C. T. CARNAHAN.

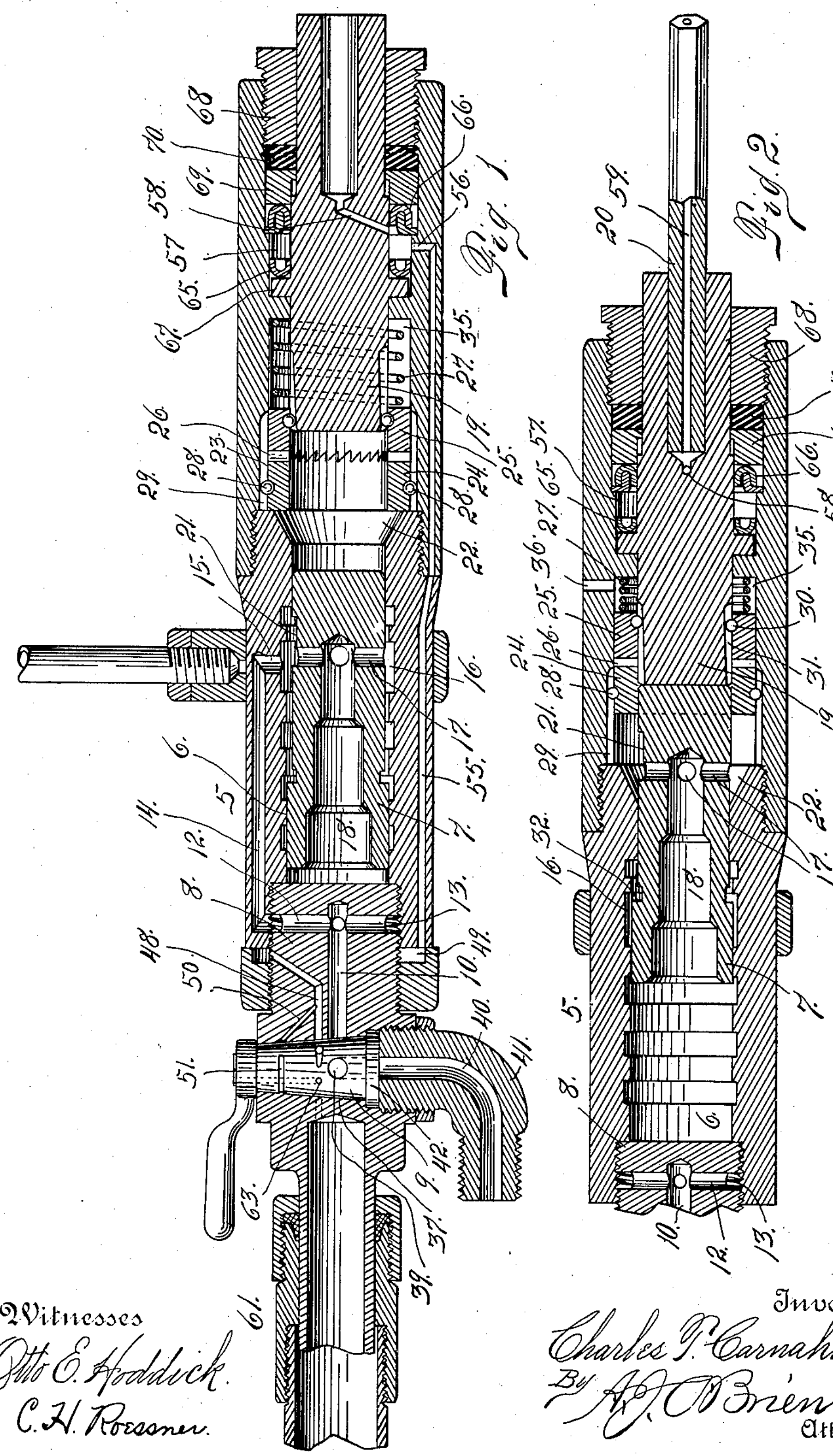
ROTATOR FOR ROCK DRILLS.

APPLICATION FILED APR. 22, 1911.

1,050,806.

Patented Jan. 21, 1913.

3 SHEETS—SHEET 1.




Witnesses

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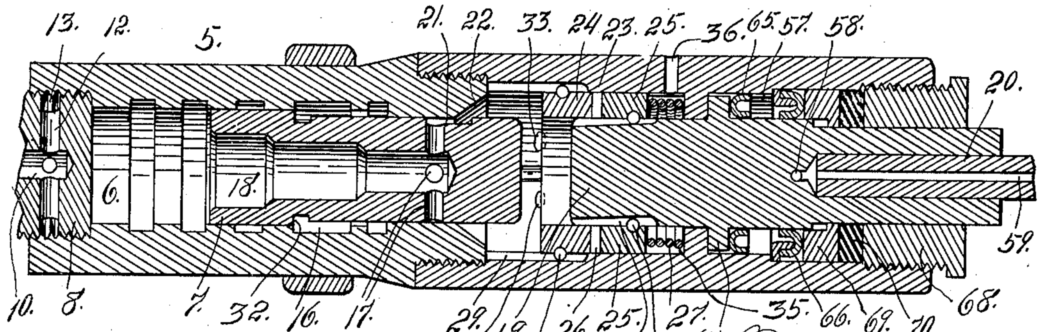


Fig. 3.

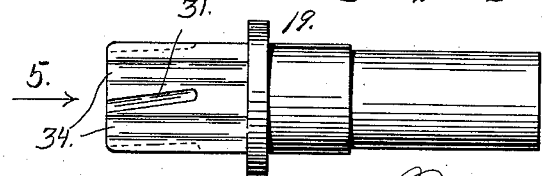


Fig. 4.

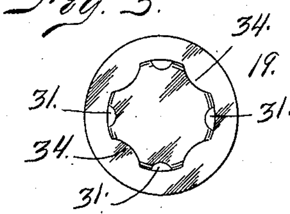


Fig. 5.

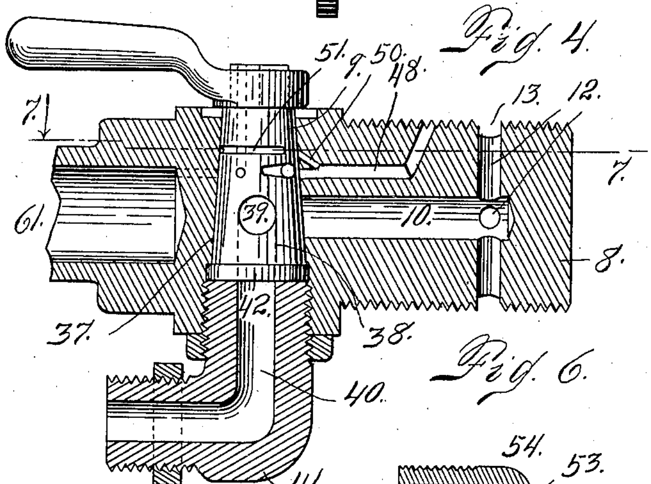


Fig. 6.

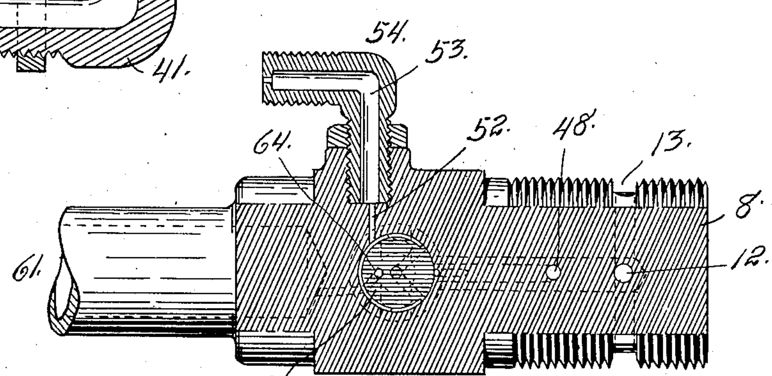


Fig. 7.

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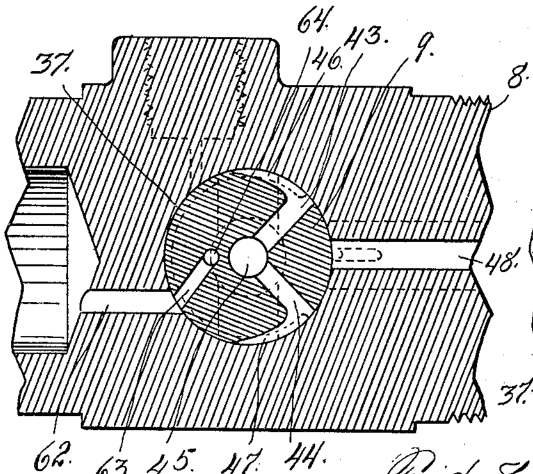


Fig. 8

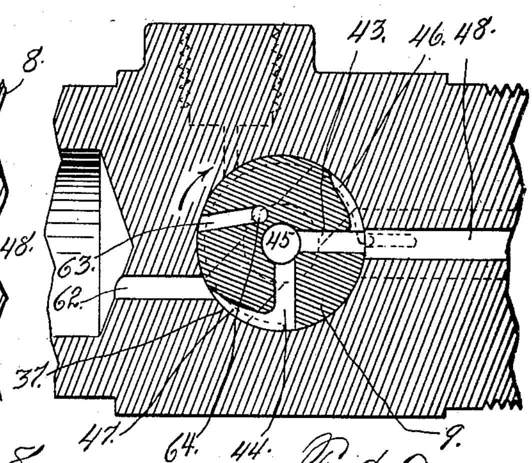


Fig. 9

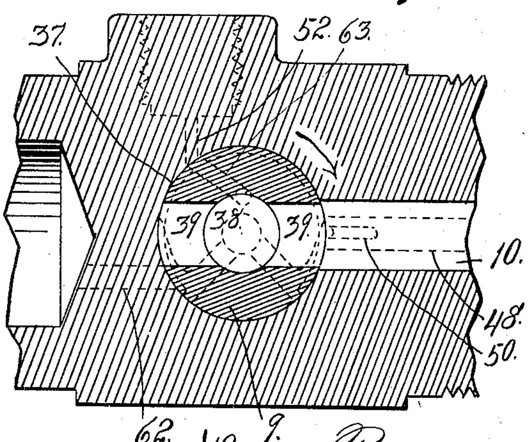


Fig. 10.

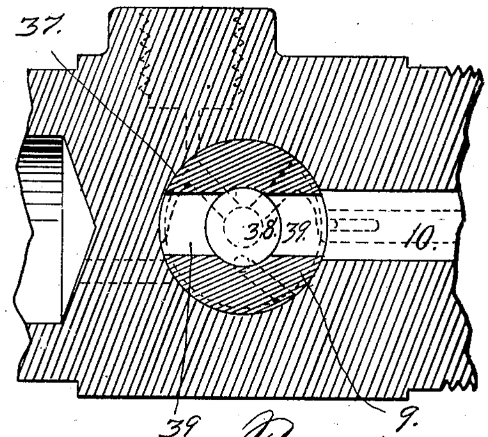


Fig. 11.

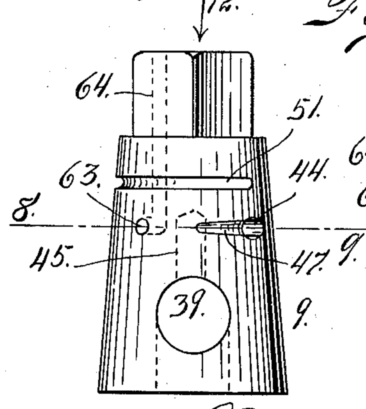


Fig. 13.

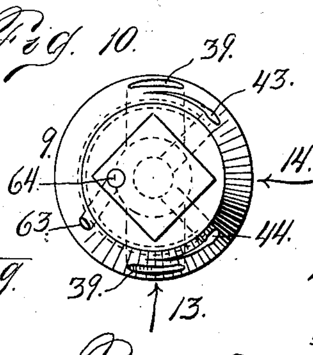


Fig. 12.

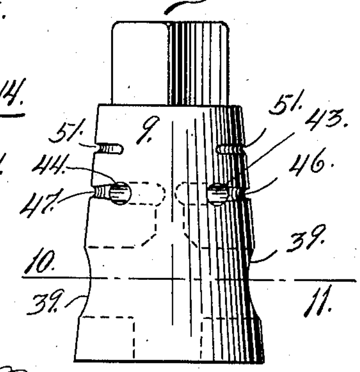


Fig. 14.

Witnesses

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# UNITED STATES PATENT OFFICE.

CHARLES T. CARNAHAN, OF DENVER, COLORADO.

ROTATOR FOR ROCK-DRILLS.

1,050,806. Specification of Letters Patent. Patented Jan. 21, 1913.

Application filed April 22, 1911. Serial No. 622,848.

*To all whom it may concern:*

Be it known that I, CHARLES T. CARNAHAN, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Rotators for Rock-Drills; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

My invention relates to improvements in rock drilling machines of the valveless hammer type.

In the rotating mechanism I employ two ratchet collars, the teeth of which engage each other. One of these collars carries antifrictional balls, which engage longitudinally disposed grooves formed in the adjacent portion of the casing, the said grooves being parallel with the axis of the machine. The other collar carries similar balls which engage spirally arranged grooves formed in the tappet which carries the drill steel or tool. The toothed portions of the two collars intermesh with each other in such a manner that as the piston composed of these two collars moves forwardly under the influence of the motive fluid pressure in the low pressure chamber, the forward collar is caused to move on its companion collar by virtue of the spiral grooves in the tappet; while during the return movement of the said piston the forward collar is locked against rotation in the direction of the stress due to the spiral grooves in the tappet, and consequently the tappet must rotate. In this manner the partial rotary movement is imparted to the drill steel between strokes which is necessary in order to change the position of the cutting face of the tool after each stroke. A novel feature of this rotating mechanism is believed to be the employment of the antifrictional balls engaging the straight and spiral grooves as aforesaid, whereby the collars may be subjected to considerable lateral strain without materially interfering with their movement in a longitudinal direction.

Having briefly outlined my improved construction, I will proceed to describe the same in detail, reference being made to the accompanying drawing in which is illustrated an embodiment thereof.

In this drawing: Figure 1 is a central longitudinal section taken through a machine equipped with my improved construction, the drill steel being omitted from the forward extremity of the machine and the feed bar casing being broken away in the rear. Fig. 2 is a similar view with the throttle valve portion of the machine broken away in the rear, and illustrating the drill bit or tool inserted in the tappet at the forward extremity of the machine, the hammer being shown in its striking position or in engagement with the drill steel tappet. Fig. 3 is a similar view, but showing the hammer after it has commenced its rearward stroke and uncovered the exhaust ports leading from the low pressure chamber, and before the piston composed of the ratchet collars has commenced its rearward stroke under the influence of its actuating spring. Fig. 4 is a detail view in elevation of the tappet. Fig. 5 is an end elevation of the tappet looking in the direction of arrow 5, Fig. 4. Fig. 6 is a fragmentary view of the portion of the machine carrying the throttle valve, being substantially the construction shown in Fig. 1, but on a larger scale. Fig. 7 is a section taken on the line 7—7, Fig. 6, viewed in the direction of the arrow. Fig. 8 is a section taken through the machine cutting the throttle valve on the line 8—9, Fig. 13. Fig. 9 is a similar view, showing the valve, however, in a slightly changed position, the same having been given approximately a quarter rotation from the position shown in Fig. 8. Fig. 10 is a fragmentary section taken through the machine cutting the throttle valve on the line 10—11, Fig. 14. In this view the valve is given approximately a quarter turn from the position shown in Fig. 9, whereby the motive fluid is turned on full to the engine, while it is also passing to the feed bar casing and uniting with the water for passage to the drill hole. Fig. 11 is a similar view, but showing the valve in a different position, the motive fluid, however, being still turned on full to the engine, but cut off from the feed bar casing. Fig. 12 is a top plan view of the valve, or a view looking in the direction of arrow 12, Fig. 13. Fig. 13 is a side elevation of the valve looking in the direction of arrow 13, Fig. 12. Fig. 14 is an elevation of the valve looking at right angles to Fig. 13 or in the direction of arrow 14, Fig. 12.

The same reference characters indicate the same parts in all the views.

Let the numeral 5 designate the drill cylinder provided with a chamber 6 in which is located a reciprocable hammer 7, which when at its rearward limit of movement has its rear extremity in close proximity to a block 8 in which is located a throttle valve 9 for regulating the passage of motive fluid to the hammer chamber through a longitudinal passage 10 formed in the head block and lateral passages 12 communicating with the longitudinal passages at their inner extremities, and at their outer extremities with a circumferential groove 13 in the head block, which communicates with a passage 14 formed in the wall of the cylinder and extending forwardly and communicating by a short lateral passage 15, with a circumferential groove 16 formed in the wall of the cylinder, and in communication with laterally extending passages 17 formed in the hammer and communicating with the central chamber 18 of the hammer. In this manner the motive fluid acts upon the hammer to drive the latter forward, and when at its extreme forward limit of movement it strikes the tappet or striking bar 19 which carries the drill steel 20 (see Fig. 2). Just before the hammer reaches its forward limit of movement, its chamber 18 is placed in communication with a short passage 21 leading to an expansion or low pressure chamber 22, whereby the motive fluid acts by expansion to move forward a piston 23 composed of two ratchet collars 24 and 25 having intermeshing ratchet teeth 26, the forward collar 25 being acted on by a spiral spring 27 which is placed under tension for imparting the reverse movement to the ratchet piston. The rear collar 24 carries steel balls 28 arranged to move in straight grooves 29 formed in the cylinder casing; while the collar 25 carries similar balls 30 which engage spiral grooves 31 formed in the tappet or striking bar 19. During the forward movement of the ratchet piston 23, the collar 24 is locked against rotation, since the balls 28 fit in straight grooves 29 which extend parallel with the axis of the machine. The collar 25, however, must make a partial rotation in one direction, since its balls 30 travel in the spiral grooves 31 of the striking bar. Hence the teeth of the collar 25 must slip past the adjacent teeth of the collar 24. However, as the hammer recedes or makes the return stroke, and the air exhausts from the expansion chamber forward of the piston 23, the recoil of the spring 27 acting on the said piston moves the same rearwardly. During this action the collar 24 cannot rotate and the collar 25 cannot rotate in the direction of stress, but as the balls 30 engage the spiral grooves of the striking ball, a partial rotation must be imparted to the latter, whereby a corresponding movement is imparted to the drill steel, as is required for effective work in a machine of this kind. As soon as the piston 23 is at its forward limit of movement, the hammer begins its rearward travel under the influence of motive fluid from the circumferential groove 16, which is in communication with the live motive fluid as heretofore explained, the hammer during its forward travel having brought its shoulder 32 into communication with the said groove. The live motive fluid acting upon the shoulder 32 drives the hammer rearwardly more rapidly than the spring 27 imparts a similar travel to the piston 23, thus prolonging exposure of exhaust ports 33 through which the motive fluid in the low pressure chamber exhausts to the atmosphere. The exhaust through the ports 33, however, is supplemented by a further exhaust through grooves 34 formed in the striking bar, (see Fig. 5), the said grooves being in communication with the chamber 35 in which the spring 27 is located, the said chamber being in communication with a port 36 leading to the atmosphere.

The construction of the throttle valve 9, and the manner in which it serves to control the passage of motive fluid to the hammer cylinder and the feed bar casing, will now be described, as will also the manner of controlling the passage of water and air to the hollow drill steel for the purpose of removing the rock cuttings from the drill hole.

The throttle valve 9 is frusto-conical in shape and occupies a counterpart opening 37 formed in the head block 8. The lower portion of this valve has a central vertical opening 38 communicating at its upper extremity with lateral passages 39 extending in opposite directions through the valve, and at its lower extremity with a passage 40 formed in an elbow 41 adapted to be connected with a source of motive fluid for operating the drill. This elbow is screwed into a socket formed directly beneath the valve opening 37 of the head block, there being a space 42 between the elbow and the valve whereby the valve is subjected to upward pressure and as its lower extremity is largest, this action of the motive fluid keeps the valve tight in the head block at all times regardless of wear. When the valve is turned in such position that one of its openings 39 is in communication with the passage 10 of the head block, the motive fluid is turned into the hammer cylinder to the maximum capacity. The throttle valve is further provided with two passages 43 and 44 in communication with an opening 45 formed in the valve above the openings 39, the said openings 43 and 44 communicating at their outer extremities with grooves 46 and 47 which extend in a circumferential direction around the valve, diminishing in size from the openings 43 and 44. One of these openings 43 or 44 serves to deliver air to an angular passage 48 of the head block, whose extremity remote from the valve communicates with a circumferential groove 49 formed in the casing. A small passage 50 is also in communication with the angular passage 48 at one extremity, while its other extremity is adapted to register with a groove 51 extending circumferentially around the valve approximately three-fourths of the distance. This groove 51 is in communication by means of a passage 52 (see Figs. 6 and 7), with a passage 53 formed in an elbow 54 connected with a suitable source of water supply, not shown. Hence by virtue of the construction just described, when the valve is properly adjusted (see Figs. 10 and 11), air will enter the angular passage 48 of the head block from a passage 43 or 44, simultaneously with the entrance of water to the angular passage through the passage 50 of the head block which is in communication with the groove 51 and elbow passage 53 for supplying water as aforesaid. The air and water are carried through the angular passage to the circumferential groove 49, thence through a relatively long passage 55 formed in the wall of the drill cylinder, thence through a port 56 to a circumferential chamber 57 which is in communication with a port 58, the latter being in communication with a central passage 59 formed in the drill 20, whereby the water and air pass through the drill steel and may be constantly supplied to the drill hole for removing the rock cuttings and allaying the dust.

In order to form a fluid-tight joint, the striking bar 19 is surrounded on opposite sides of the chamber 57 with packings 65 and 66 formed preferably of leather. By virtue of the forward packing 66 the escape of the air and water through the port 57 may be cut off in case the drill should be started without the drill steel in place, since in this event the striking bar would be moved forwardly a sufficient distance to cause the packing 66 to cover the outer extremity of the port 58, thus forming an air cushion in the chamber 57 and preventing the collar 67 formed on the striking bar, from moving forwardly and injuring the machine by crushing the packing leathers 65 and 66 together.

Between a screw plug 68 inserted in the forward extremity of the cylinder and through which the striking bar passes, and a collar 69 located immediately forward of the packing washer 66, is located a packing 70 whose special function is to produce sufficient friction upon the striking bar to prevent the rotary action of the latter during the forward movement of the piston 23, or when the collar 25 moves on the collar 24, the teeth of the one collar slipping past those of the other collar. If the rotary action of the striking bar were not retarded by friction resulting from the use of the packing 70 or its equivalent, or in other words, if the striking bar rotated easily within the cylinder, it would rotate instead of the collar 25. By virtue of my improved construction, however, the friction of the packing 70 makes it more difficult to rotate the striking bar than for the teeth of the collar 25 to slip past the teeth of its companion collar 24. Hence the construction operates as it should; while if it were otherwise and the striking bar rotated instead of the collar 25, the said bar would make a partial rotary movement during the forward movement of the piston 23, and reverse its action during the rearward movement of the said piston, and consequently the face of the drill steel would not change its position. In other words, the rotating mechanism would be inoperative. At the same time the motive fluid may be supplied to the feed bar casing 61 through a passage 62 formed in the head block and in communication with the passage 44 of the throttle valve. When, however, it is not desired to supply motive fluid to the feed bar casing by reason of the fact that the material is so soft through which the drill steel is passing that it is not desirable to use motive fluid to hold the drill in position, the valve may be turned to the position shown in Fig. 11, whereby the motive fluid is cut off from the passage 62, and the air is fed to the angular passage 48 of the head block, through the passage 44 of the valve, while the passage 43 is out of commission.

From the foregoing it will be understood that when the drill is regularly on operation, the throttle valve is in the position shown in Fig. 10; while when it is desired to run the drill in the regular way except that the motive fluid is cut off from the feed bar casing, the valve is given a half turn from the position shown in Fig. 10 or to the position shown in Fig. 11. In this event the passage 39 of the valve through which the motive fluid passes to the central passage 10 of the head block when the valve is in the position shown in Fig. 10, is thrown out of commission, while the opposite passage 39 becomes that through which the motive fluid enters the passage 10 of the head block on its way to the hammer cylinder. When it is desired to exhaust the motive fluid from the feed bar casing, the valve 9 is turned to the position shown in Fig. 8, whereby a lateral passage 63 formed in the valve is placed in communication with the passage 62 of the head block leading to the feed bar casing. This lateral passage 63 also communicates with a vertical passage 64 formed in the valve and through which the motive fluid escapes to the atmosphere.

From the foregoing description the use and operation of my improved rock drilling machine will be readily understood, and its various steps will now be briefly set forth in their proper sequence. If we assume that the throttle valve is in the position shown in Fig. 8, the feed bar casing is open to the atmosphere through the passage 62 of the head block and the passages 63 and 64 of the valve. At the same time the valve is in position to cut off the live motive fluid from the feed bar casing and the drill cylinder, and also to cut off the water and air from the hollow drill steel and the various passages forming the path for the water and air between the drill steel and the valve. Now if it is desired to start the machine, the valve may be given a quarter turn (see Fig. 9), whereby a small amount of motive fluid will be turned into the feed bar casing from the passage 44 of the valve, since the tapering groove 47 of the latter is slightly in communication with the passage 62 of the head block leading to the feed bar casing. This will be sufficient to set the drill against the rock. It will be noted that when the valve is in the position shown in Fig. 9, no motive fluid is turned into the cylinder, since neither passage 39 of the valve is in communication even to the smallest extent, with the passage 10 of the head block. The water and air, however, are delivered to the angular passage 48, by virtue of the fact that one extremity of the groove 51 of the valve is in communication with the passage 50 of the head block leading to the angular passage 48, while the passage 43 of the valve is also in communication with the angular passage 48. Hence when the valve is in the position shown in Fig. 9, there is sufficient motive fluid turned into the feed bar casing to move the drill against the rock or into operative position, while a mixture of water and air is started on its way to the hollow drill steel. The valve will now be farther turned in the same direction, being that indicated by the arrow in Figs. 9 and 10, to the position shown in Fig. 10. During this operation the motive fluid is gradually turned into the hammer cylinder and into the feed bar casing until the maximum limit is reached, by virtue of the tapering grooves 46 and 47 which are respectively in communication with the passages 43 and 44, as heretofore explained. Hence when the valve is in the position shown in Fig. 10, the machine is running in the regular way, the motive fluid being turned on to its full capacity, and a corresponding supply furnished to the feed bar casing, whereby the drill is held up to its work in the proper manner. If now during the drilling operation a soft place in the rock should be encountered, as a streak of clay or material so soft that the pressure of the motive fluid in the feed bar casing would not be required, the operator may quickly turn the valve from the position shown in Fig. 10 to that shown in Fig. 11, the valve being given a half rotation so that the passage 39 on one side of the center of the valve which was out of commission when the valve was in the position shown in Fig. 10, will be in register with the passage 10 of the head block, while the passage 39 which was formerly in register with the said passage of the head block is out of commission. At the same time communication of the live motive fluid with the feed bar casing is completely cut off, since the passage 44 is thrown out of communication with the passage 62, while the passage 43 has not moved quite far enough to communicate with the passage 62 of the head block leading to the feed bar casing. The passage 44, nevertheless, supplies sufficient motive fluid to mingle with the water entering through the circular passage 51, so that the supply of the air and water mixture to the hollow drill steel, as well as the complete supply of motive fluid to the hammer cylinder, is maintained. The valve will be kept in the position shown in Fig. 4 until the drill steel has passed through the soft spot in the rock and encountered material of the proper hardness to justify the use of the pressure supply from the feed bar casing to hold the machine up to its work. The motive fluid being turned into the hammer cylinder, imparts the necessary reciprocating movement to the hammer, the motive fluid entering the central chamber of the hammer through the ports and passages as heretofore explained. During the time the hammer moves forward to its limit of movement, the motive fluid from the central chamber 18 of the hammer exhausts into the low pressure chamber 22 of the cylinder and acts upon the piston 23 composed of the two ratchet collars 24 and 25 and causes them to move forwardly, whereby the collar 25 is given a partial rotary movement on its companion collar 24 by virtue of the fact that the balls carried by the collar 25 engage the spiral grooves of the striking bar, whereby the spiral spring 27 is compressed. Now as the hammer recedes, due to the action of the motive fluid upon its exterior shoulder 32, the exhaust ports 33 are uncovered and the exhaust from the chamber 18 of the hammer is completed through the said ports together with the grooves 34 of the striking bar, the spring chamber 35 and the port 36 leading from said chamber to the atmosphere. Simultaneously with the escape of the exhaust from the chamber 18 of the hammer into the low-pressure chamber 22, the forward extremity of the hammer enters the opening in the member 24 of the piston 23. As the hammer-extremity fits closely within the said piston-member 24, the exhaust which enters the low-pressure chamber from the chamber 18 of the hammer, acts upon the piston 23 to move the latter forwardly, the hammer-extremity cutting off the escape of the exhaust from the low-pressure chamber until the piston 23 has been actuated as aforesaid. It must be understood that the small exhaust ports 33 are not uncovered until the piston 23 is at its forward limit of movement, consequently there is no avenue of escape for the exhaust from the chamber 18 after entering the low-pressure chamber, until the piston 23 is at its forward limit of movement. The exhaust then commences to a limited extent through the ports 33, but as soon as the hammer retreats sufficiently to disengage itself from the member 24 of the piston 23, there is free exhaust through the opening in the piston 23 by way of the grooves 34 in the drill-steel holder, the spring chamber 27 and the port 36. It will thus be seen that the entrance of the forward extremity of the hammer into the opening of the ring-member 24 of the piston 23 is of the utmost importance in order to prevent the escape of the exhaust-motive-fluid from the low-pressure chamber 22 until the piston 23 has been actuated as aforesaid. The special construction of the piston 23 is important. It must be ring-shaped in order to allow the piston-hammer to enter it in order to strike the drill-steel holder.

Having thus described my invention, what I claim is:

1. A rock drilling engine, equipped with a rotatable drill steel, the said engine being provided with high and low pressure chambers, pistons in the respective chambers, the said pistons having their axes in alinement with each other, the piston in the high pressure chamber constituting the hammer of the machine and the piston in the low pressure chamber being moved in one direction in response to the exhaust motive fluid pressure, a spring for moving the last-named piston in the opposite direction, and an operative connection between the last-named piston and the drill steel, whereby, as the piston is reciprocated, the drill steel is rotated, including a drill steel holder formed with grooves, and parts carried by the piston and engaging said grooves, substantially as described.

2. A rock drilling engine provided with high and low pressure chambers, pistons in said chambers, the piston in the high pressure chamber constituting the hammer and the piston in the low pressure chamber being motive fluid actuated in one direction by the exhaust fluid, a spring for moving the last-named piston in the opposite direction, the last-named piston being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation, but longitudinally movable, a drill steel holder having spiral grooves, and balls carried by the other collar and engaging the spiral grooves of the drill steel holder, whereby the latter is rotated as the piston in the low pressure chamber is reciprocated.

3. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the said pistons having their axes in alinement with each other, the piston in the high pressure chamber constituting the hammer of the machine, the piston in the low pressure chamber being actuated in one direction by exhaust motive fluid, a spring for actuating the last-named piston in the opposite direction, the last-named piston being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation but longitudinally movable, a drill steel holder having spiral grooves, balls carried by the other collar and engaging said spiral grooves of the drill steel holder.

4. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the piston in the high pressure chamber constituting the hammer of the machine, a striking bar carrying the drill steel and having spiral grooves, the piston in the low pressure chamber being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation but longitudinally movable, balls carried by the other collar and engaging the spiral grooves of the striking bar for drill steel rotating purposes, the piston in the low pressure chamber being actuated in one direction by the exhaust motive fluid, a spring for moving the last-named piston in the opposite direction.

5. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the piston in the high pressure chamber constituting the hammer of the machine, the piston in the low pressure chamber being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation but longitudinally movable, a striking bar carrying the drill steel and having spiral grooves, the other collar having balls engaging the spiral grooves of the striking bar for drill steel rotating purposes, the piston in the low pressure chamber being actuated by the ex-

haust motive fluid, a spring for moving it in the opposite direction, and means for exhausting the motive fluid from the high pressure chamber through the low pressure chamber.

6. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the piston in the high pressure chamber constituting the hammer of the machine and the piston in the low pressure chamber being composed of two collars having toothed engaging faces, one collar being locked against rotation but longitudinally movable, a striking bar carrying the drill steel and having spiral grooves, the other collar having parts engaging the spiral grooves of the striking bar, means for frictionally retarding the rotary action of the striking bar in one direction to a greater extent than the frictional resistance offered by one of the toother collars.

7. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the piston in the high pressure chamber constituting the hammer of the machine, means for reciprocating the piston in the low pressure chamber, the last-named piston being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation, but longitudinally movable, a striking bar carrying the drill steel, and having spiral grooves, the other collar having parts engaging the spiral grooves of the striking bar, and means for frictionally retarding the rotary action of the striking bar in one direction to a greater extent than the resistance offered to the rotary action of one of the toothed collars in the opposite direction.

8. A rock drilling engine provided with high and low pressure chambers, pistons in the respective chambers, the piston in the high pressure chamber constituting the hammer of the machine, means for reciprocating the piston in the low pressure chamber, the last-named piston being composed of two collars having toothed engaging faces, one collar being locked to a stationary part of the engine against rotation but longitudinally movable, a striking bar carrying the drill steel, and having spiral grooves, the other collar having parts engaging the spiral grooves of the striking bar, and means for frictionally retarding the rotary action of the striking bar, whereby the resistance offered to the rotary action of the said bar in one direction is greater than the resistance offered to the rotary movement of one of the collars in the opposite direction during the forward movement of the collar piston.

9. A rock-drilling engine provided with high and low-pressure chambers, pistons in the respective chambers in alinement with each other, the piston in the low-pressure chamber forming a ring through which exhaust from both chambers passes, the exhaust from the high-pressure chamber entering the low-pressure chamber and serving to move the piston therein in one direction, the high-pressure piston entering the ring of the low-pressure piston and cutting off the exhaust therethrough during the movement of the low-pressure piston.

10. A rock-drilling engine provided with high and low-pressure chambers, pistons in the respective chambers in alinement with each other, the piston in the low-pressure chamber forming a ring through which exhaust from both chambers passes, the exhaust from the high-pressure chamber entering the low-pressure chamber and serving to move the piston therein in one direction, the high-pressure piston entering the ring of the low-pressure piston and closing the opening therethrough whereby the escape of the exhaust motive-fluid from the low-pressure chamber is prevented during the forward movement of the low-pressure piston, and means for reversing the movement of both pistons, the rearward travel of the high-pressure piston being more rapid than that of the low-pressure piston.

11. A rock-drilling engine equipped with a rotatable drill-steel, the engine being provided with high and low-pressure chambers, pistons in the respective chambers in alinement with each other, the piston in the low-pressure chamber forming a ring through which exhaust from both chambers passes, the exhaust from the high-pressure chamber entering the low-pressure chamber and serving to move the piston in the last-named chamber in the forward direction, the high-pressure piston entering the ring-opening of the low-pressure piston and fitting closely therein, whereby the escape of the exhaust-motive-fluid from the low-pressure chamber is cut off during the forward movement of the low-pressure piston, means for reversing the movement of the two pistons, the reverse-travel of the high-pressure piston being more rapid than that of the low-pressure piston, and an operative connection between the low-pressure piston and the drill-steel for imparting rotary movement to the latter.

12. A rock-drilling engine provided with high and low-pressure chambers, pistons in the respective chambers, the axes of the pistons being in alinement, a drill-steel holder, the piston in the low-pressure chamber forming a ring and the piston in the high-pressure chamber constituting a hammer which strikes the drill-steel holder after entering the opening of the low-pressure piston, means for permitting the exhaust from the high-pressure chamber to enter the low

pressure chamber and act on the low-pressure piston to move the latter forwardly, means for allowing the exhaust-motive-fluid to escape from the low-pressure chamber after the low-pressure piston has made its forward stroke, an operative connection between the low-pressure piston and the drill-steel holder for rotating the latter, and means for imparting reverse movement to both pistons.

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

CHARLES T. CARNAHAN.

Witnesses:

F. E. BOWEN,

HORTENSE UHLRICH.