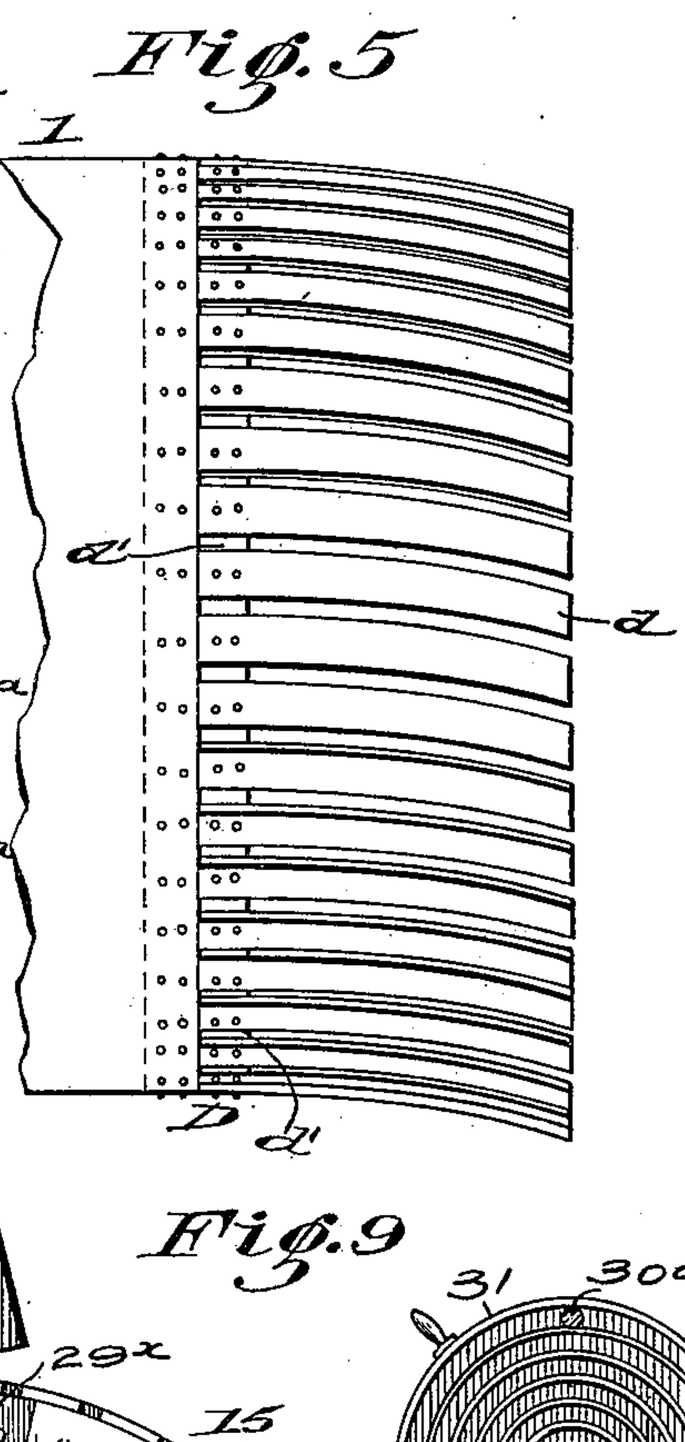


Fig. 9

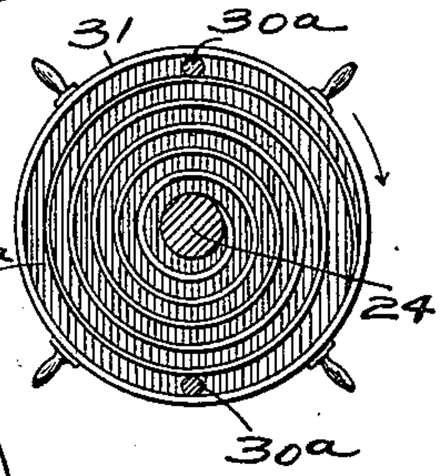
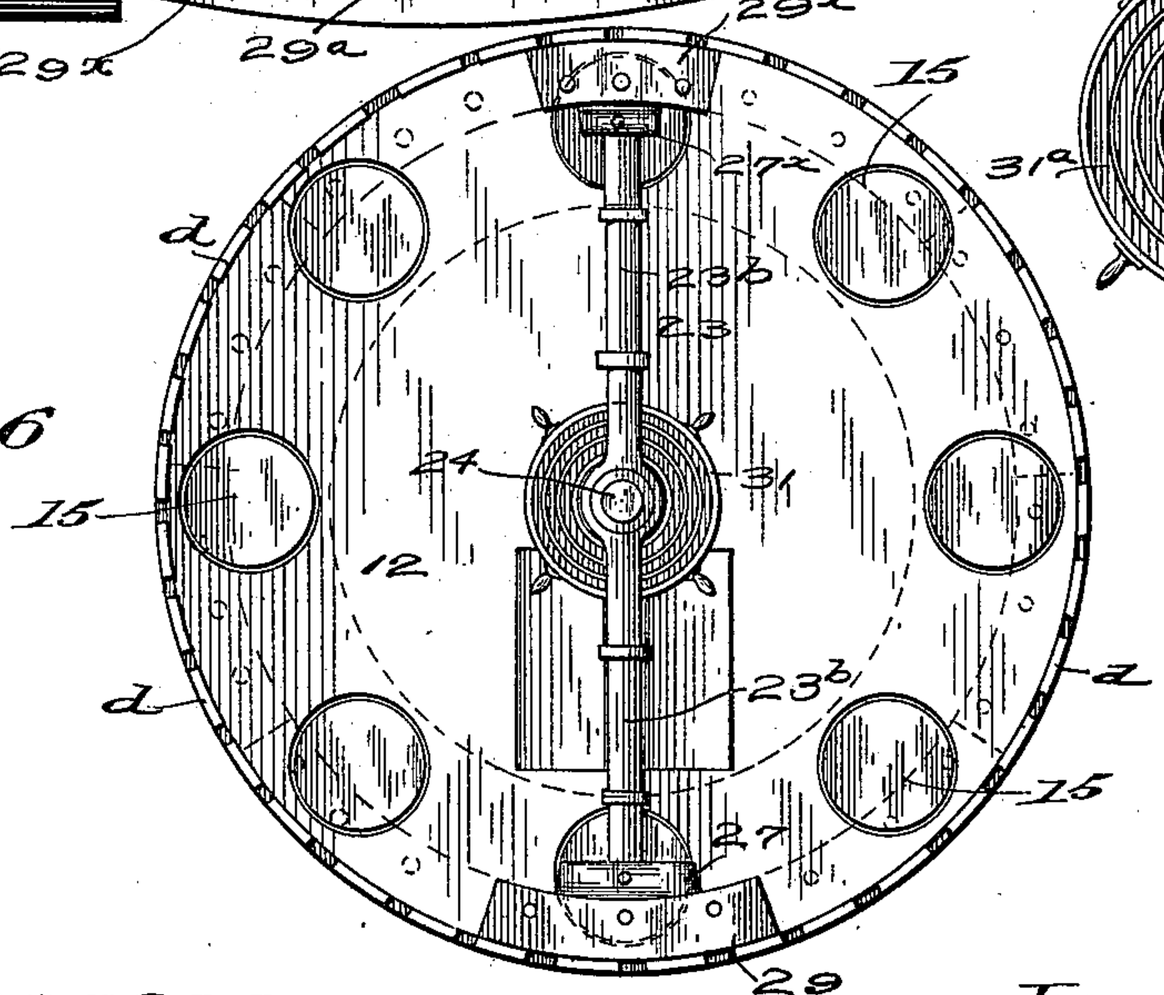


Fig. 6



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UNITED STATES PATENT OFFICE.

CORNELIUS G. HASTINGS, OF CHICAGO, ILLINOIS.

TUNNELING-SHIELD.

SPECIFICATION forming part of Letters Patent No. 626,063, dated May 30, 1899.

Application filed March 30, 1898. Serial No. 675,674. (No model.)

To all whom it may concern:

Be it known that I, CORNELIUS G. HASTINGS, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Tunneling-Shields, of which the following is a specification.

My invention relates to improvements in tunneling-shields and devices connected therewith which are employed for excavating tunnels, subways, and conduits, and especially to shields which are used to best advantage in sand, gravel, silt, and similar loose, soft, or crumbling soils, the said shields being pushed forward to displace or aid in the displacement of the material in front of the shields by means of pneumatic or hydraulic pressure, or both, the intervals between each forward movement of the shield being employed in constructing within a rear projection of the shield a suitable tunnel-lining.

The object of my invention is primarily to provide a very strong, light, and inexpensive shield which will resist any and all strains which may come upon its various members; and the invention consists, essentially, in forming the entire length of the shields of two cylinders suitably connected together one with the other from the cutting-face to the rear bulkhead thereof, and it also consists in certain means for connecting, staging, and dividing the space between said cylinders for various purposes and for providing access thereto, as will hereinafter appear.

A further object of my invention is to divide the said tunneling-shield by means of one or more transverse bulkheads, each of which is braced in a novel manner to resist the force of concussion from blasting or extreme pneumatic pressure and to present a smooth concave face upon the forward side thereof to prevent the lodgment of material within the shield; to provide a plurality of bulkheads within the shield, each of which may be closed air-tight by suitable doors, and to provide an intermediate chamber within which the workmen may escape from either the front working section or from rearward of the shield when desired, and may be supplied with air under any safe and convenient degree of pressure, while the pressure of air may be materially increased to a degree dangerous to life, both at the head and at the hood at the rear of the shield within the tunnel, as will hereinafter appear.

A further object of my invention is to provide suitable means in conjunction with my double-walled shield for directing the movement of the shield, for lessening the friction upon the outer surface thereof, for changing the grade of the tunnel, and for following the curvature or deflection from a straight line thereof if required.

A further object of my invention is to provide certain improvements in the construction of the revolving crane and in certain other details of construction hereinafter particularly described with reference to the accompanying drawings, in which—

Figure 1 is a longitudinal vertical section through a tunneling-shield complete; Fig. 2, an elevation of the forward end or cutting-face of the shield; Fig. 3, a transverse section in line *x x* of Fig. 1, looking to the rear; Fig. 4, a similar section in line *y y* of Fig. 1; Fig. 5, a plan view of the rear end of the shield, showing the flexible hood; Fig. 6, a rear elevation of the shield, showing the double-armed crane; Fig. 7, an enlarged side elevation, and Fig. 8 a similar end elevation, of the crane, partly broken away; Fig. 9, an enlarged face view of the scroll-disk for operating the segment-holders on the ends of the crane; Fig. 10, a perspective view of one of the cast-iron segments, and Fig. 11 a similar view of the wooden segment to be used as an outer lining when a brick lining only is to be employed.

The shell of the tunnel-shield comprises two cylinders 1 and 2, made of boiler-plates connected together, the cylinders being placed one within the other and connected at one end to the rear bulkhead 12, at its junction with the hood D, and at the opposite end to a peripheral dished rim-plate 5, which is provided with radial cutter-blades 6, projecting inwardly therefrom, and thus provide, together with the dished rim-plate, a suitable cutting-face for the shield which will effectively direct the excavated material from the outer cutting edge to the interior of the forward cylindrical compartment, the latter being provided with a bulkhead 8, consisting of a rear flat plate 9, secured at its periphery to the inner cylinder 2 of the shell, and a forward concave or dished plate 10, projecting forwardly

at the top and dished or curved inwardly and downwardly at the top and sides until it meets the flat plate 9, which forms the inner wall of the bulkhead. The plate 9 is preferably stayed upon its inner face by angle-irons 9^a, secured vertically thereto, which may also serve as supports or guides for the doors, the latter being either hinged or made to slide therein and are adapted to be closed tight to form an air-tight partition at the forward end of the middle compartment 11, the rear end of said compartment being provided with a similar air-tight bulkhead 12, formed of double plates of flat sheet metal placed parallel to each other and stayed by a dished plate 12^a, similar to the plate 10 at the front side of the bulkhead 8, the dished plates 10 and 12^a serving to resist not only the excessive pneumatic pressure when caused to act upon the rear bulkhead to push forward the shield, but will effectually resist the concussive force of blasts used at the heading for breaking up solid obstructions of any kind. The outer and inner cylinders are connected at the forward shell-section A by longitudinal flat stay-plates 13, placed radially between said inner and outer cylinders and secured thereto in a suitable manner, and said cylinders are connected at the rear shell-section B by longitudinal cradle-plates 14 of U-shaped cross-sections, which are connected at their inner open ends to the inner cylinder and are riveted at the center line of the bow by a single row of rivets, the bow-shaped outer portion giving great strength and allowing but one row of rivets to be employed for each longitudinal plate, which forms the sides 14^a 14^b of the cradles 14, the said sides being located in the same plane with the stay-plates 13 and the cradles 14 providing suitable compartments to receive the hydraulic rams 15, which are placed at equal distances from each other around the shield. The stay-plates 13 and cradles 14 will thus be in the direct line of pressure of the rams, thus serving also as stays for connecting the inner and outer cylinders, and will give great strength to the shield both to resist longitudinal thrust and direct radial pressure. Diametric ring-stay segments 3 connect the inner and outer shell between the bulkheads, and diametric ring-stays 4, in the same plane with the bulkheads, give additional strength to the shield.

Air-pipes 18 extend through the lower portions of the sections, and above these pipes are larger pipes 19, through which water, running quicksand, or soft earth may be forced by the air-pressure between the heading and the forward bulkhead. The forward ends of air-pipes 19 may be either fitted with caps or with nozzles, upon which may be secured air-pipes leading to pneumatic or other drills should said pipes be used as conduits for such purpose. The forward bulkhead or both bulkheads may be provided with pipes 21, fitted with stop-cocks 21^a, which admit the air from one compartment to the other on completing such communication.

Horizontal partitions, platforms, and division-walls may be arranged in any suitable or preferred manner within the shields, as shown in Fig. 4, and a scaffold may be suspended both at the front and rear ends thereof, upon which the workmen may stand, the said scaffolds being preferably made removable. The rear end of the shield is provided with a hood D, which is formed in a novel manner of a series of straight strips of plate spring-steel d, secured at their forward ends to a rim d' of the outer cylinder 1 of the shell and placed sufficiently near together to prevent the loose earth from falling between them and also admit of their being slightly bent out of a straight line, as shown in Fig. 5 of the drawings, when it is required to change the grade or angle of the shield or to conduct the same in a curved line without causing the shield to bind or be cramped crosswise within the excavation. The crane 23 at the rear end of the shield is supported upon the rear end of a shaft 24, carried by bearings 25, supported upon the bulkheads 8 and 12, and projects rearwardly into the hood D, the end of the said shaft having the hub 23^a of the crane-arm 23 secured thereto; a platform 11^a in the middle compartment 11 serving to support an engine or other suitable machine 25^a, which is geared by pinion 24^a and 24^b to the said shaft 24, by means of which the crane is operated. The arm 23^b supports a movable chuck 27, fitted thereon by means of slotted arm extensions 23^c, which slide between the side plates of the arm 23^b of the crane, and is slotted to receive the pins 23^d, connecting said arm-plates. The chuck 27 is fitted with two cross-plates 27^b, slotted to receive a bolt 27^c and supported upon lug 27^d of the chuck 27, suitable clamp-nuts being fitted upon the bolt 27^c to hold the cross-plates in any position at which they are set, studs 27 upon the ends of plates 27^b also being provided to engage with the rivet-holes 29^a of segment-blocks 29, which are thus supported and secured upon the ends of the crane-arm. The chuck 27 is held and adjusted to any required position distant from the center of the crane-shaft by means of a rod 30, which connects the chuck with a scroll-disk 31, a pin 30^a of the said rod engaging with the groove 31^a of the disk, suitable guide-blocks 23^e on the crane-arms serving to hold the rod in working position. The chuck 27 is designed to support a small key-segment upon the arm extensions at one end of the double crane-arm, and a chuck $27^\times$ is provided to support the large main segments upon similar extensions, and rod $30^\times$ serving to connect the chuck $27^\times$ with the scroll-disk 31 at a point opposite the inner end of the rod 30, the rod 30 $30^\times$ and chuck 27 $27^\times$ being thus drawn together by the rotation of the scroll-disk. When the chucks are thus placed either in or

out to the required position, they may be secured fixedly to the crane-arms by means of a pin 28^a on a collar 28 of the crane-hub, which engages with a hole 31^b in the hub of the scroll-disk, thus causing the said scroll-disk and crane to revolve together. It will be understood that one of the segments is placed upon the end of the crane-arm when the chucks are drawn together. The crane-arm then revolves by the driving mechanism until this segment is properly opposite its position and the chucks then forced outwardly by the scroll-disk until the segment is held in its position to be riveted in place. The cross-plates are then drawn together by suitable means or by pushing them from opposite sides, thus releasing the segments. The segments are made, preferably, of cast iron, as shown in Fig. 10, a rim-flange having rivet-holes therein providing suitable means for securing them together.

The operation of the several parts herein claimed will be readily understood from the foregoing description, a detailed description of the placing of the shield in working position connecting it with the tunnel heading and bulkheads, means for connecting the various air, water, and conduit pipes with a supply and delivery apparatus, and the details of the mode of operating and conducting the work within the shield being well known by practical tunnel engineers and superintendents.

The shield may employ some of the features herein claimed without embodying all of them, and features now shown may be added when required for carrying out well-known objects without departing from my invention.

I claim as my invention and desire to secure by Letters Patent—

1. A tunneling-shield comprising a cutting-face at the forward end, and a hood at the rear end thereof, two concentric cylindrical shells extending from and connecting said outer face and hood, connected together at both ends thereof, and a plurality of hydraulic rams placed at the rear end of said cylindrical shells, substantially as described.

2. A tunneling-shield comprising a cutting-face, at the forward end, a hood at the rear end thereof, two concentric cylindrical shells connecting the same, and a series of radial plates interposed between and connecting said cylindrical shells longitudinally, substantially as described.

3. A tunneling-shield comprising a double-walled cylindrical shell, a bulkhead at the forward end thereof and a series of trough-shaped partitions, extending longitudinally thereof, and connected to both the inner and outer cylindrical shells, substantially as described.

4. A tunneling-shield comprising a double-walled cylindrical shell, a bulkhead at the forward end thereof a series of trough-shaped plates extending longitudinally thereof, connecting said shells, and hydraulic rams inclosed within said troughs, substantially as described.

5. A tunneling-shield comprising a double-walled cylindrical shell, a cutting-face and bulkhead at the forward end thereof, a bulkhead at the rear end thereof and a number of stays extending diametrically between and secured to the said cylinder, providing cellular compartments between the shells substantially as described.

6. A tunneling-shield comprising a cylindrical shell a cutting-face at the forward end thereof, a working hood at the rear end thereof, a bulkhead fitted with air-tight covered openings at the forward end of the shield and a similar bulkhead at the rear end thereof, also provided with air-tight covered openings to provide a closed chamber between the said air-tight bulkheads for the workmen within the shields substantially as described.

7. A tunneling-shield comprising a cylindrical shell a bulkhead provided with doors therein and having a concaved face to strengthen the bulkhead and direct the loose material toward the door-opening substantially as described.

8. A tunneling-shield comprising a cutting-face at the forward end, a cylindrical shell, a hood at the rear end thereof, having longitudinal strips projecting rearwardly from the cylinder and separated from each other to admit of independent movement or deflection, substantially as described.

9. A tunneling-shield comprising a cutting-face at the forward end, a cylindrical shell, and hood at the rear end thereof and a crane-arm, having each of its ends provided with an extension-piece, fitted with heads for carrying respectively the large and small segments of the tunnel-lining, substantially as described.

10. A crane for tunneling-shields comprising an arm having a central hub, a shaft upon which said hub is supported, a scroll-disk, adapted to rotate upon said shaft, a segment-holding head movably secured to the end of said arm, and a link connecting the said head to the scroll-disk, substantially as described.

11. In a crane for tunneling-shields, the combination with the supporting-shaft of the hub, the crane-arm, the segment-holding block movably secured to the end thereof, the scroll-disk mounted upon the shaft, and a bolt connecting the said hub, and scroll-disk, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CORNELIUS G. HASTINGS.

Witnesses:

GEO. L. GOETZ,

ARTHUR H. DINANDI.