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DISTRIBUTING VALVE FOR ROCK DRILLS

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Fig. 1.

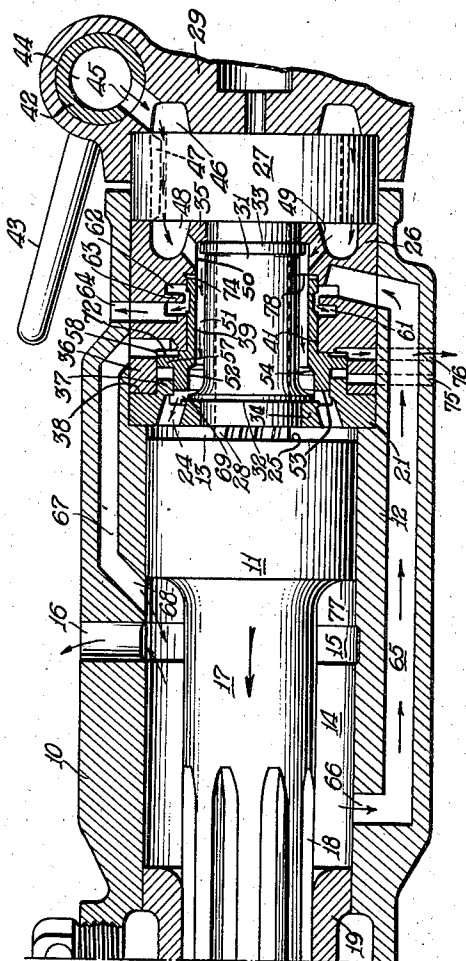


Fig. 3.

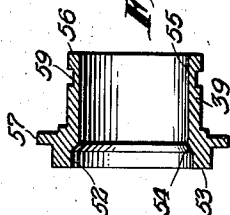
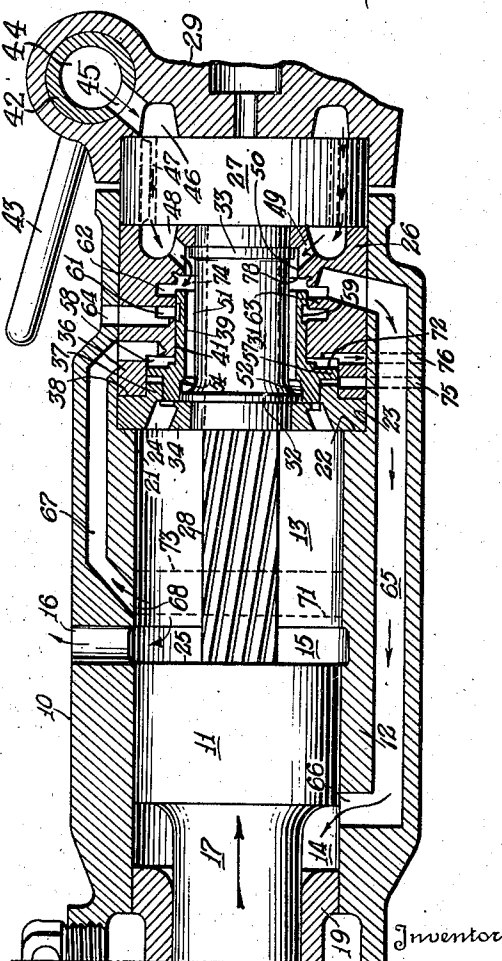


Fig. 2.



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DISTRIBUTING VALVE FOR ROCK DRILLS

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5 Claims. (Cl. 121-26)

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This invention relates to rock drills of the pneumatic percussive type with particular reference to automatically operated distributing valves therefor.

The main object of the invention is to provide a rock drill or other fluid operated tool with a distributing valve which is not only positively and automatically tripped or actuated, but has such a simple and improved streamlined form that the motive fluid can flow past said valve with substantially full power from the fluid source to the hammer piston.

Another object is to arrange the motive fluid passages and ports and especially the latter in as nearly straight lines as possible in order to avoid abrupt or sharp changes in direction being imposed on the flowing motive fluid and thereby largely eliminate power loss during operation.

A further object is to provide a distributing valve of the character indicated with two opposed holding areas which are only slightly different in size and individually effective at certain stages of the operation to constitute active pressure areas for positively tripping or shifting the valve.

It is also an object of the invention to associate one of the mentioned holding areas of the valve with a working space or chamber so proportioned that it can cooperate with the valve in rearward movement of the latter and cause cushioning of the valve by braking the same in its rearward movement.

Other objects and the advantages of the invention will appear more fully in the following description when taken with the accompanying drawing, in which:

Fig. 1 is a fragmentary longitudinal section of the main portion of a rock drill having a distributing valve embodying the invention in practical form, the valve and hammer piston being shown in initial rearward operative positions;

Fig. 2 is a similar view showing the valve and piston in fully operated forward positions at the start of the return stroke of the piston; and

Fig. 3 is a section of the distributing valve of Figs. 1 and 2.

In rock drills and other fluid operated tools of the percussive type it is quite evident that intensity of the blow delivered by the hammer piston or striking element of the tool is in great measure determined by the ease with which the motive fluid flows through the passages controlled by the distributing valve thereof as well as past the latter during the forward working

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stroke of the piston. To this end, the design of the valve itself as well as the arrangement of the ports and passages for the motive fluid should obviously be as free as possible from sharp bends, corners and constrictions, etc., in order to provide a streamlined path for the fluid travelling toward said piston to drive the latter as efficiently as possible.

Referring again to the drawing, in the practice of the invention a rock drill casing, generally indicated at 10 contains a hammer piston 11 reciprocable within a cylinder 12 divided into a rear piston chamber 13 and a front piston chamber 14 by means of an intermediately located annular exhaust groove or channel 15 communicating with atmosphere through a main exhaust opening or port 16. The forward portion or shank 17 of the piston is fluted at 18 and guided in a front cylinder washer 19 which forms a fixed part of the casing 10. The washer also provides a closure for the front end of forward cylinder chamber 14, while the rear end of the cylinder chamber 13 is closed by a valve cap 21 seated against a shoulder 22 in a counterbore 23 in the casing. Valve cap 21 is provided with a plurality of fluid inlet passages or ports 24, 24 for supplying motive fluid directly against the rear end or face 25 of piston 11, as will presently be explained. Located rearwardly of said valve cap in the same counterbore 23 is a valve block 26, beyond which is located a ratchet ring 27 of conventional type surrounding a plurality of pawls (not shown) carried by a ratchet bar 28 associated with the hammer piston to rotate the latter. A back head 29 completes the end closure of casing 10 and confines the ratchet ring 27 in place between the back head and the casing, said back head being secured to the latter by the usual through bolts (not shown).

Within the valve cap 21 and valve block 26 is mounted the fixed bushing 31 virtually suspended by the ends thereof, with one end secured in the valve cap and the other end secured in the rear portion of the valve block. The bushing has a pair of separate locating flanges 32, 33 respectively engaging against inwardly extending flanges 34 and 35 of said valve cap and valve block serving to retain the bushing in place. The forward end 36 of the valve block is fitted upon the rearward projection 37 of the valve cap against shoulder 38 thereof, with the result that said valve cap 21, valve block 26, and bushing 31 together form a valve casing or chest for a hollow reciprocable distributing valve 39 surrounding the fixed bushing 31 generally without

contact therewith and mounted for longitudinal sliding movement within said valve cap in counterbore 41 in the valve block.

In order to supply motive fluid to the distributing valve, the throttle valve 42 is rotatably mounted in back head 29 and controlled by hand lever 43, while the interior chamber 44 thereof is connected to a continuous supply of motive fluid under pressure (not shown). When the throttle valve is open, as illustrated, the path of the motive fluid leads through passage 45 to chamber or reservoir 46 in the back head and thence through passages 47 within the ratchet ring 27 to fluid reservoir 48 in valve block 26. From this reservoir the fluid path leads onward through several inlet ports 49 and a central bore 50 in block 26 to the annular passage 51 about bushing 31 and within the hollow valve 39. Bushing 31 extends throughout the interior of the distributing valve and the position of the latter valve with respect to the bushing determines the further course of the fluid during operation.

The distributing valve 39 has a counterbore or increased internal diameter 52 within the forward end 53 virtually forming a clearance portion which terminates rearwardly in an inclined portion or shoulder 54, while the remaining internal diameter or bore 55 is substantially uniform from said shoulder to the rear end 56 but exteriorly the valve has a radially projecting flange 57 near the forward end located in a valve flange chamber 58. Upon its rearward portion and spaced a short distance from the rear end portion 56 thereof the valve is exteriorly grooved to form a neck 59 adapted to cooperate in a manner shortly to be explained with a pair of annular grooves 61 and 62 spaced apart in block 26 by a partition 63. The first groove 61 serves as an exhaust groove vented directly to atmosphere through auxiliary exhaust port 64 while the other groove 62 is connected to piston return passage 65 which opens into the front piston chamber 14 through port 66. In somewhat similar fashion to the latter, the valve flange chamber 58 communicates with a valve operating fluid passage 67 opening into the rear piston chamber 13 through port 68 just rearwardly of the exhaust groove 61 and main exhaust port 66.

The distributing valve just described and the hammer piston are the only moving parts in the apparatus driven by the motive fluid which is preferably compressed air, and the operation is entirely automatic as will now be noted in detail. Assuming that pressure fluid from a given source is supplied to the chamber 44 of throttle valve 42, and with the hammer piston 11 as well as the distributing valve 39 occupying their initial rearward positions shown in Fig. 1, the motive fluid travels through ports 45 to rear chamber or reservoir 46, as already indicated, and through ratchet passage 47 into reservoir 48 and thence through inlet ports 49 and bore 50 into annular passage 51 between the distributing valve and bushing 31, past inclined shoulder portion 54 in said valve and over the shoulder formed by retaining flange 32 into annular distributing chamber 59 and thence through rear inlet ports 24 into the rear piston chamber 13 where the motive fluid exerts its force against the rear end 25 of piston 11, immediately driving the latter forward toward the position shown in Fig. 2. The valve is held in its rearward position by the pressure of live motive fluid against the front end 53 of the valve, which is aided by the pressure

on internal shoulder 54 but opposed by the pressure on the rear end 56.

As the piston is driven forward, the residual fluid in its path in front piston chamber 14 is partly exhausted through groove 15 and exhaust port 16 which, however, are shortly covered by the advancing piston, despite the importance of clearing out all fluid from before said piston so that the forward driving stroke of the latter may occur with maximum force. As the main exhaust groove and port are no longer useful to exhaust the front chamber directly during the further forward travel of the piston, the auxiliary exhaust port 66 with associated passage 65 then serve to exhaust said front chamber by leading off the fluid therefrom to groove 62, from which the fluid proceeds past the inner periphery of partition 63 along neck 59 on the distributing valve to annular groove 61 and then out to atmosphere through port 64 so long as the valve remains in the initial rear position of Fig. 1.

However, during the forward travel of the hammer piston, and approximately at the position indicated by broken line 71 (Fig. 2), the piston uncovers port 68 in the upper cylinder wall, allowing pressure fluid from rear piston chamber 13 suddenly to rush through passage 67 to annular flange chamber 58 and immediately exert pressure on the rear surface 72 of the valve flange 57 and tend to overcome the active fluid pressure on the front end 53 of the valve and shift the latter forward into the position shown in Fig. 2. It is, of course, understood that the stroke of the hammer piston is very swift, so that the portion of the movement thereof occurring from the point indicated by broken line 73 forward while uncovering port 68 just described is substantially instantaneous. Shortly thereafter, when the valve has been shifted forward so as to cut off the flow of motive fluid to the rear piston chamber the rear end 25 of the piston has attained the final operating position in the forward direction and has also uncovered the annular exhaust groove 15 to the rear piston chamber for release of the more or less spent fluid therein through exhaust port 16.

Associated with the valve flange 57 is the usual exhaust port or breather 75, venting the front face of the flange to facilitate forward tripping of the valve; also the usual bleeding passage 76 which gradually relieves the pressure on the rear face of the flange to permit the valve to return.

When distributing valve 39 has tripped from the rear position, it is held in the forward position by the fluid pressure on its rear face 56 resulting from the flow of motive fluid into chamber 74 and groove 62. The rear face or end 56 of the valve is designed to have an effective area slightly in excess of that of internal inclined shoulder 54, so that a state of unbalance exists which causes the valve to be held in its attained forward position.

In the attained forward position of the valve 39 (Fig. 2) the end 53 thereof overlies flange 32 on bushing 31 in sufficiently close contact with the periphery thereof to cut off the motive fluid supply to the rear piston chamber 13 and instead allow active motive fluid to enter front piston chamber 14, as the rear end 56 of the valve then allows direct communication between annular groove 62 and chamber 74 which is in constant communication with the pressure fluid entering through passages 49 and 51. During the travel of the motive fluid in the forward direction into

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passage 65 and thence into front piston chamber 14 through port 66 said fluid exerts its force on the forward end 77 of the hammer piston and drives the latter rearwardly toward initial position.

During the return stroke the piston covers port 68 while beginning to compress the fluid in rear piston chamber 13. After the piston has returned to a predetermined position short of the fully returned initial position the fluid pressure due to piston compression rises to a sufficient height to act through ports 24 against the forward end 53 of valve 39 and overcome motive fluid pressure pressing on rear end 56 of the valve and thereby effect rearward tripping or shifting of the latter to the initial rearward position of Fig. 1. Both the piston and valve are now again in initial rear positions ready for a new cycle of operation, and such operation continues indefinitely and automatically as long as valve 42 remains open and motive fluid is supplied thereto.

Because of the high velocity of the valve on its rearward stroke, a packing or pumping effect is produced by face 56 of valve driving into space 74. This causes a building up of pressure on face 56 in inverse ratio to volume of space 74. Because this feature lends itself as a highly effective control of the valve movement and a consequent improvement in energy output of tool, it is imperative that dimensions of space 74 be held to fairly close limits.

What is claimed is:

1. A fluid pressure actuated percussive tool comprising a cylinder, a piston mounted for reciprocation therein, a valve chest positioned adjacent the rear end of the cylinder, an annular distributing valve mounted in said chest for axial reciprocation, a bushing co-axially disposed within the valve and spaced therefrom to provide an annular passageway therebetween, a flange upon the bushing, means for delivering motive fluid constantly to the rear end of the annular passageway, a rear cylinder port or ports connecting the front end of the annular passageway with the rear end of the cylinder and adapted to be uncovered by the valve during rearward movement, a front cylinder passage connecting the rear end of the valve passageway with the front end of the cylinder and arranged to be uncovered upon forward movement of the valve, the front extremity of the valve being intermittently exposed to fluid compressed by the piston to move the valve rearward and then being exposed to live motive fluid to hold the valve in rearward position, the rear extremity of the valve being constantly exposed to live air tending to shift or hold the valve forward, characterized in that the valve has a single counterbore adjoining its forward face to provide a sliding fit for the valve upon the bushing flange to control communication past the front extremity of the valve, said counterbore being disposed in reference to the valve bore to form a shoulder exposed to live fluid pressure constantly opposing the pressure on the rear extremity, whereby to reduce the effectiveness of the latter, the counterbore being of uniform diameter from the shoulder to the front extremity of the valve.

2. A fluid pressure actuated percussive tool comprising a cylinder, a piston mounted for reciprocation therein, a valve chest positioned adjacent the rear end of the cylinder, an annular distributing valve mounted in said chest for axial reciprocation, a bushing co-axially disposed with-

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in the valve and spaced therefrom to provide an annular passageway therebetween, means for delivering motive fluid constantly to the rear end of the annular passageway, a rear cylinder port or ports connecting the front end of the annular passageway with the rear end of the cylinder and adapted to be uncovered by the valve during the rearward movement, a front cylinder passage connecting the rear end of the valve passageway with the front end of the cylinder and arranged to be uncovered upon forward movement of the valve, the front extremity of the valve being intermittently exposed to fluid compressed by the piston to move the valve rearward and then being exposed to live motive fluid to hold the valve in rearward position, the rear extremity of the valve being constantly exposed to live air tending to shift or hold the valve forward, characterized in that the front portion of the valve is counterbored to provide a shoulder exposed to live fluid pressure constantly opposing the pressure on the rear extremity, whereby to reduce the effectiveness of the latter, the effective area of said shoulder being less than the opposing area on the rear extremity of the valve, the counterbored portion of the valve extending from the shoulder to the front extremity of the valve.

3. A fluid pressure actuated percussive tool according to claim 1 in which the shoulder is inclined or tapered in a rearward direction from the counterbored portion of the valve.

4. A fluid pressure actuated percussive tool according to claim 1 in which the valve chest is recessed to receive the rear end of the valve and cushion the rear stroke thereof.

5. A pneumatic percussive tool comprising a cylinder, a piston mounted for reciprocation therein, a valve chest at the rear end of the cylinder, said chest having a central bore adapted to be constantly supplied with live air and having a counterbore extending forwardly from said bore, an annular distributing valve mounted in said counterbore for axial reciprocation, a bushing coaxially disposed within the valve and spaced therefrom to provide an annular passageway therebetween, a flange on the bushing near the front end of the valve, a port or ports arranged to connect the front end of the annular passageway with the rear end of the cylinder to supply live air thereto in the rear position of the valve, the interior surface of the valve comprising a forwardly facing shoulder, a cylindrical bore of uniform diameter extending from the shoulder to the rear extremity of the valve and a cylindrical counterbore of uniform diameter extending from the shoulder to the front extremity of the valve, the diameter of said valve bore being approximately equal to the diameter of said valve chest bore, the counterbore being of such diameter as to fit over the bushing flange and thus periodically cut off the flow of live air through said port or ports.

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