No. 879,828. PATENTED FEB. 18, 1908.

O. S. PROCTOR.

ELECTROPNEUMATIC DRILL.

APPLICATION FILED AUG. 26, 1905.

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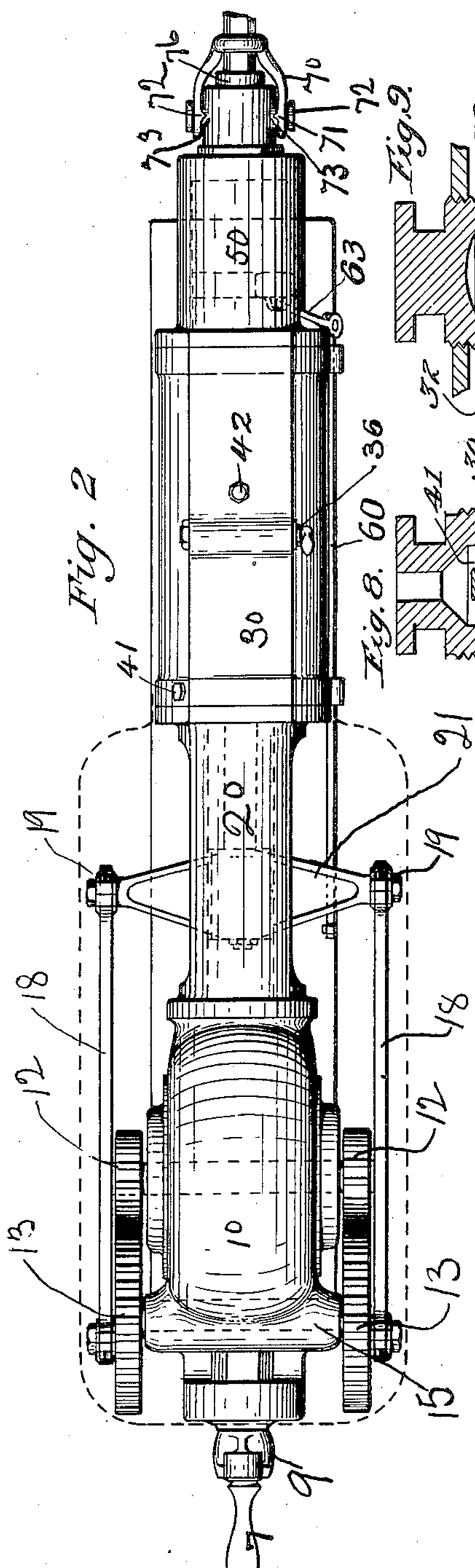

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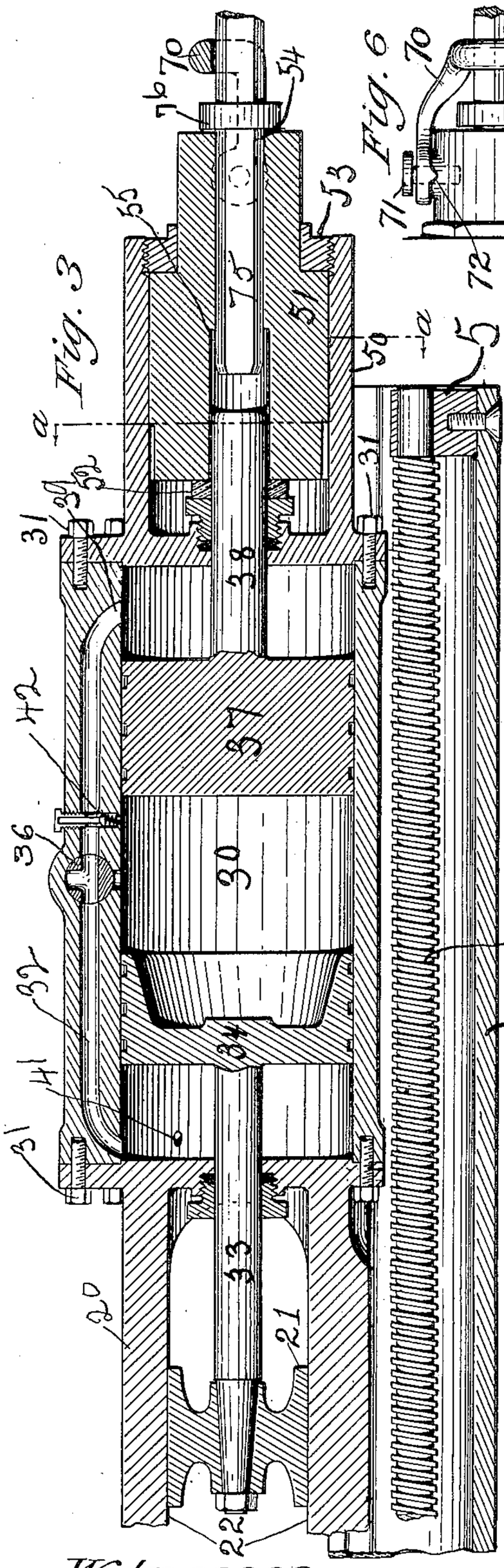

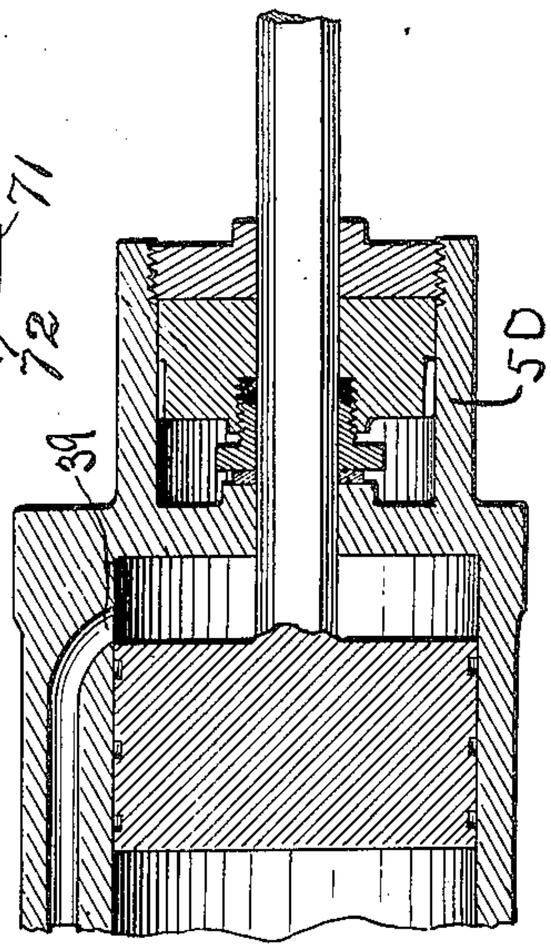

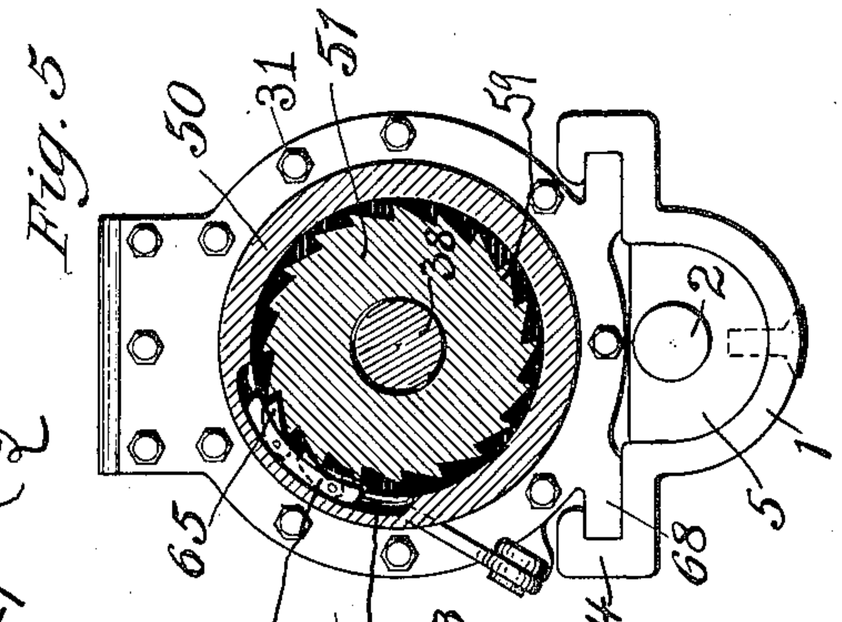

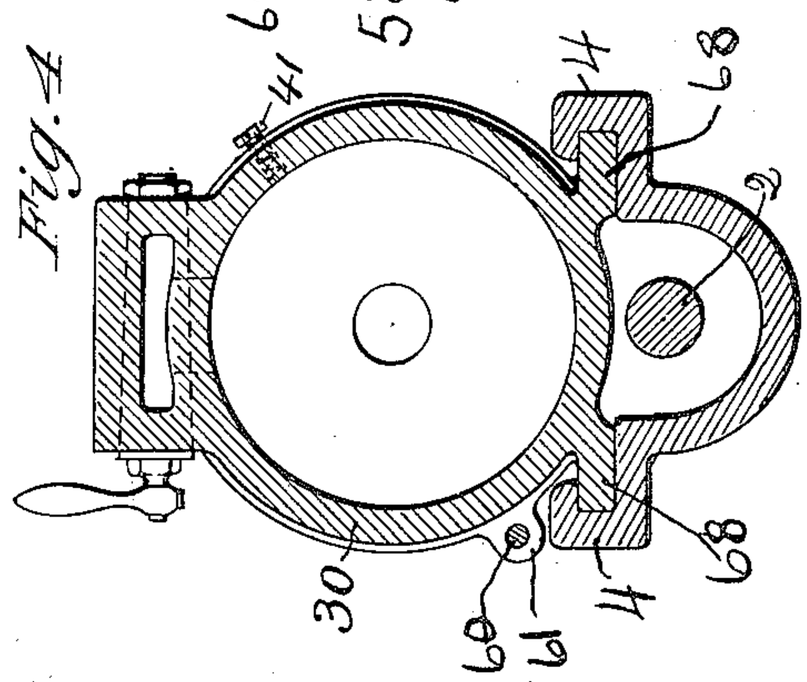

Witnesses.
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UNITED STATES PATENT OFFICE.

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ELECTROPNEUMATIC DRILL.

No. 879,828. Specification of Letters Patent. Patented Feb. 18, 1908.

Application filed August 26, 1905. Serial No. 275,921.

To all whom it may concern:

Be it known that I, OLIN S. PROCTOR, citizen of the United States, residing at Denver, city and county of Denver, and State of Colorado, have invented certain new and useful Improvements in Electropneumatic Drills, of which the following is a specification.

My invention relates to power drills of the percussion type, and more particularly to that class of portable drills used for drilling rock in the operations of mining, quarrying, tunneling and the like. Heretofore drilling machines of this class have been driven by steam or compressed air, conducted to the machine through piping, from some distant source of supply, and more recently by electric power through a motor, placed on the drill or in mechanical connection with it. This latter method does not possess the elastic properties of the air or steam drill, and it is the object of my invention to produce a machine of this character, which may be driven by an electric or other motor, and at the same time utilize the elastic properties of the air, in the communication of the action of said driving motor to the drill, and which will be, incidentally, more economical in the use of power, more simple of construction, easier to operate, and more extended in its application than machines of this class at present in use. I attain this object, principally, by the use of a plunger in the same chamber with the reciprocating hammer or drill piston, and the interposition of a cushion of air, confined in the chamber, between said plunger and piston in such a way, that the reciprocation of the plunger produces alternate compression and rarefaction of this air, thereby causing the piston to reciprocate correspondingly in unison with said plunger, the air serving as an highly elastic medium of connection between the two; and further in the combination and application of this principle, as illustrated in the drawings and hereinafter more clearly set forth.

My invention may be embodied in various forms for practical use, the construction which I prefer and have most highly developed being shown in the drawings accompanying this specification, wherein—

Figure 1 is a side elevation of the complete drilling apparatus with the exception of the stand, electrical conductors, switches and connections, which are not necessary to an understanding of the invention; Fig. 2 is a top plan view of the same; Fig. 3 is a longitudinal section of the drill mechanism proper; Fig. 4 is a transverse section through the air cylinder of the same; Fig. 5 is a section taken on line *a*, *a* of Fig. 3; Fig. 6 is a top view of the chuck end of the machine, to show more clearly the hinged yoke; and Fig. 7 is a longitudinal section of a modified form of the front end of the machine. Fig. 8, is a detail view of valve 41; Fig. 9 is a detail view of valve 42. These valves in the relation shown and described afford means for compressing air in the central chamber.

Similar numerals refer to similar parts throughout the several views.

My complete drilling machine, as shown in Figs. 1 and 2, comprises in its essential parts, a guide frame 1, with a feed screw 2, mounted thereon, which constitute the supporting and feeding frame or bed of the machine; and an electric motor 10, a crosshead frame 20, having a crosshead sliding therein, an air cylinder 30, containing a plunger and a piston, and a chuck or support 50, for the drill, all of which are rigidly fastened together, axially in line with each other, and which, together with their connections and attachments, constitute the actuating mechanism of the machine, adapted to travel longitudinally on the guide frame 1, and be fed forward and backward thereon by the feed screw 2. The guide frame 1, is formed with a boss 3, on its under side, adapted to be fastened, rotatably, to an adjustable stand, such as are generally used for this purpose, and has a slotted guide 4, on each side, to receive corresponding flanges 63, on the casing of the actuating mechanism, and has bearings 5 and 6, to support a feed screw 2, at its ends, the bearing 6, serving also to take the longitudinal thrust of the feed screw. The feed screw 2, is turned by means of the crank 7, and is fixed against longitudinal motion by a collar 8, and the hub 9, of the crank 7, adapted to bear against opposite sides of the bearing lug 6, on the guide frame. This portion of the apparatus, constituting the supporting and feeding frame, is not, in itself, new and is not an essential feature of my invention, except as used in connection with the actuating mechanism hereinafter described.

The motor 10, may be of any suitable type, and has its armature shaft 11, extending beyond its bearings sufficiently on each side to receive pinions 12, engaging gear wheels 13,

carried on a shaft 14, supported in a journal bearing 15, on the motor frame. The gear wheels 13, are connected by crank pins 17, and connecting rods 18, to the journals 19, of the crosshead 21, adapted to reciprocate in the guides 22, of the crosshead guide frame 20. The crosshead 21, is rigidly connected to the stem 33, of the plunger 34, which, together with the remaining portion of the mechanism, is more clearly shown in Figs. 3 to 6. The end of the crosshead guide frame 20, forms one head of the air cylinder 30, and may be secured to it by bolts or set screws 31, as shown, or by means of annular screw threads, the other head being formed by the casing 50, of the chuck or drill support, which may likewise be bolted or fastened with set screws 31, or by means of annular screw threads, or preferably made in one piece with the walls of the air cylinder, as shown in Fig. 7. The passage or port 32, outside the cylindrical air chamber 30, communicates from one end of said chamber to the other and a three-way valve 36, placed in this passage as shown, controls it in such a way, that according to the position in which it is set, communication is established, either between both ends of the cylinder or between either end and the center or is shut off altogether. A plunger 34, fitting tightly against the wall of the air cylinder, is rigidly connected by its stem 33, to the crosshead 21, before mentioned, occupying in its travels, less than one half of the air chamber. A piston 37, serving as a striking hammer and free to move independently, occupies the other end of the chamber, and has a stem 38, extending through an axial aperture in the cylinder head, to strike the end of the drill 75. Suitable packing boxes are fitted to the apertures in the cylinder heads, to prevent leakage around the moving stems of the plunger and piston, the stem of the latter being of such length, that it will not be withdrawn through the packing-box in the extreme position of the piston. In the cylindrical casing 50, on the front end of the machine, rests a cylindrical chuck or support 51, for the drill, fixed against longitudinal motion, by bearing washers 52, and the head 53, of said casing, but free to be rotated by an arrangement hereinafter to be described. This chuck has a hexagonal or square shaped aperture 54, to admit the end of a drill 75, of similar cross section, which is free to move longitudinally therein, but rotates with the chuck, and an enlargement 55, of this aperture, allows the striking stem of the piston hammer to enter the chuck to the limit of its travel.

The operation of the mechanism above described and illustrated is practically as follows: When the plunger is drawn toward the end of the cylinder, by the action of the crosshead 21, the confined air between said plunger and the piston is rarefied, tending to draw the piston after it, and the air between the plunger and the head of the cylinder is, at the same time, compressed, which compression is immediately communicated, through the passage 32, to the far side of the piston 37, thereby increasing the difference of pressure on the two sides of said piston, so that when this difference is sufficiently great, the piston 37, will follow the plunger 34, and approach it until some time after the return stroke of the latter, depending on the momentum of the piston. On the return stroke of the plunger, the process is reversed, the air between the plunger and piston being compressed and that outside them being rarefied, until the stem of the piston strikes the drill, when the operation is repeated. It will be observed that the piston or striking hammer reaches its highest velocity at the moment it strikes the drill, delivering to the latter all the kinetic energy it has acquired.

The entrance 39, of the passage 32, into the air chamber 30, is located some little distance from the head at this end of the cylinder, in order to provide a dash pot for the piston to strike against, when the drill is out of striking range of the hammer.

If there were no leakage into or out of the air chamber and none between the plunger and the piston, the relative position of the two would remain unchanged. As such leakage, however, is unavoidable, I provide two spring pressure valves, one 41, to admit air into air chamber, the other 42, communicating between the end and middle of said chamber, to regulate the density of the air between the plunger and piston, with respect to that outside them, in the air chamber. These valves are adjustable from the outside and by means of the valve 41, the density of the air in the cylinder may be much increased, thereby decreasing the elasticity of the connecting medium between the plunger and piston.

It is manifest that the valve 41 is an adjustable inlet check. As the plunger 34 reaches the limit of its backward stroke followed by piston 37, the plunger 34 is stopped by the driving mechanism, or the cylinder head. The piston 37 continues in the backward direction until the compression of the air between the plunger and the piston, assisted by the rarefaction in the end chambers, overcomes the momentum of the piston 37. This rarefaction will be atmospheric pressure if the valve 41 works without friction. That is to say, the lowest pressure will be atmospheric so that the average pressure in the cylinder must be considerably above atmospheric, for the momentum of the piston 37 will be of considerable force in the smallest machines at the rate they run. The operation of the valve 41 may be influenced at the will of the operator, by the three way valve 36, which acts as a resistance to the air re-

turning from the front end chamber to the rear end chamber. The adjustable valve 42 in the bypass controls the relative amount of air in the end chambers and the central chamber, acting in the beginning of the return stroke, which controls the relative positions of the pistons.

The mechanism for rotating the chuck 51, is shown in Figs. 1, 2 and 3, and consists of a rod 60, adapted to slide and rotate in bearings 61, on the cylinder 30, and to be reciprocated by means of a lug 23, on the crosshead 21, bearing, alternately, against one or the other of the shoulders 62, on said rod, and connected by a rod 63, extending through an opening 57, in the chuck casing, to a shuttle 64, movable, concentrically, about the axis of the chuck, in a slot 58, on the inner surface of the cylindrical chuck casing, said shuttle being provided with one or more pawls 65, to engage ratchet teeth 59, on the chuck 51. The shoulders 62, are adjustable, to give greater or less motion to the shuttle. It will be observed that the rod 60 is reciprocated from the cross head and slides in bearings formed in the casing. The rod 63 is hinged to the rod 60 and being in a plane at or near 90 degrees to the rod 60, it is evident the reciprocation of the rod 60 will reciprocate the hinge of the rod 63 to the shuttle 64 a sufficient distance to cause the pawls to engage a new tooth on the ratchet at each stroke. I do not confine myself to the use of this rotating device, for various other devices may be used without departing from the spirit of my invention, as, for instance, a system of bevel gearing and shafting, communicating from the motor to the drill chuck. The chuck 51, has hinged to it, by screws 71, a yoke 70, adapted to fit over the drill 75, and having, at the end of each arm, a rib 72, engaging a corresponding groove 73, in the chuck, by virtue of the spring pressure in the yoke itself, whereby said yoke is kept in position over the drill, preventing the latter from falling or being driven out, and aiding in withdrawing it, by engaging the collar 76, thereof. This collar also prevents the drill from being inserted in the chuck beyond a certain point.

The machine so far described is of that class using an independently movable hammer to strike the drill. My invention is equally applicable to the class of machines, wherein the drill is rigidly connected to the piston and reciprocated with it, with such modifications as are illustrated in Fig. 7, the remainder of the machine being the same as hereinbefore described. The essential difference is that the stem 38 will be long enough to extend through the cylinder head when the piston 37 is in its extreme backward stroke and also provided with any desirable piston drill chuck.

The apparatus herein described and illustrated, constitutes but one form of construction and development of my invention, and it is evident, that in matters of detail and design it is capable of wide variation, without departing from the principles which characterize it.

What I claim as my invention, and desire to secure by Letters Patent is:—

1. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a bypass connecting the end chambers and means to control the flow of fluid through said bypass.

2. The combination with a cylinder, a pair of pistons movable therein, a motor for driving one of the pistons, of the inlet check valve 41 located in the wall of said cylinder near the rear end and means for affording communication between the space included by the wall of the cylinder, the rear cylinder head and the rear face of the motor driven piston and the space included by the wall of the cylinder the forward face of the motor driven piston and the rear face of the forward piston.

3. The combination with a cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the end chambers and means for affording communication between said central chamber and said by-pass and for controlling the flow of fluid between said by-pass and said central chamber.

4. The combination, as a rock drilling apparatus; of a casing or shell, a drilling tool supported therein; an air cylinder comprised in the casing and having a port or passage outside the air chamber, communicating from one end thereof to the other; a piston, movable, independently, in said cylinder and constituting a hammer to strike the tool; a plunger, also in said air cylinder, axially behind and movable independently of the piston; and means for reciprocating the plunger in the air cylinder, behind the piston, to alternately compress and rarefy the air between said plunger and piston, so as to cause the latter to strike the drill at every stroke of the plunger.

5. In a rock drilling machine, the combination, in a suitable casing or frame, of an actuating motor, an air cylinder, comprised in said casing, and provided with spring pressure valves, to automatically regulate the density of the air in the cylinder, a bypass or port, communicating with each end of the air chamber of the cylinder, a plunger and a piston adapted to reciprocate in said air cylinder, independently of each other, the latter constituting a hammer to strike the tool, means for transmitting the motion of the motor to the plunger, a chuck or drill support held in the casing against longitu-

dinal motion, and mechanism for rotating the said chuck, all substantially as shown and described.

6. The combination with a substantially air tight cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers so that the reciprocation of one piston causes the fluid contained in the cylinder to impart an elastic reciprocating motion to the other piston.

7. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, and said cylinder provided with a by-pass connecting the two end chambers.

8. The combination with a substantially air tight cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, and an inlet check valve near one end of the cylinder adapted to admit air from the atmosphere.

9. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the end chambers, and an inlet check valve near one end of the cylinder adapted to admit air from the atmosphere.

10. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the end chambers, and a check valve adapted to admit air from the by-pass into the central chamber.

11. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the end chambers, and a three way valve located in said by-pass adapted to establish communication between either end chamber and the central, shutting off the other end chamber, or to shut off the central and connect the end chambers.

12. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the two end chambers, an inlet check valve near one end of the cylinder adapted to admit air from the atmosphere, and a check valve adapted to admit air from the by-pass into the central chamber.

13. The combination with a fluid cylinder of two pistons in said cylinder, whereby it is divided into a central and two end chambers, said cylinder provided with a by-pass connecting the two end chambers, a motor for reciprocating one of said pistons, an inlet check valve near one end of the cylinder adapted to admit air from the atmosphere, and a three way valve located in the said by-pass to control the flow of the fluid between the end chambers and the central chamber.

14. The combination with a cylinder of a pair of pistons movable therein, a motor for driving one of said pistons, said cylinder provided with a by-pass connecting the ends of the cylinder, a three way valve located in said by-pass to control the flow of fluid between the end chambers and the central chamber, an inlet check valve near one end of the cylinder adapted to admit air from the atmosphere, and a check valve to admit air from the by-pass to the central part of the cylinder.

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

OLIN S. PROCTOR.

Witnesses:
ARTHUR G. COX,
PAULA WARRACK.