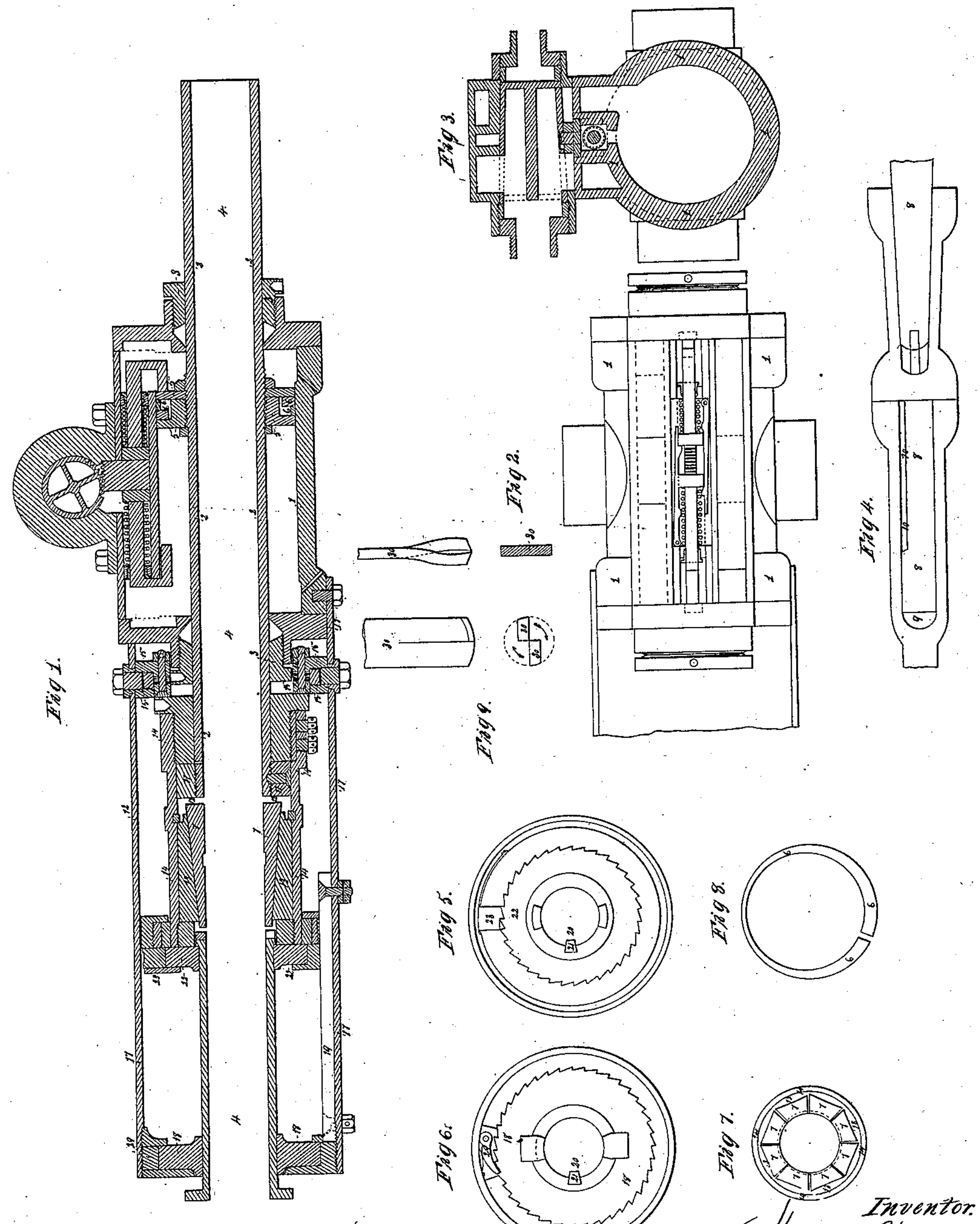
3 Sheets—Sheet 1.

H. Haupt,

Steam Rock-Drill.

No. 46,668. Patented Mar. 7, 1865.



Witnesses.
L. Towne
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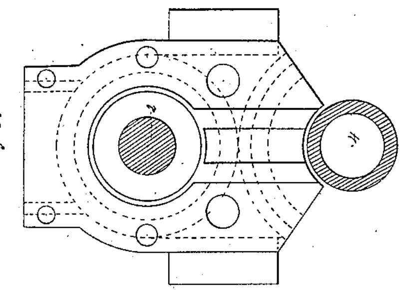

Fig 5.

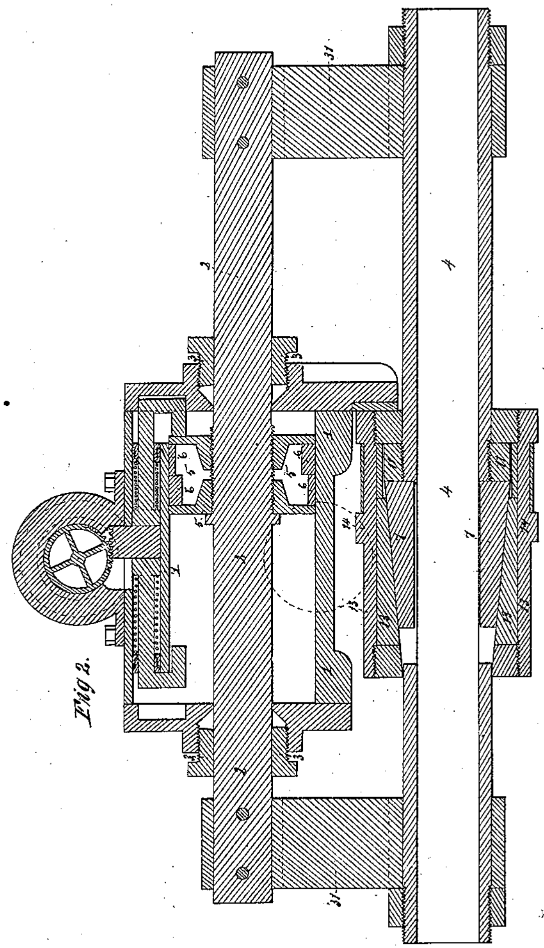

Fig 2.

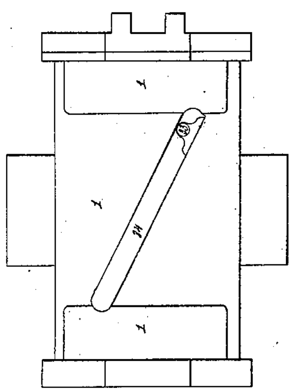

Fig 4.

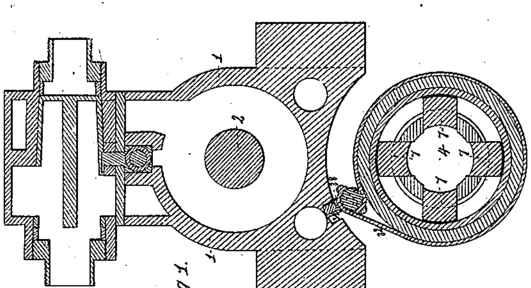

Fig 1.

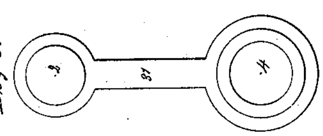

Fig 3.

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3 Sheets–Sheet 3.

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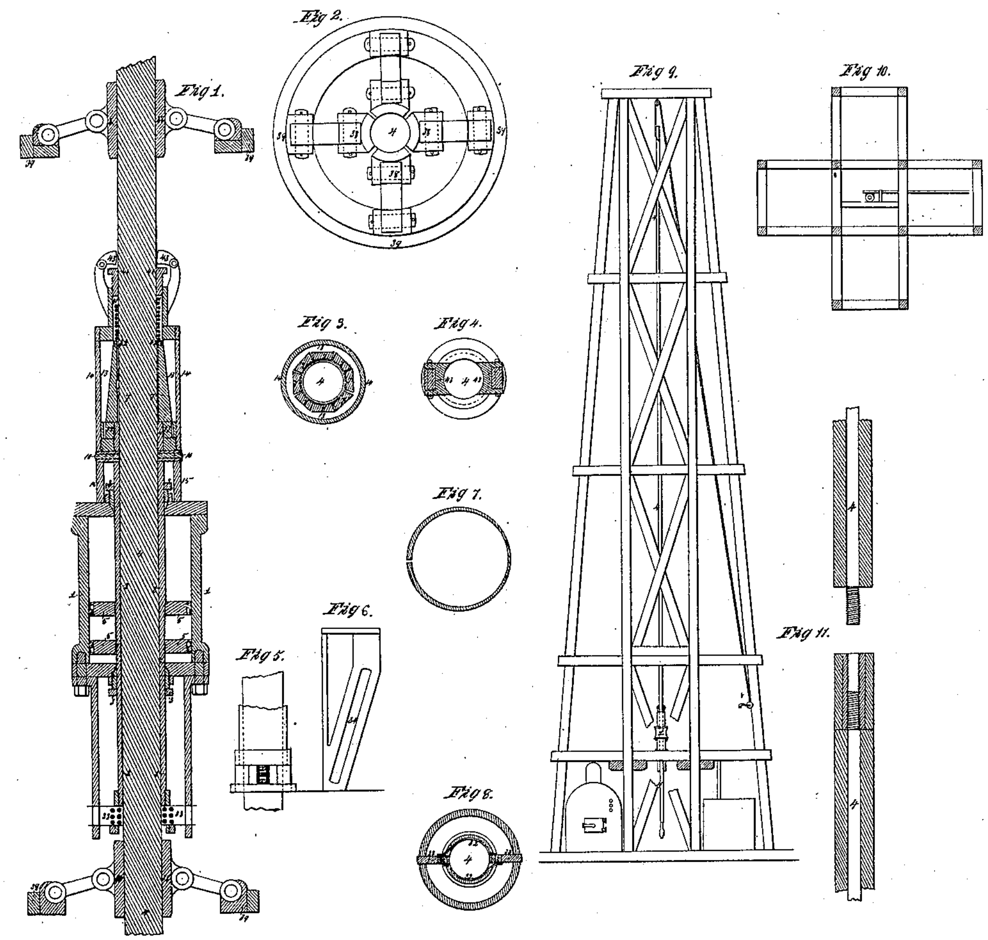

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UNITED STATES PATENT OFFICE.

HERMAN HAUPT, OF CAMBRIDGE, MASSACHUSETTS.

IMPROVEMENT IN PNEUMATIC DRILLS.

Specification forming part of Letters Patent No. **46,668**, dated March 7, 1865.

To all whom it may concern:

Be it known that I, HERMAN HAUPT, of Cambridge, Massachusetts, have invented certain new and useful Improvements in Pneumatic Drilling Machinery; and I hereby declare that the following, taken in connection with the accompanying drawings, is such a full, clear, and exact description of the same as will enable others to make and use the same.

In the said drawings, Plate 1 represents views of my improved drill. Figure 1 is a sectional elevation of the same; Fig. 2, a top view of the same with the valve-box removed, and Fig. 3 a cross-section of the same through the axis of the valve-box.

The drill subject of this patent consists of a cylinder, 1, in which steam or air is admitted to work a piston. The piston-rod 2 is hollow, passing through stuffing-boxes 3 3 at both ends of the cylinder. The drill-rod 4 is passed through the piston-rod from either end and is advanced by a peculiar mechanism to be hereinafter described. As the drill penetrates the rock the drill-cylinder is stationary; the drill-rod alone moves forward. The mode of mounting is peculiar and admits of motion in any direction while occupying the smallest possible amount of space.

With this general idea of the form of the drill, a detailed description will be given of the parts as arranged in the latest and most improved form. The first drills were constructed with the ordinary slide-valve as used on high-pressure engines; but the operation of this valve was unsatisfactory for various reasons. It was worked by means of an arm projecting from the piston-rod, which, coming in contact with rings or stops on the valve-rod, moved it from one side to the other to open or close the ports. The force of the blow upon the rings was relieved by springs. The result was not very satisfactory, as the springs and rings were frequently broken by the force of the blow, and in commencing the movement it was necessary to drive the valve either to one end or the other of the steam chest by pounding on the valve-rod in order to start the machine. It was also desirable that the valve-rod when struck should oppose as little resistance as possible to the motion of the piston, and that the valve should shift rapidly. All difficulties were obviated and all desired conditions fulfilled by the invention of an equilibrated spring-valve, applicable not only to drilling engines, but also to all other engines, and to steam, water, and gas meters. A description of the valve is contained in the specification accompanying an application for Letters Patent now pending, and will not be herein repeated. The cylinder in the drills which have been constructed have been made of cast-iron, the interior diameter four inches, the length eight inches, the stroke four one-half inches, leaving a space of nearly an inch at each end to form a steam-cushion. On the top of the cylinder are ports for steam-passages, and on the exterior are trunnions to admit of rotation in a vertical plane. It is not essential that the cylinder should be made of cast-iron, and a machine has been designed for drilling a row of holes at one and the same time by using wrought-iron pipes in pieces 6 or 8 inches long instead of the cast-iron cylinders, and dispensing with steam chest or valves, the motion of the piston in these small cylinders being effected by pipes communicating with a larger cylinder of sufficient capacity to supply them, which larger cylinder is furnished with a balance or other valve to admit the steam alternately to each side of the piston; or the valve may be worked by independent mechanism. This is a novel and may be a very useful contrivance. A single cylinder, with its valve and rods or even a single valve without a cylinder worked by hand or by any other power, may communicate motion to the pistons of any number of small cylinders which have no valves simply by pipes leading from a steam-chest or from the ends of the larger cylinder to the corresponding ends of the small cylinders through which the steam and exhaust may pass; in fact, the small cylinders may be considered as parts of a larger cylinder operated by one valve. To prevent too rapid motion of the piston in the larger cylinder, springs may be inserted, the compression of which will retard the motion of the larger piston until a sufficient pressure of steam has been accumulated to operate the small pistons. Such a machine, which is merely an extension of the principle involved in this drill, would be applicable to drilling a row of small holes at the same time for the purpose of splitting rocks or for separating masses in tunneling or for pounding or crushing minerals. The piston does not present any peculiarity. It is constructed of two or more metallic packing-rings, 6, (see Fig. 8,) sprung into position, which, expanding by their elasticity, compensate for wear and keep the parts in contact. The piston-rod is hollow, the cylinder is stationary, and the drill-rod becomes the only part of the drill which advances, feeding forward in proportion as the rock is penetrated. By this arrangement the end of the cylinder may be placed within six inches of the face of the rock, while in the Mount Cenis drills the distance must be several feet. This is a very important consideration in tunneling, as it permits the operation of drilling to be resumed immediately after a blast without waiting for the removal of the material previously blown down. The stuffing-boxes through which the piston-rod passes present no peculiarity, and are constructed in the usual manner. The drill-rod consists of two portions—an iron cylindrical rod at least equal in diameter to that of the hole to be drilled and a steel drill attached thereto by welding or otherwise. The portion of the drill-rod which passes into the piston is made equal to or greater than the diameter of the hole to be drilled, chiefly to secure two important objects: First, a large surface to prevent the grippers 7, (see Fig. 7,) which are smooth pieces of steel, from slipping along the rod, and, second, to permit the drill-rod to be readily inserted or removed from the back end without stopping other drills working in the same gang in case a drill should break or it should become necessary from any other cause to remove it. There are two forms of drills, which differ from each other only in the drill-rod, and not in any other parts of the engine. In the first the drill is securely attached to the drill-rod and moves forward and back with it on the principle of the churn-drill. In the second form a blow is struck on the end of the drill by an enlargement of the end of the drill-rod forming a hammer or sledge, the rotation being effected by a projection on drill 8, Fig. 4, fitting into a cavity, 9, in the drill-rod, and prevented from turning therein by a feather, 10. In the first drills constructed the feed was given by means of a large screw, through which the drill-rod passed, and which in its rotation moved forward slowly by passing through a a nut, which maintained a fixed position in regard to the cylinder; but a screw-feed was found objectionable for the reason that it was constant, while the rate of penetration of the drill was variable. This variation was due to the varying hardness of the rock and to the condition as to sharpness of the edge of the drill. If the feed were too rapid, the piston would shorten stroke at each revolution and finally stop, when it would become necessary to take out the screw, adjust it, and start the machine anew, causing much trouble and delay. To obviate these difficulties the momentum feed was designed, of which a description will be given. The piston 5 being supposed at the forward end of the stroke and the steam admitted to commence the backward movement, the collar 11 on the rear end of the piston rod is moved over the space 12, and comes in contact with the ends of the steel grippers 7. These grippers consist of eight (more or less) pieces of steel moving on inclined surfaces in the inside of an octagonal box, 13, the outside of which is cylindrical. These inclined surfaces form the faces of the frustum of an octagonal pyramid, along which the eight gripper-pieces are driven by the pressure of the piston acting on the collar 11. They are consequently brought in contact with the drill-rod 4 with great force, and hold it firmly, drawing it backward until the end of the stroke is reached. When the motion is reversed and the piston is on the forward stroke, the grippers are not relaxed, for the outer cylinder of the gripper-box 14, being attached to the piston-rod, is suddenly thrown forward before the inertia of the drill-rod is overcome and the gripper-box 13 is pressed against the grippers 7, holding them firmly in contact with the rod. At the instant when the piston reaches the end of the stroke the gripper-box is suddenly checked in its forward movement by coming in contact with a ring of metal, 15; but as the drill-rod has acquired a great momentum it continues its motion, relaxes the hold of the gripper-pieces 7, and strikes a forcible blow upon the rock. On the backward motion the drill is rotated and on the forward stroke the blow is repeated. The number of blows per minute may be from two hundred to one thousand, according to the force of the steam.

To diminish the force with which the gripper-box 14 comes in contact with the metallic ring 15, the latter is divided and a ring of vulcanized rubber packing, 16, interposed between. The metallic ring is also made adjustable, so that the collar of the gripper-box comes in contact with it at the proper moment. This adjustment is effected by means of spiral slots in the cylinder 17, so arranged that when the ring 15 is turned its distance from the end of the cast-iron cylinder 1 is varied.

The gripper-box, the ratchet-wheels, and other working parts are surrounded by a light wrought-iron cylinder, 17, which performs several very important offices. It gives a firm support to the metallic ring 15, it holds the back ratchet 18, it contains the spiral rod 19, by which the rotation is effected, and it effectually covers all the parts, excluding dust, dirt, and stones.

A design was made for a drill on which were two gripper-boxes, one in front and one in rear, so arranged that by varying the spaces between the ends of the gripper pieces and the collars in the piston-rod an adjustable feed was obtained which could be regulated to the thousandth part of an inch; but such nicety is of no practical value, and the arrangement for feed which has been described is preferable.

To cause the drill to rotate, a long slot is made in the drill-rod 20. In this slot slides a steel-piece, 21, which is attached to and forms part of the ratchet-wheel 22. (See Fig. 5.)

To move the ratchet-wheel, a rod, 19, is screwed spirally around the inner surface of the external cylinder, and over this slides a notch or fork, which moves the ratchet by means of the steel piece 23. This piece is pressed against the ratchet by means of a spring, moves it in one direction, but slips over the teeth without turning them when the motion is reversed. The rotation is given on the back stroke.

To prevent the drill-rod from turning in the wrong direction, to enable it to retain firmly in the forward movement all the rotation given to it in the back stroke, and to crush any pebbles or pieces of stone that it may encounter without being turned from its course, a second ratchet, 18, is provided, which permits motion only in one direction, and by means of a strong dog, 29, attached to the exterior cylinder, prevents any motion except in the direction in which the drill is designed to rotate. (See Fig. 6.)

The whole length of the drilling engine, with all its parts complete and in position, scarcely exceeds two and a half feet. The width from out to out of trunnions is eight and a half inches, and the height nine inches. A rectangular box thirty inches long and nine inches square in section would contain the whole engine, which develops from three to four horse-power, and weighs about one hundred and fifty pounds.

In driving the heading of a tunnel it is intended to mount four of these drills on a frame, of which a description will now be given.

The supports of the frame consist of four pieces of wrought-iron pipe two and a half inches in diameter and about five feet long, when the gallery is intended to be six feet high. In the ends of these four vertical pipes are inserted eight steel screws with pointed ends. The screws are turned by means of a bar passed through holes in the head. The sharp points are forced into the rock at top and bottom, and the screws are prevented from loosening by rods passed through the holes of each pair, locking them together. By this means the frame is securely attached to the rock at the top and bottom of the gallery. The four vertical pipes which support a gang of drills are connected at top and bottom by eight pieces of horizontal pipe forming an iron frame. These pipes serve the double purpose of forming a frame and furnishing steam-passages, so that the utmost degree of compactness is secured. The steam passes up one pair of vertical pipes and the exhaust escapes downward through the other pair. On one of these frames are placed four drills. Each drill is attached to the vertical pipes by means of two pieces of boiler-plate about four inches wide, which are bent to conform to a cylinder of which the intersections of the diagonal planes through the vertical pipes would form the axis. Each of these pieces of boiler plate is slotted horizontally to admit of a horizontal movement of the drill to the extent of about thirty degrees on each side of a vertical plane, while the trunnions on the drill-cylinder permit motion vertically around the entire circumference. The drills can also be placed at any desired elevation by sliding the slotted pieces of boiler-plate up or down the vertical pipes, and clamping them by means of the clamps in any desired position.

It will be perceived from this description that the drills have the following movements, first, in a vertical plane around the entire circumference; second, in a horizontal plane a movement of sixty degrees; third, they can be fixed at any elevation.

The whole width of the frame with the four drills attached is but fifteen inches, and three feet in the length of the tunnel, measured from the face of the rock, will be sufficient to give them room to work exclusive of the projection of the drill-rod at the commencement of the movement. The first drills constructed were mounted on two columns, but four are preferred. With equal weight they give greater stiffness and reduce the width of the frame three inches, besides increasing threefold the extent of the horizontal range. A small stream of water must be forced into each hole while the operation of drilling progresses. This is accomplished by conveying the water in pipes from a head of fifty or sixty feet outside the tunnel, and allowing the pressure of this head to force a stream through an orifice one-tenth of an inch in diameter directly into the hole. Small tubes of tin or copper clamped to the pipes which form the frame, and connected with the water-pipe by means of small pieces of rubber hose, will fulfill every condition desired. The form of point which is preferred is one which presents vertical chisel-shaped edges on each side of the center, as in 30, Fig. 9. Other forms of points may be used—for instance, diamond points, which it is believed are more durable and attack the hardest kind of rock. The diamond used for this purpose is the common black diamond, the points of which are inserted in the edges of a soft wrought-iron tube or pipe which forms the drill. The drill operates in this instance by rotation, cuts out an annular cavity, leaving a core of stone in the middle which is easily broken off. To carry this into effect, I use, instead of the solid drill-rod passed through the hollow piston, a wrought-iron pipe enlarged at the end, which may be fitted with any kind of cutting-tool, the diamond point, steel saw-teeth of file hardness, emery, vulcanite, or any other cutting device. Rotary motion is imparted by means of a pair of spiral slots or grooves in the tube opposite to each other, and a pair of projecting studs in the lower end of the piston-rod fitted into these slots or grooves. Reciprocatory motion of the piston will cause the rotation back and forth upon the axis of the drill-rod. The steam is conveyed from the boilers to the drills, a distance of about two hundred feet. Of this distance one hundred and seventy-five feet may be an iron pipe laid on the floor of the gallery and close into the corner, so as to be out of the way. The remaining twenty-five feet should be of very strong but flexible hose, and across the end of the gallery, and close to the face of the rock, is laid another piece of metallic pipe, with which connections are made to each gang of drills by screwing on short pieces of hose. The steam-pipe connects with the boiler by another piece of flexible hose, so as to prevent strain upon the joints when the boilers are moved forward. The exhaust-pipes, which carry off the exhaust-steam, are of larger diameter than the steam-pipes, but similarly constructed. They convey the exhaust into a vacuum-pipe, in which a current is produced by one or more exhaust-fans placed near the end of the tunnel. When a blast is to be made, the flexible hose and the short piece of metallic pipe connected therewith are laid back along side of the pipes of which they form the continuation, and are covered with logs. To prevent injury from the blasts, a single log rolled on top of the pipes is sufficient. There are several other equivalent arrangements, but that which has been described is considered to be most simple and practical. In connecting each gang of drills with the steam and exhaust pipes it is only necessary to screw one hose-nut for each of the two pipes. In a gallery fifteen feet wide and six feet high it is proposed to use five gangs of four drills each, making twenty drills, each drill making one hole of twenty-four inches in about twenty minutes, forming the number required for one blast; or the same number of holes may be made by a smaller number of drills by repeating the operation. The steam is supplied by one or more boilers of the tubular form similar to those used in locomotives. The boilers are placed on wheels or rollers, and are moved forward daily as the work advances. Giffard's injector is best to supply the boilers, but a small steam-pump may be used. The water is taken from a tank mounted on wheels, which follows the boiler as a tender follows a locomotive. The tank is supplied from a head outside the tunnel. The draft for the boilers is supplied by means of a vacuum-pipe. This pipe is made of wood or sheet-iron twelve to eighteen inches in diameter. It extends from the outside of the tunnel, where it is connected with one or more vacuum fans of large diameter. The air through the grates and tubes of the boilers is drawn into this pipe and the smoke, gases, products of combustion, exhaust-steam, powder-smoke, vitiated air, and all impurities are drawn through this pipe and ejected from the tunnel without being permitted to contaminate the atmosphere. It is only by the use of such a vacuum-pipe that the application of steam to tunneling is possible; but with it all difficulties in the application of steam to such purposes are overcome and great advantages are secured in economy, efficiency, and rapidity of progress. The whole apparatus will not cost one-tenth part as much as the apparatus for compressed air used at the tunnel of the Alps, and the progress will be much more rapid. The power required to compress air into reservoirs as is now employed at the tunnel of the Alps is many times greater than the useful effect obtained from the air when compressed. The draft of air through the boilers into the vacuum-pipe is regulated by dampers. The vacuum-pipe affords the most perfect system of ventilation possible. Assuming the gallery to be fifteen feet wide and six feet high, which was the size of the advanced gallery or the Hoosac Tunnel; that twenty drills representing three horse-power each are at work in the heading and twenty more in the enlargement to the full size, making one hundred and twenty horse-power, requiring two thousand one hundred and twenty-three cubic feet of air per minute; also, that eighty men and forty lamps must be supplied with air, the total amount will be four thousand three hundred and thirty six cubic feet per minute, while one vacuum fan of four feet diameter, driven with a power of twelve horses, will exhaust nine thousand one hundred and twenty-eight cubic feet per minute through a pipe twelve inches in diameter, which is replaced by fresh air from the outside. The supply of air therefore would be double the greatest possible consumption, and would produce a current in the gallery of one hundred linear feet per minute. The use of the vacuum-pipe for the double purpose of creating a draft in steam boilers in mines and tunnels and for ventilation is one of the most important points in my improved system of mining and tunneling. After the holes have been drilled to the proper depth they are loaded with cartridges previously prepared on the plan discovered and patented by George W. Beardslee. The tamping is effected by the use of a sand cartridge followed by a plug of wood or clay, or by wood alone, strongly compressed and driven into the hole after dipping in water to cause it to swell. The wires which proceed from each cartridge are connected with other wires, which are attached to a Beardslee magneto-electric apparatus, by means of which the instantaneous ignition of all the charges is effected or the successive ignition of rows of charges may be effected if preferred. In a recent experiment forty-seven blasts were ignited at the same time with an apparatus only one-third as powerful as is proposed to be used in tunneling. After a blast the powder smoke is immediately drawn into the vacuum-pipe and the operation may be resumed without delay. The hollow piston-rod is not essential to the construction of a compact drilling engine; in fact, the length of the apparatus may be shortened nine inches and without any increase in depth, by using the ordinary solid piston-rod and suspending the drill therefrom by two short arms in which the drill-rod rotates. This arrangement, which involves precisely the same valve movements and the same devices for feed and rotation as in the plans previously described, is represented in Plate 2, in which Figs. 1 and 2 are transverse and longitudinal sections of an apparatus constructed in accordance with this modification, and Figs. 3, 4, and 5 detail views of the same. The piston-rod 2 is of iron, to which the piston is attached in the ordinary manner. The gripper-box 13 is suspended from the ends of the piston-rod by means of two suspenders, 31, which embrace the tubes which form the extension of the gripper-box and permit rotation at the points of support. The rotation is effected by means of a strap, 32, around the gripper-box connected with an arm, 33, which moves in an inclined slot, 34, on the under side of the cylinder. Stiffness will be increased by making the tube which is supported by and turns in the suspenders 31 continuous between the supports; but this is not necessary, as the short pieces of tube on each side may be simply inserted into the ends of the gripper-box without passing through. In this case the gripper-box is precisely similar to that which has been described, and the grippers would consist of eight pieces; but if the tube is continuous the number of gripper-pieces should be reduced to four, and four slots or openings, 35, must be made in the tube through which the grippers act. The stop to check the motion of the gripper-box and detach the drill is made by extending the cylinder-head 36 and placing a piece of gum, 37, on the surface which receives the blow. The cylinder-head may be of wrought-iron. This form of drill will work equally well in an inverted position, so that it is better adapted than the form with the hollow piston to drilling horizontal holes very close to the floor or roof of a tunnel. A hole can be drilled in a perfectly horizontal direction within an inch and a half of the floor or roof. It would be difficult to drill so closely by hand, and impossible with any other form of machine.

The drilling-engine described is applicable also to boring wells, subject of course to some variations in the details.

In Plate 3 I have shown in the several figures the manner in which the principles of my drill may be applied to well-boring. The balance spring-valve and the momentum feed with the steel or iron grippers sliding along inclined planes are common to both. The rotation is different, and is effected by means of a strap of steel surrounding the boring rod, which tightens when moved in one direction and loosens when moved in the opposite direction. The strap is riveted to the steel pieces 33, which move in inclined slots in the guides 34, which guides are bolted to the head of the cylinder. While drilling, the movements are in every respect similar to those of the rock-drill, except that the cylinder must be of larger diameter, so that the pressure of steam upon the piston will always be sufficient to raise the rod, and the stroke should be larger. When the rod is to be removed, a peculiar mechanism is required to effect the removal rapidly. On the upward stroke of the piston the rod is raised, and when the stroke is completed it is necessary that the boring-rod shall be held firmly to keep it from falling back, and also that the grippers should be detached from the rod. The rod is held by clutches 38, which are attached to a strong ring of iron, 39, and grasp the rod on four sides. One of these rings should be placed near the surface of the ground and another above the engine, so as to afford greater security against slipping. To detach the grippers 7 at the end of the upper stroke, the follower 40 is screwed down, so as to compress the spiral spring 41, which acts on a ring, 42, resting on the ends of the grippers. Two small clutches, 43, are also thrown into position against the rod, so as to prevent the grippers from sliding along the rod without moving it. By these arrangements fifty feet or more of rod may be run out per minute. When rods are used, a wooden tower may be erected over the well, and from the top a block and pulley suspended, by the aid of which forty or fifty feet of rod may be added or removed at once. In lowering the rods breaks should be employed in addition to the pulley, and the rods descend by their own weight.

Instead of rods, the boring tools may be supported by a wire rope passing around a drum, the reciprocating motion and the rotation being communicated by mechanisn similar to that which has been described. The wire rope for a length of ten or fifteen feet should be clasped by two semi-cylinders of wood, clamped at top and bottom, so as to present a cylindrical surface of the proper diameter to the action of the grippers. As the boring progresses, these pieces must be occasionally moved upward.

When the wire rope is to be withdrawn, the steam-cylinder by a very simple mechanism can be made to revolve the drum upon which it winds.

Having thus fully described my invention and the manner in which the same is or may be performed, I claim—

The method of and apparatus for drilling rock for mining, tunneling, and boring purposes, substantially as hereinbefore described.

In testimony whereof I have signed my name to this specification before two subscribing witnesses.

H. HAUPT.

Witnesses:
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MICHAEL R. MULLEN.