Oct. 27, 1936. F. B. DOYLE 2,058,425

FLUID OPERATED TOOL

Filed July 11, 1935 2 Sheets-Sheet 1

Fig. 1.

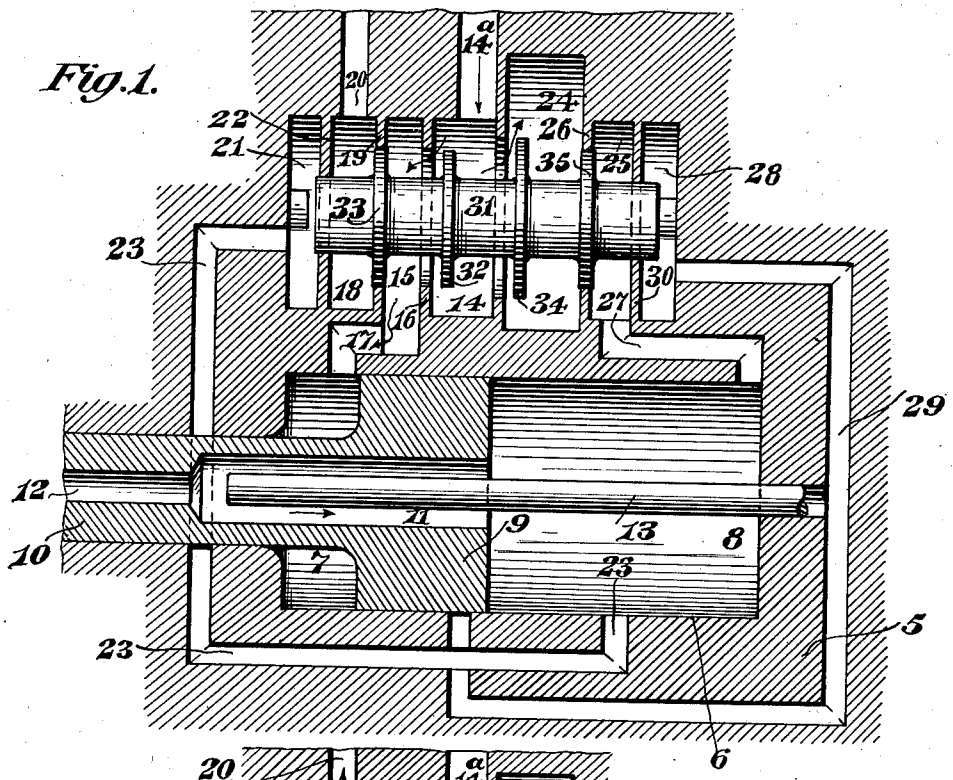
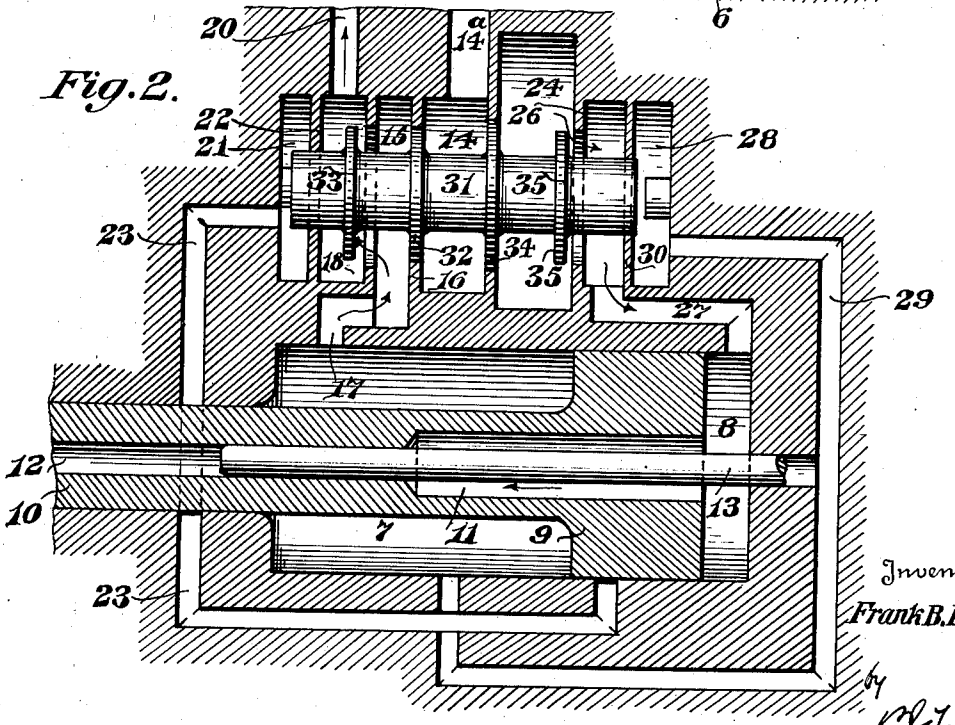


Fig. 2.



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Fig. 3.

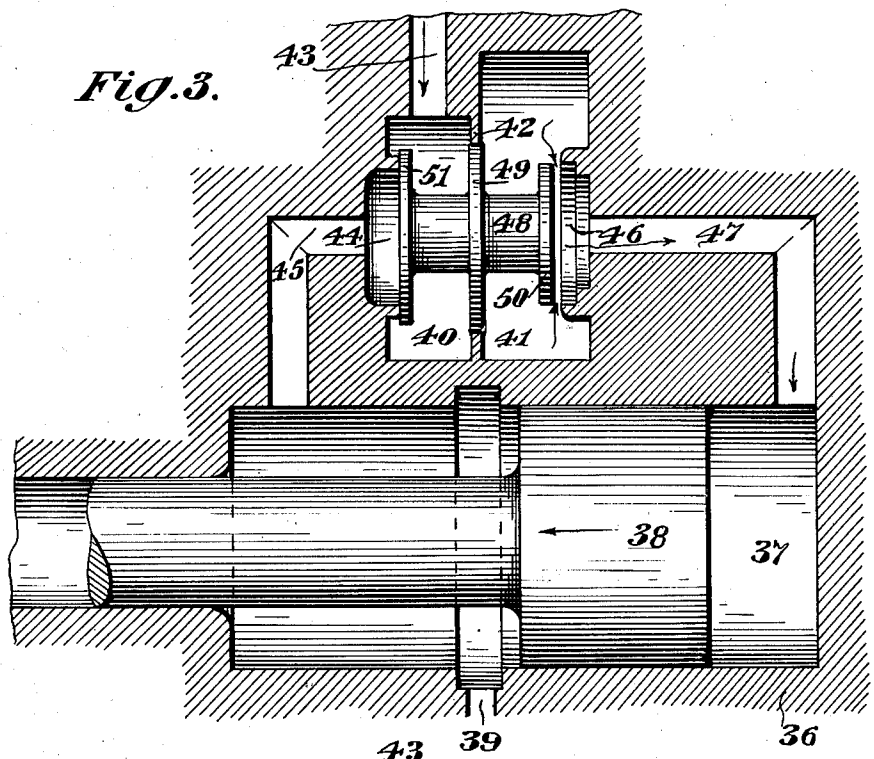
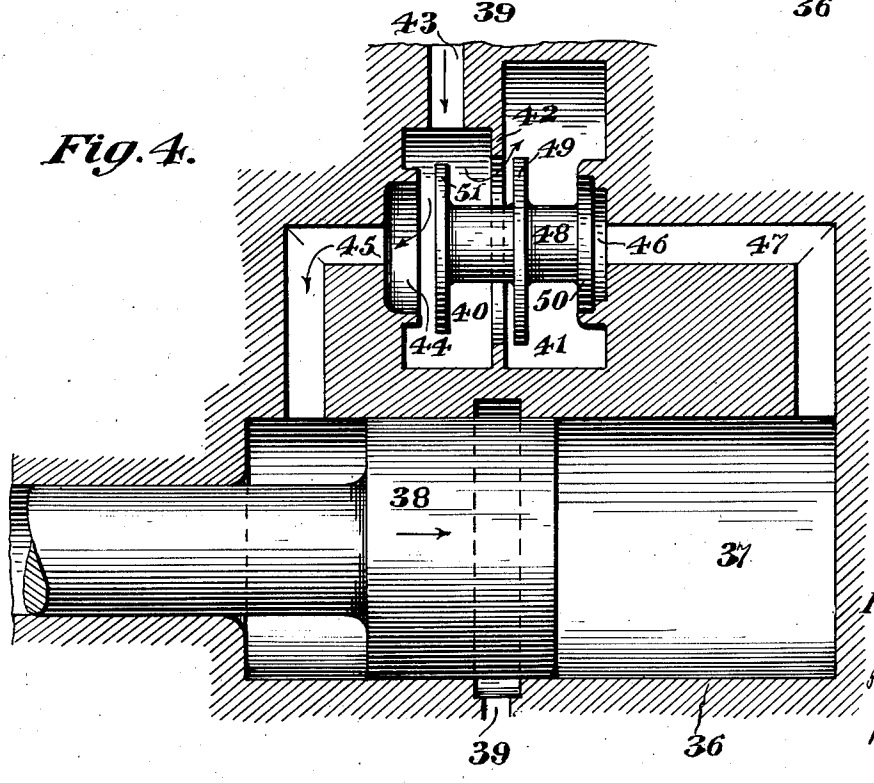


Fig. 4.



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Patented Oct. 27, 1936

2,058,425

UNITED STATES PATENT OFFICE

2,058,425

FLUID OPERATED TOOL

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Application July 11, 1935, Serial No. 30,920

8 Claims. (Cl. 121—16)

In the commonly employed form of pneumatic tools, and particularly rock drills of the hammer piston type, the relation of the clearance volume to the piston displacement of the rear portion of the cylinder is such that the compression pressure exceeds that of the supply pressure, commonly employed in practice, before the piston has reached the end of its backward travel, excepting those machines which are provided with a compression relief valve. It is also common practice to open the admission valve to the piston chamber in rear of the piston before the piston has completed it backward travel. Thus the piston is permitted to push a portion of the operating fluid, which was trapped in rear of the same after the exhaust port was closed, out through the admission valve into the supply line.

It is the general practice to restrict either the admission valve opening or the port leading to the front end of the piston chamber, or both, to such an extent that the pressure obtained in the front of the piston cylinder is appreciably lower than line pressure. This restriction has been the means designers of rock drills have employed for obtaining low air consumption and preventing the piston from striking the back head on its rearward travel.

Now if the admission valve port and passageway leading to the rear end of the piston chamber is eliminated the compression pressure of the piston on its rearward stroke will rise to such a degree as to stop the backward motion of the piston without danger of striking the back head, even though the admission valve and ports leading to the front cylinder are of sufficient size to establish approximately full line pressure in the front of the piston chamber during the major portion of the rearward travel of the piston. As a consequence by increasing the work done in the front portion of the piston chamber it is possible to compensate for the elimination of any work due to live pressure that may have been done in the rear end of the piston chamber, and thus save substantially all of the motive fluid usually supplied to the rear end of the piston chamber.

Inasmuch as in a conventional rock drill the operating fluid is divided between the front and rear ends of the piston chamber substantially in the ratio of 1 to 3 if the actuating fluid supplied to the front end of the piston chamber is doubled and that supplied to the rear end of the piston chamber is eliminated, then 50 percent of the motive fluid is saved.

In these tools, however, there is a certain amount of leakage of the motive fluid from the rear end of the piston chamber during each operating stroke, and with rock drills a portion of the actuating fluid at the rear of the piston is often employed for drill hole cleaning purposes.

The object of the present invention then is to provide a fluid operated tool, preferably of the hammer type, and in a specific sense a rock drill, in which the fluid compressed on the rearward stroke is held against escape into the supply line, and constitutes the operating medium for the power stroke, and in connection therewith to provide a means for intermittently supplying additional fluid under pressure from the main motive fluid supply to offset that lost by leakage or used for other purposes, as in hole cleaning. This latter feature incidentally is possible of use whether employed in connection with the rear end of the piston chamber or in an equipment where compression may be utilized for return strokes. Moreover this auxiliary supply also acts as motive fluid.

In the accompanying drawings:

Figure 1 is a diagrammatic view of one embodiment of the invention showing the piston during its return stroke.

Figure 2 is a similar view but illustrating the relation of the parts during the power stroke of the piston.

Figure 3 is a schematic view of a modified form of construction with the piston on its power stroke.

Figure 4 is a similar view of the structure shown in Figure 3 with the piston moving on its rearward or return stroke.

Referring first to the embodiment disclosed in Figures 1 and 2, a cylinder member is shown generally at **5**, and has a piston chamber **6**, with the front end designated **7** and the rear end designated **8**. In this piston chamber is a reciprocatory piston head **9** having the usual extension **10**. This structure being for rock drilling, is provided with a longitudinal rearwardly opening chamber **11** communicating with a port **12** that is in communication with the drill steel for the usual hole cleaning purposes in a manner well understood by those skilled in the art. A controlling valve in the form of a rod **13** extends into the chamber **11** and is adapted to substantially fit in the passageway **12** when the piston moves rearwardly so as to close the same.

An automatic valve chamber is also provided having a central live fluid supply chamber **14** which is in communication through a port **14a** with any suitable source of supply of fluid under pressure. At one side of this chamber **14** is an annular distributing channel **15** separated therefrom by a wall **16** and in communication with a passageway or supply port **17** leading to the front end **7** of the piston chamber. Beyond the channel **15** is a second channel **18** separated therefrom by a wall **19** and having an exhaust port **20** leading therefrom. The adjacent end of the valve chamber is in the form of a kicker pocket **21** separated from the channel **18** by an annular wall **22**. A kicker passageway **23** leads from the rear end portion **8** of the piston chamber to said pock-

et 21. On the opposite side of the supply chamber 14 to the channel 15 is a reservoir chamber 24 somewhat larger than the various channels already described and suitably proportioned according to the work that is to be done. Beyond this reservoir chamber 24 is an annular channel 25 separated therefrom by a wall 26. This channel 25 has a passageway or port 27 leading to the rear end of the piston chamber. Beyond the channel 25 is a kicker pocket 28 in communication with the front portion 7 of the piston chamber by a kicker port or passageway 29. A wall 30 separates this pocket from the channel 25.

In the valve chamber is an automatic reciprocatory valve 31 having its ends slidable respectively, in the walls 22 and 30, and thus operating in the kicker pockets 21 and 28. The valve has an annular flange 32 that is movable into and out of the opening in the wall 16, so as to close the communication between the supply chamber 14 and the channel 15 with which the supply port 17 communicates. Another annular flange 33 on the valve correspondingly controls communication between the groove 15 and the exhaust channel 18. A third annular flange 34 on the valve controls the communication between the supply chamber 14 and the reservoir chamber 24, and a fourth flange 35 on said valve controls communication between the reservoir chamber 24 and the channel 25 having the port 27 in communication with the rear end of the piston chamber.

It will be noted by reference to Figure 1 that when the exhaust channel 18 is cut off from the distributing channel 15, said distributing channel is in communication with the main supply chamber 14, and simultaneously said supply chamber is in communication with the reservoir chamber 24, while said reservoir chamber is cut off from communication with the channel 25 and consequently with the rear end of the piston chamber. On the other hand by reference to Figure 2 it will be noted that when the exhaust channel 18 is in communication with the distributing channel 15 and consequently with the front end of the piston chamber, the supply chamber 14 is out of communication with said distributing chamber 15 and with the reservoir chamber 24, while the reservoir chamber is now in communication with the rear end of the piston chamber through the opening in the wall 26, being uncovered by the flange 35.

Briefly described the operation of the mechanism is as follows:

Motive fluid, as air under pressure, is constantly in the chamber 14 and with the valve in the position shown in Figure 1, this motive fluid finds access to the front end of the piston chamber 7 through the distributing channel 15 and port 17, thereby driving the piston rearwardly. This movement of the piston causes compression in the rear end 8 of the piston chamber to a degree above that of the live fluid supply, it being understood that the port 17 is of sufficient capacity to admit full pressure to the front end 7 of the piston chamber. This fluid under high pressure is substantially held in the rear end 8 of the piston chamber, except for such amount as flows through the port 27 into the channel 25. As the channel 25 is now cut off from the reservoir chamber 24 and the main line supply 14*a*, a relatively high pressure is created. When the kicker port 29 is uncovered by the front end of the piston, live motive fluid pressure will be admitted to the pocket 28, and the area of the end of the automatic valve 31 in said pocket plus the area under pressure of the flange 33 will be sufficient to overcome the opposite pressure against the flange 35 and move the valve to the left or to the position shown in Figure 2. When this movement takes place the supply to the front end of the piston chamber in advance of the piston is cut off and the exhaust is open so that the piston is now driven forwardly by the highly compressed fluid behind it to effect its working stroke. As soon as the pressure in the rear end 8 of the piston chamber falls below line pressure the reservoir chamber 24 though cut off from the main supply 14*a*, will furnish an additional supply of fluid into the rear portion of the piston chamber, this auxiliary supply being sufficient to take care of leakage, or as in the present disclosure, to supply sufficient fluid through the passageway 11—12 of the piston to the drill steel for hole cleaning purposes, while leaving a sufficient amount behind the piston for action on the next compression stroke. It will also be noted that when the auxiliary reservoir chamber 24 is in communication with the rear end of the piston chamber, its communication with the main supply is closed so that there can be no loss of pressure back into the supply line.

A slightly modified form of construction is shown in Figures 3 and 4, wherein the cylinder member is designated 36, having a piston chamber 37, in which is a reciprocatory piston 38. This piston chamber has a direct exhaust 39 to atmosphere, which is controlled by the piston on its reciprocation. In this embodiment a valve chamber is provided with a motive fluid supply chamber 40, and alongside the same is the fluid reservoir 41 separated therefrom by an annular wall 42. Motive fluid from the usual line is supplied to the chamber 40 through the port 43. At the front end of the supply chamber 40 is a distributing pocket 44 from which leads a passageway or port 45 communicating with the front end of the piston chamber. At the rear end of the reservoir chamber 41, is a pocket 46 with which communicates a passageway or port 47 leading to the rear end of the piston chamber. A reciprocatory automatic valve 48 is provided having a central annular flange 49 that is movable into and out of the opening in the wall 42 to control communication between the supply chamber 40 and the reservoir chamber 41. The end of the valve is enlarged, as shown at 50, and is adapted to enter the pocket 46 when the flange 49 is in a position to uncover or open communication between the supply chamber 40 and the reservoir chamber 41. The opposite end of the valve is enlarged as shown at 51 and moves to and from a position to close communication between the supply chamber 40 and the distributing pocket 44.

It will be noted that the operation of this mechanism is substantially the same as in the first described embodiment of the invention. When the valve is in the position shown in Figure 4 communication between the reservoir chamber 41 and the rear end of the piston chamber 37 is closed, but the fluid supply chamber 40 is now simultaneously in communication with the reservoir chamber 41 and with the front end of the piston chamber. The consequence is that pressure in the reservoir chamber builds up to line pressure, while live motive fluid flows into the front of the piston chamber and drives the piston 38 rearwardly. When compression of the fluid behind the piston increases sufficiently, the end 50 of the valve is unseated and the valve moves

to the left, thereby closing communication between the supply chamber 40 and the reservoir chamber 41 and also communication between the supply chamber 40 and the front end of the piston chamber. The exhaust port being now uncovered, the fluid will exhaust from in front of the piston and the compression will drive the piston forwardly on its working stroke, an additional supply of fluid being now admitted from the reservoir chamber to take care of leakage. This forward movement continues until the exhaust port 39 being closed, pressure builds up in advance of the piston sufficient to shift the valve to the right or to the position shown in Figure 4, whereupon a new cycle of action begins.

From the foregoing, it is thought that the construction, operation and many advantages of the herein described invention will be apparent to those skilled in the art without further description, and it will be understood that various changes in the size, shape, proportion and minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

What I claim, is:

1. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston operating therein, of means for constantly supplying actuating fluid to the tool, passageways respectively leading from the constant supply to the piston chamber at opposite sides of the piston, and means for controlling the passage of fluid to the respective passageways and operating to open both passageways to the simultaneous entrance of fluid thereto and at the same time cutting off access of the fluid through one of said passageways to the piston chamber, said means further operating to periodically open said latter passageway to the piston chamber.

2. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston operating therein, of a valve chamber, and passageways leading from the valve chamber to the piston chamber at opposite sides of the piston, means for supplying actuating fluid to the valve chamber, and a valve in the valve chamber controlling the passage of fluid to the piston chamber and operating to admit fluid to both passageways and prevent its passage entirely through one to the piston chamber, said means further operating to open the latter passageway to admit the fluid to the piston chamber.

3. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston operating therein, of a valve chamber and passageways leading from the valve chamber to the piston chamber at opposite sides of the piston, means for supplying actuating fluid to the valve chamber, and an automatic valve in the valve chamber acting to intermittently admit fluid to a portion of one of the passageways, and simultaneously prevent its passage through said passageway to the piston chamber and later admit such fluid through the passageway to the piston chamber.

4. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston operating therein, of a valve chamber and passageways leading from the valve chamber to the piston chamber at opposite sides of the piston, means for supplying actuating fluid to the valve chamber, and an automatic valve in the valve chamber acting to intermittently admit fluid to a portion of one of the passageways and simultaneously prevent its passage through said passageway to the piston chamber, and thereafter closing said portion of the passageway to the admission of fluid and opening it to permit the first admitted fluid to flow to the piston chamber.

5. In a fluid operated tool, the combination with a cylinder member having a piston chamber, a piston in the chamber, a valve chamber, means for supplying motive fluid to the valve chamber, a reservoir chamber having communication with the valve chamber, a passageway leading to the piston chamber at one side of the piston, and a direct supply passageway leading from the valve chamber to the piston chamber at the opposite side of the piston, of an automatic valve in the valve chamber having means for simultaneously opening the communication between the fluid supply and the chamber and closing the passageway leading from the reservoir chamber to the piston chamber and vice versa, and opening the direct supply passageway when the communication is open between the supply and the reservoir chamber and the passageway from the reservoir chamber is closed.

6. In a fluid operated tool, the combination with a cylinder member having a piston chamber, a piston in the chamber, a valve chamber, means for supplying motive fluid to the valve chamber, a reservoir chamber having communication with the valve chamber, a passageway leading to the rear end of the piston chamber, and a supply passageway leading from the valve chamber to the front end of the piston chamber, of an automatic valve in the valve chamber having means for simultaneously opening the communication between the fluid supply and the chamber and closing the rear passageway and alternately opening the rear passageway and closing said communication with the chamber, said valve having means for opening the first passageway when communication between the fluid supply and reservoir chamber is open and for closing the first passageway when the passageway from the reservoir chamber to the piston chamber is open.

7. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston therein, of means for alternately supplying motive fluid under pressure to and exhausting it from the piston chamber at one side of the piston to cause the repeated movements of said piston in one direction, means for holding the fluid behind the piston on such movements to cause its compression and returning the piston when the said exhausts take place, and means for intermittently admitting an auxiliary supply of motive fluid under pressure to the piston chamber at the side of the piston where the fluid is compressed.

8. In a fluid operated tool, the combination with a cylinder member having a piston chamber and a piston therein, of an automatic valve for controlling the supply of motive fluid under pressure to the piston chamber at one side of the piston to cause the repeated movements of said piston in one direction, means for holding the fluid behind the piston on such movements to cause its compression and returning the piston when the said exhausts take place, and means controlled by said automatic valve for intermittently admitting an auxiliary supply of motive fluid under pressure to the piston chamber at the side of the piston where the fluid is compressed.

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