Jan. 18, 1949. P. A. BANCEL ET AL 2,459,484

ROCK DRILL

Filed Oct. 20, 1945

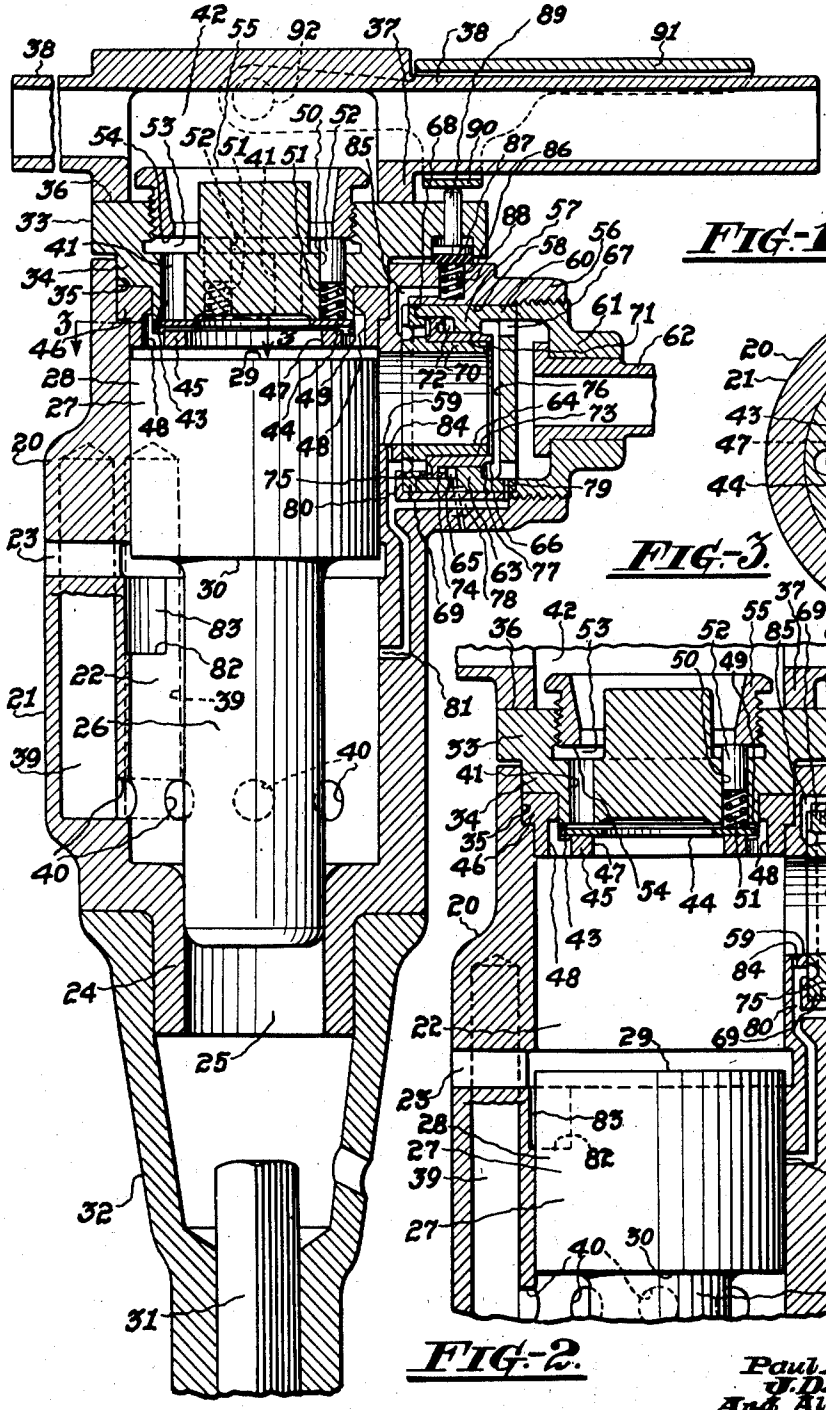


FIG. 1.

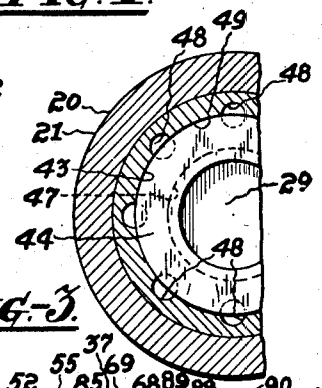


FIG. 3.

FIG. 2.

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Patented Jan. 18, 1949 2,459,484

UNITED STATES PATENT OFFICE

2,459,484

ROCK DRILL

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Application October 20, 1945, Serial No. 623,532

12 Claims. (Cl. 121—18)

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This invention relates to rock drills, and more particularly to rock drills of the fluid actuated reciprocatory piston type.

One object of the invention is to minimize the pressure fluid consumption of the rock drill.

Another object is to vary the stroke characteristics of the drill piston in accordance with the requirements of the work.

Other objects will be in part obvious and in part pointed out hereinafter.

In the drawing accompanying this specification and in which similar reference numerals refer to similar parts,

Figure 1 is an elevation, partly in section, of a rock drill constructed in accordance with the practice of the invention and showing the reciprocatory piston in one of its limiting positions,

Figure 2 is a view similar to Figure 1 showing the piston in another limiting position, and

Figure 3 is a transverse view taken through Figure 1 on the line 3—3 looking in the direction indicated by the arrows.

Referring more particularly to the drawing, 20 designates, in general, a rock drill of the type commonly known as a paving breaker comprising a cylinder 21 having a piston chamber 22 and a free exhaust port 23 for the piston chamber.

The front end of the cylinder has a reduced hollow extension 24 the internal surface 25 of which serves as a guide for the stem 26 of a differential piston 27 reciprocable in the piston chamber 22. The head 28 of the piston 27 controls the exhaust port 23 and has the enlarged rearward and the reduced forward pressure surfaces 29 and 30, respectively, that are subjected to pressure medium for actuating the piston against a working implement 31 that extends into the path of the piston extension 26 and is guided by a front head 32 on the hollow extension 24.

At the rearward end of the cylinder is a back head 33 having a boss 34 that lies in an enlarged bore 35 at the end of the piston chamber 22. The outer end of the back head 33 serves as a seating surface 36 for the hub portion 37 of a handle 38 whereby the rock drill may be supported and guided with respect to the work. The hub portion 37, the back head 33, the cylinder 21, and the front head 32 may be clamped securely together in assembled relationship with each other by any suitable means, as for example, side rods, or bolts (not shown).

In order to minimize the cost of operation of the rock drill pressure fluid from a source of supply is used only in the rearward end of the piston chamber 22 for driving the piston 27 forwardly on its working stroke, and the piston is actuated on its return stroke by the force of an elastic medium, as for example air or a helical

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spring, compressed by the piston in the front portion of the piston chamber. In structures in which air serves this function the cylinder is provided, as shown, with volume chambers 39 that communicate with the front end of the piston chamber through ports 40. The expansion of compressed air from the volume chambers 39 aids the rebound of the piston from the working implement 31 to impart sufficient velocity to the piston 27 such that the momentum of the piston enables the completion of the non-working stroke.

To the end that a force of only a low value may be required to thus return the piston, means are provided to permit the air in the rearward end of the piston chamber to be freely expelled by the piston so that the piston may execute its return stroke with little or no resistance to its movement and for its full nominal distance, if desired. In furtherance of this end, the back head 33 is provided with a port, or as shown, a series of ports 41 arranged in circular fashion to afford communication between the rearward end of the piston chamber and the atmosphere, in the present instance with a channel 42 extending through the handle 38 and its hub portion 37.

The forward end portion of the back head 33 adjacent the ports 41 constitutes a seating surface 43 for a valve 44 shown as being in the form of an annular plate that reciprocates between the seating surface 43 and a stop plate 45 spaced from and overlying the seating surface 43. The stop plate 45 is in telescopic engagement with the front end of the back head and has an annular flange 46 that is pressed against the bottom of the enlarged bore 35 by the back head.

The stop plate, proper, is of substantially annular shape having an axial opening 47 for the passage of air from the piston chamber to the ports 41. It is further provided with passages 48 arranged in circular fashion for the escape of air from the piston chamber across the periphery of the valve 44 to the ports 41. Preferably, the circle upon which the passages 41 are located coincides with the periphery of the valve 44, and said valve is guided only at its outer edge by the inner surface 49 of the stop plate 45.

Suitable means are provided to yieldingly hold the valve 44 against the stop plate 45 so that the valve will constantly tend to assume a position to uncover the ports 41. To this end the back head 33 is provided with a group of apertures 50 that are arranged on the same circle as the ports 41, for the accomodation of springs 51 that seat upon the valve 44 to press it against the stop plate 45. The springs may be calibrated to yield only to a desired predetermined value of pressure medium in the rearward end of the piston chamber for closing the valve 44 or, as illustrated, means may be provided for selectively

varying the force of the springs so that they will yield at different pressure values of fluid medium in the piston chamber. This is desirable and makes possible either the expulsion of all the air from the piston chamber, or the early closing of the valve 44 to retain a certain volume of air in the piston chamber for cushioning the rearward stroke of the piston.

The means illustrated for thus varying the forces of the springs 51 include plungers 52 in the apertures 50 seating against the springs 51. The plungers extend from the apertures 50 into a cavity 53 in the back head 33 for engagement with an end surface 54 of a hollow plug 55 threadedly connected to the wall of the cavity 53 so that it may be conveniently shifted for increasing or relieving the pressure of the springs 51 against the valve 44.

The valve mechanism serving to charge the rearward end of the piston chamber for driving the piston 27 on its working stroke is shown arranged adjacent the rearward end of the cylinder 21 which, for the sake of simplicity of illustration, is shown as having a boss 56 on the side thereof to accommodate the admission valve mechanism designated in its entirety by 57. The valve mechanism 57 is arranged within a bore 58 communicating with the rearward end of the piston chamber 22 through an aperture 59 and comprises a valve cage 60 that is clamped immovably against the bottom of the bore 58 by a hollow plug 61 threaded into the outer end of the bore 58 to support a pressure fluid supply conduit 62.

The valve cage 60 consists of two members 63 and 64 having opposed surfaces contoured to define a valve chamber 65 for the accommodation of a valve 66 that controls the flow of pressure fluid from the supply conduit 62 to the piston chamber. The member 63 is of cup-shape and in the bottom thereof are ports 67 for the passage of pressure fluid from the conduit 62 into the valve chamber. Its rim 68 bears against an external flange 69 on the member 64 for pressing the latter against the bottom of the bore 58.

The valve chamber 65 is of annular shape. Its inner surface is defined by a tubular portion 70 on the member 64 that extends part way through the member 63 and terminates short of the bottom portion of the member 63 to permit the flow of pressure fluid thereover from the ports 67 to the piston chamber.

The internal surface of the valve chamber 65 is of uniform diameter, and the valve chamber consists of a reduced portion 71 and an enlarged portion 72 to accommodate, respectively, the skirt 73 of the valve 66 and an external flange 74 the end surface of which constitutes an actuating surface 75 that is subjected intermittently to pressure fluid for throwing the valve into position to cut-off the flow of pressure fluid to the piston chamber, a position in which the free end of the skirt 73 engages a seating surface 76 on the bottom of the member 63.

An opposed actuating surface 77 of smaller area than the surface 75 is formed around the skirt 73 of the valve 66 and is constantly subjected to pressure fluid tending to throw the valve to its other limiting position.

Pressure fluid also flows constantly from supply for action against the actuating surface 75 to throw the valve 66 in the opposite direction, and the period of its effectiveness in the cycle of operation is controlled by the piston 27. To this end the boss 56 is provided with a constant supply passage 78 the inlet port 79 of which opens,

in the example shown, into a port 67. The opposite end of the supply passage 78 opens into a tripper passage 80 that leads from the enlarged portion 72 of the valve chamber 65 through the cylinder 21 and communicates with the piston chamber 22 through a port 81 located at a point forwardly of the exhaust port 23 and controlled by the piston 27.

The port 81 is so positioned that when the piston extension rests upon the working implement 31, as it normally will at the beginning of an operating period of a paving breaker, the head 28 will overlie the port 81 and pressure fluid will flow through the clearance between the head 28 and the wall of the piston chamber forwardly of the piston head to set the piston in motion.

The port 81 lies in the same transverse plane as the lower end 82 of a gash 83 extending forwardly through the wall of the piston chamber from the exhaust port 23 to permit the escape of air from the front end of the piston chamber in excess of that required for the compression serving to retract the piston 27. Owing to this arrangement of the port 81 with respect to the gash 83 the said port will be covered and uncovered simultaneously with the gash 83, and during the downward stroke of the piston only air at atmospheric pressure will exist in the forward end of the piston chamber to be compressed by the piston for returning it.

The port 79 is shown as being of smaller flow area than either the passage 78, the tripper passage 80 and the port 81, the flow area of the port 79 being so chosen that the pressure of the fluid acting against the actuating surface 75 will not reach the value required to overcome that acting against the surface 77 until a sufficient charge of pressure fluid has been admitted into the rearward end of the piston chamber to impart the required driving force to the piston. In effect, the port 79 meters the pressure fluid into the associated channels, including the tripper passage 80, and said port may vary in flow area in accordance with the point in the working stroke of the piston at which it may be intended to cut-off the flow of pressure fluid into the piston chamber.

In the form of the invention illustrated, such control of the valve is further effected by providing the casing with an orifice 84 to afford communication between the tripper passage 80 and the rearward end of the piston chamber so that pressure fluid may flow into the tripper passage during the charging of the piston chamber to augment the pressure acting against the actuating surface 75 for effecting a timely shifting of the valve.

The flow area of the orifice 84 may vary with the flow area of the port 79. It may, for example, be smaller so that the rate of flow therethrough will take place comparatively slowly and the ultimate pressure acting against the actuating surface 75 will be reached immediately before the piston 27 uncovers the free exhaust port 23. It may, on the other hand, be of greater flow area than the port 79 so that the tripping pressure acting against the surface 75 will be reached comparatively early during the working stroke of the piston and the valve will be thrown to cut-off the flow of pressure fluid at an earlier point in the piston stroke.

An additional function of the orifice 84 is that of a bleeder passage for the escape of pressure fluid from the tripper passage during the time the rearward end of the piston chamber is open to the atmosphere through the exhaust port 23

and, throughout the return stroke of the piston, through the ports 81 and thereby reduce the pressure acting against the surface 75 to only the actual value required for holding the valve 66 against the seating surface 76. Here again, as will be readily seen, the flow area of the orifice 84 with respect to that of the port 79 determines the point during the rearward stroke of the piston at which the valve will be tripped for charging the rearward end of the piston chamber. Thus, if the rate of flow of pressure fluid through the orifice 84 is in excess of that of the port 79 the pressure within the tripper passage will drop quickly to a value permitting the valve 66 to be thrown for charging the piston chamber at the instant the port 81 is uncovered by the piston. In this way an early admission of pressure fluid may be effected and the piston will, in consequence, be reversed before completing its full rearward stroke.

If, on the other hand, the orifice 84 be comparatively small the exhaust of fluid therethrough from the tripper passage will take place at a reduced rate and the time required for evacuating the tripper passage and associated channels after the port 81 has been uncovered by the piston will be correspondingly longer. As a result, the piston will complete or more nearly approach its full nominal stroke before a new charge of pressure fluid is admitted into the piston chamber.

In instances of use where the rock drill is connected directly to the discharge end of a compressor, in a manner illustrated more particularly in U. S. Patent No. 2,378,802 to Fred M. Slater, and in which case it may be desirable that the entire discharge output of the compressor pass through the piston chamber, even when the compressor is operating at idling speed, as when the rock drill is inactive, it is desirable that the rock drill be equipped with means for setting the valve 66 and the piston in action quickly and without requiring the manipulation of a multiplicity of valve devices. In furtherance of this end, the rock drill is provided with a leak passage 85 that leads from the tripper passage 80 through the cylinder and the boss 56 and opens into a bore 86 arranged radially in the boss 56, beneath the handle 38, to communicate with the atmosphere.

The outlet end of the bore 86 is controlled by a valve 87, and a spring 88 in the bore 86 acts against the valve for unseating it. The valve 87 is actuated manually in the opposite direction. It has a stem 89 that extends slidably through an overlying portion of the back head 33 for engagement with a wing 90 located between the handle 38 and the back head 33 and forming an integral portion of a lever 91 which overlies the handle 38 and is connected pivotally to the hub portion 37 by a pin 92.

The operation of the device is as follows: Let it be assumed that the piston is in the forward position illustrated in Figure 2 to uncover the exhaust port 23, and that the discharge output of the compressor, while idling, is passing through the rearward end of the piston chamber and the exhaust port 23 to the atmosphere and through the port 79 into the tripper passage 80. The tripper passage will then be covered by the piston and a certain portion of pressure fluid will then, of course, flow from the tripper passage through the orifice 84 to the atmosphere. The valve of the pressure fluid acting against the actuating surface 75 will, in consequence, be less than the pressure fluid acting against the actuating surface 77 and the valve 66 will be unseated to establish a free path for the pressure fluid from the ports 67 to the piston chamber.

At the same time, pressure fluid will also flow from the tripper passage through the passage 85 and the bore 86 to the atmosphere, thus precluding the accumulation of sufficient pressure beneath the actuating surface 75 to alter the position of the valve 66.

If, under these conditions, it be intended to set the hammer piston 27 in motion the lever 91 is depressed and the valve 87 is pressed thereby against the boss 56 to seal the bore 86. Thereafter, the value of pressure fluid flowing into the tripper passage through the port 79 will be reduced only by that amount which escapes through the orifice 84. The pressure then existing in the tripper passage and acting against the actuating surface 75 will overcome that acting against the surface 77 and will throw the valve against the seating surface 76 and cut-off the flow of pressure fluid through the rearward end of the piston chamber and the exhaust port to the atmosphere. At the same time pressure fluid flows downwardly through the clearance existing between the piston 27 and the wall of the piston chamber into the front end thereof and will lift the piston to establish communication between the port 81 and the gash 83.

The pressure fluid in the tripper passage 80 will then escape through the front end of the piston chamber, the gash 83 and the exhaust port 23 to the atmosphere, and the pressure fluid acting against the actuating surface 77 will shift the valve to charge the rearward end of the piston chamber for driving the piston on its working stroke.

During the charging of the piston chamber, pressure fluid also flows from the tubular portion 70 through the orifice 84 into the tripper passage to augment the pressure fluid flowing constantly through the port 79 into the tripper passage to the surface 75. Thus, as the piston proceeds forwardly and covers the port 81 the combined charges of pressure fluid through the port 79 and the orifice 84 into the tripper passage will overcome the pressure against the surface 77 and shift the valve to its closed position. This movement of the valve will take place before the piston uncovers the exhaust port 23 and no pressure fluid will, therefore, pass from supply to the atmosphere without doing useful work.

Immediately prior to the delivery of its blow against the working implement 31 the piston uncovers the exhaust port 23 and a portion of the pressure fluid flowing into the tripper passage through the port 79 will thereafter escape through the orifice 84, the piston chamber and the exhaust port 23 to the atmosphere. The pressure then acting against the surface 75 will be somewhat lower than nominal line pressure and only a slight amount of fluid need be further exhausted from the tripper passage to enable the pressure against the actuating surface 77 to return the valve.

Upon covering the port 81 and the gash 83 the piston will compress the air in the forward end of the piston chamber during the remaining portion of its working stroke and will be again returned by such compression which acts expansively against the pressure surface 30. When, during its return stroke, the piston again covers the exhaust port, the air thereafter displaced by the piston is expelled through the passages 48,

the opening 47, ports 41 and the hollow plug 55 to the atmosphere.

When the piston again places the port 81 in communication with the gash 83 the pressure fluid acting against the actuating surface 75 for holding the valve closed will escape to the atmosphere. The pressure fluid acting against the actuating surface 77 will then unseat the valve and pressure fluid will flow into the rearward end of the piston chamber and move the valve 44 to its port closing position and start the piston on a new cycle of operation.

The rock drill will continue to operate in the manner described as long as the valve 87 is held in position to seal the outlet end of the bore 86, and when it is intended to terminate an operating period the lever 91 is released. The spring 88 and the pressure fluid in the bore will then lift the valve 87 and communicate the tripper passage and associated channel with the atmosphere to reduce the pressure acting against the actuating surface 75. The pressure fluid acting against the actuating surface 77 will then shift the valve 66 against the bottom of the enlarged portion 72 of the valve chamber and will hold the valve in this position as long as the bore 86 remains uncovered.

We claim:

1. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston in one end of the piston chamber for moving said piston in one direction, valve means for controlling the flow of compression from the other end of the piston chamber, and a valve controlled by the piston for admitting pressure fluid into the said other end of the piston chamber for moving the piston in the opposite direction.

2. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed in the forward end of the piston chamber by the piston for driving the piston rearwardly in the piston chamber, valve means for valving compression from the rearward end of the cylinder and being actuated to a limiting position by such compression, and a valve controlled by the piston for admitting pressure fluid into the rearward end of the piston chamber to drive the piston forwardly on its working stroke.

3. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston in one end of the piston chamber for moving said piston in one direction, valve means for controlling the flow of compression from the other end of the piston chamber, yieldable means for moving the valve means to one limiting position, and a valve controlled by the piston for admitting pressure fluid into the said other end of the piston chamber for driving said piston in the opposite direction and for moving the valve means to another limiting position.

4. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston in the front end of the piston chamber for driving the piston rearwardly, a port in the casing for the escape of compression from the rearward end of the piston chamber, a valve to control the port, yieldable means to hold the valve in position to uncover the port, means for adjusting the force of the yieldable means, and a valve controlled by the piston for admitting pressure fluid into the rearward end of the piston chamber to drive the piston forwardly and to move the first mentioned valve into position to cover the said port.

5. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed in the front end of the piston chamber by the piston for driving the piston rearwardly, valve means for controlling the flow of compression from the rearward end of the piston chamber, a valve for controlling the flow of pressure fluid into the rearward end of the piston chamber to drive the piston forwardly and having opposed actuating surfaces one of which is constantly subjected to pressure fluid for throwing the valve in one direction, a tripper passage leading from the other actuating surface to the piston chamber, and a passage constantly conveying pressure fluid into the tripper passage for throwing the valve in the opposite direction when the piston covers the tripper passage.

6. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston for driving the piston rearwardly, a compression relief valve for controlling the flow of air compressed by the piston from the rearward end of the piston chamber, an admission valve for valving pressure fluid only into the rearward end of the piston chamber to drive the piston forwardly, an actuating surface on the admission valve constantly subjected to pressure fluid for throwing the said valve to admit pressure fluid into the piston chamber, an opposed actuating surface on the admission valve of greater area than the first mentioned actuating surface, a trigger passage leading from the actuating surface of greater area to the forward portion of the piston chamber, and a passage constantly conveying pressure fluid into the tripper passage for throwing the admission valve to cut-off the flow of pressure fluid into the piston chamber when the piston covers the tripper passage.

7. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston for driving the piston rearwardly, a compression relief valve for controlling the flow of compression from the rearward end of the piston chamber during the rearward stroke of the piston, an admission valve for valving pressure fluid only into the rearward end of the piston chamber to drive the piston forwardly, opposed differential actuating surfaces on the admission valve the smaller of which is subjected constantly to pressure fluid for throwing the admission valve to admit pressure fluid into the piston chamber, a tripper passage leading from the other actuating surface to the forward portion of the piston chamber and being controlled by the piston, a passage constantly conveying

pressure fluid into the tripper passage for throwing the admission valve to cut-off the flow of pressure fluid into the piston chamber when the piston covers the tripper passage, and a passage in the casing to admit pressure fluid into the tripper passage only during the charging of the rearward end of the piston chamber to augment the pressure of the fluid acting against the said other actuating surface.

8. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber having a pressure surface subjected to the force of an elastic medium compressed by the piston for driving the piston rearwardly, a compression relief valve for controlling the flow of compression from the rearward end of the piston chamber during the rearward stroke of the piston, an admission valve for valving pressure fluid only into the rearward end of the piston chamber to drive the piston forwardly, opposed differential actuating surfaces on the admission valve the smaller of which is subjected constantly to pressure fluid for throwing the admission valve to admit pressure fluid into the piston chamber, a tripper passage leading from the other actuating surface to the forward portion of the piston chamber controlled by the piston, a passage in the casing to constantly convey pressure fluid into the tripper passage for throwing the admission valve to cut-off the flow of pressure into the piston chamber when the piston covers the tripper passage, and a second passage in the casing affording communication between the tripper passage and the rearward portion of the piston chamber to convey pressure fluid into the tripper passage during the charging of the rearward end of the piston chamber and to exhaust fluid from the tripper passage into the piston chamber.

9. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber, a valve for controlling the admission of pressure fluid into the piston chamber, said valve having opposed actuating surfaces and one of which is constantly subjected to pressure fluid for throwing the valve in one direction and for holding the valve in a limiting position, a tripper passage leading from the other actuating surface to the piston chamber and controlled by the piston, a supply passage to constantly convey pressure fluid into the tripper passage, there being a bleeder passage in the casing for the escape of pressure fluid from the tripper passage to maintain a sub-normal pressure in the tripper passage, and means for selectively closing the bleeder passage to entrap pressure fluid in the tripper passage for action against said other actuating surface to throw the valve in the opposite direction.

10. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber, a valve for controlling the admission of pressure fluid into the piston chamber, opposed differential actuating surfaces on the valve, the smaller of said surfaces being constantly subjected to pressure fluid for throwing the valve to a position for admitting pressure fluid from supply into one end of the piston chamber and to hold the valve in such position, a tripper passage leading from the other actuating

surface to the other end of the piston chamber and controlled by the piston, a supply passage to constantly convey pressure fluid into the tripper passage, there being a bleeder passage in the casing for the escape of pressure fluid from the tripper passage to maintain a sub-normal pressure in the tripper passage, and means for selectively closing the bleeder passage to entrap pressure fluid in the tripper passage for action against said other actuating surface to throw the valve in the opposite direction to cut-off the flow of pressure fluid into the said one end of the piston chamber.

11. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber, a valve for controlling the admission of pressure fluid into the piston chamber for actuating the piston, opposed actuating surfaces on the valve one of which is subjected constantly to pressure fluid for throwing the valve in one direction, a tripper passage leading from the other actuating surface to the piston chamber and controlled by the piston, a supply passage to constantly convey pressure fluid into the tripper passage for throwing the valve in the opposite direction, and a passage affording communication between the tripper passage and one end of the piston chamber to effect variations in the pressure in the tripper passage in accordance with the variations in pressure in the said one end of the piston chamber.

12. A pressure fluid actuated rock drill, comprising a casing having a piston chamber and an exhaust port therefor, a reciprocatory piston in the piston chamber, a valve for controlling the admission of pressure fluid into the piston chamber for actuating the piston, opposed differential actuating surfaces on the valve the smaller of which is constantly subjected to pressure fluid for throwing the valve in one direction and for holding the valve in a limiting position, a tripper passage leading from the other actuating surface to the piston chamber and controlled by the piston, a supply passage to convey pressure fluid constantly into the tripper passage for throwing the valve in the opposite direction, and a passage affording communication between the tripper passage and one end of the piston chamber to effect variations in the pressure in the tripper passage in accordance with the variations in pressure in the said one end of the piston chamber.

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