Aug. 16, 1927. 1,639,313

E. H. SHAFF

FLUID PRESSURE OPERATED TOOL

Filed April 5, 1920 2 Sheets-Sheet 1

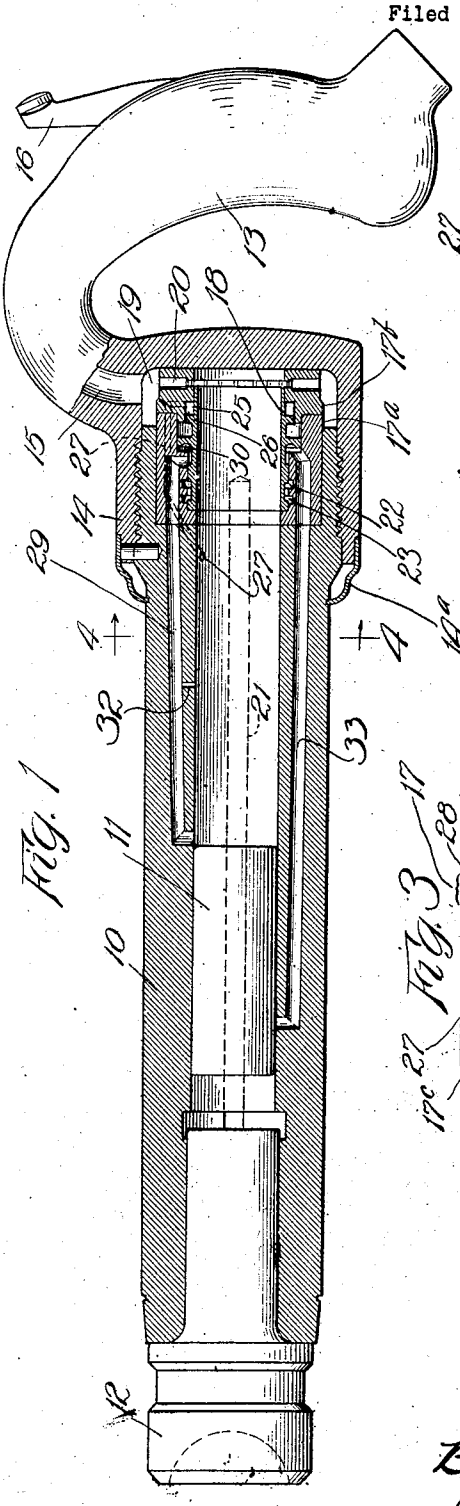

Fig. 1

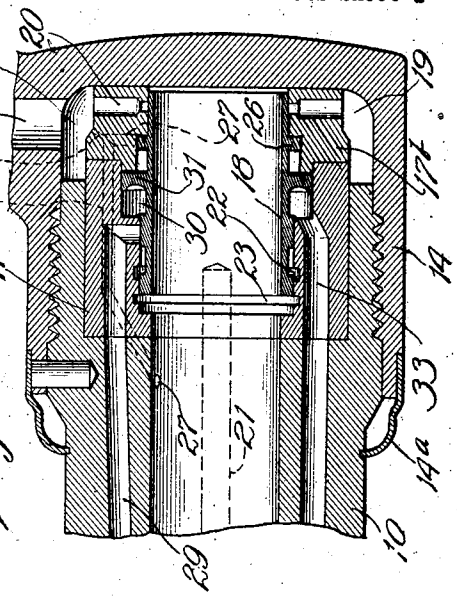

Fig. 2

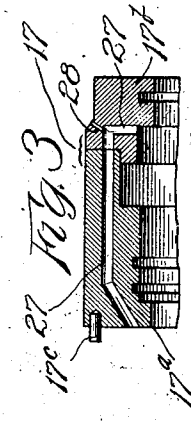

Fig. 3

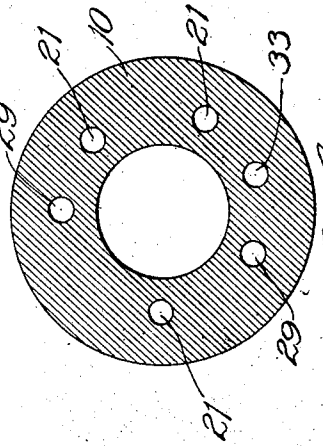

Fig. 4

Inventor
Ernest H. Shaff
By Miller Chindahl & Parker
Attys

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E. H. SHAFF

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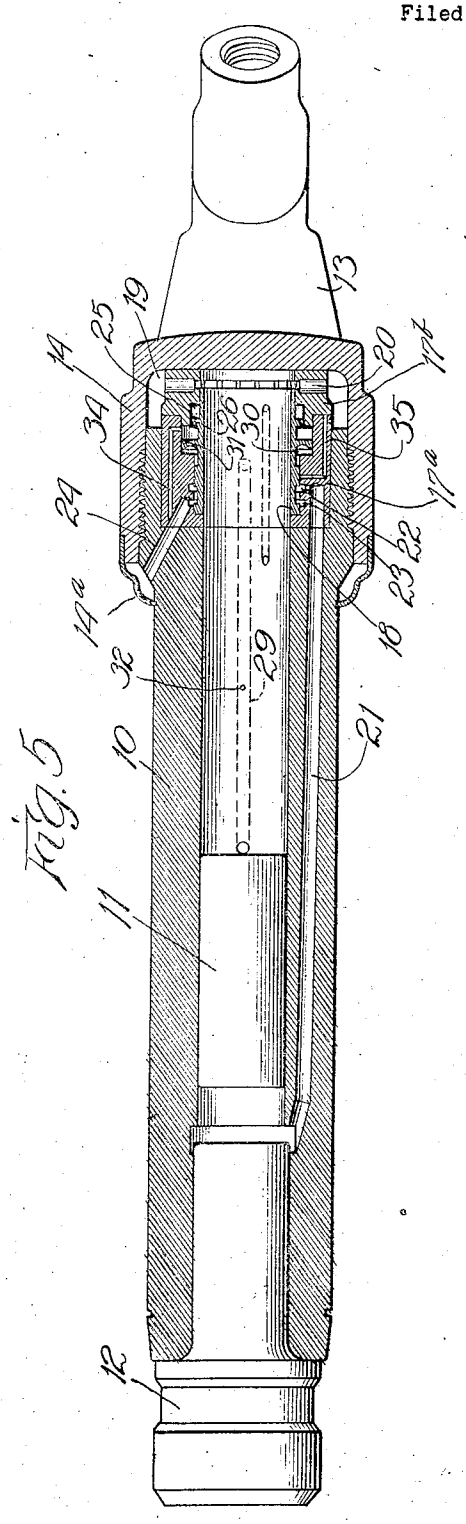

Fig. 5

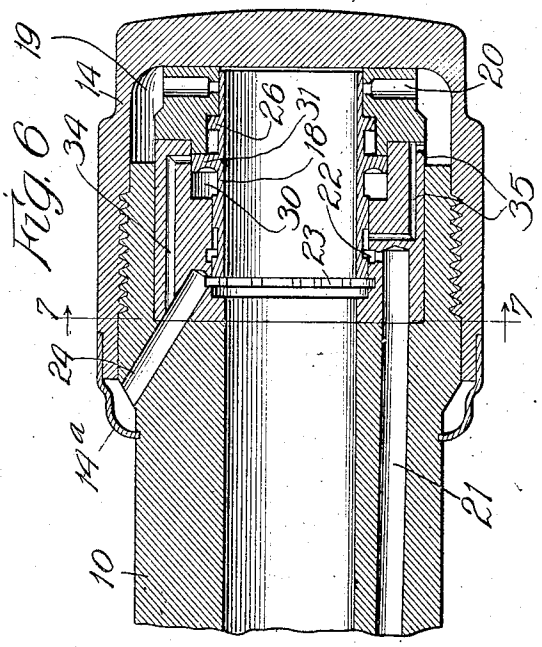

Fig. 6

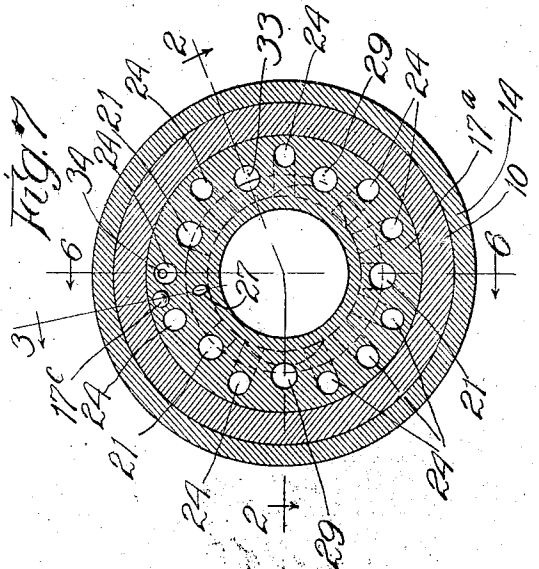

Fig. 7

Inventor
Ernest H. Shaff
By Miller Chisdall & Parker
Attys

Patented Aug. 16, 1927. 1,639,313

UNITED STATES PATENT OFFICE.

ERNEST H. SHAFF, OF GRAND HAVEN, MICHIGAN, ASSIGNOR TO WILLIAM H. KELLER, INC., OF GRAND HAVEN, MICHIGAN, A CORPORATION OF MICHIGAN.

FLUID-PRESSURE-OPERATED TOOL.

Application filed April 5, 1920. Serial No. 371,445.

This invention relates generally to fluid-pressure-actuated tools and refers more particularly to percussion tools commonly known as pneumatic hammers. In tools of this type as heretofore manufactured, the return stroke or up stroke of the piston has been cushioned by a body of dead air which is trapped in the rear or upper end of the piston chamber behind or above the live air inlet through which air is introduced into the piston chamber to drive the piston on its working stroke. The air in this cushion chamber performs no function except to cushion the piston and start it back on its forward or working stroke and inasmuch as new live air must be supplied to fill this chamber at each stroke, there may be said to be a certain amount of air wasted for cushioning purposes only. Furthermore, the cushion chamber adds to the length of the hammer for a given length of piston stroke.

It is one of the objects of my invention to eliminate such a special cushioning chamber and to provide a construction whereby the piston will be cushioned upon live air admitted at the extreme rear or upper end of the piston chamber. To this end I aim to provide a structure in which the main valve will be moved forwardly in a prompt and positive manner during the return stroke of the piston so as to insure the opening of the live air inlet at the rear end of the piston chamber at the proper time to provide a body of live air against which the piston strikes at the rear end of its stroke. In addition to eliminating the special space of the prior tools for cushioning purposes my construction has the important advantage that the body of air which cushions the piston is immediately active to start the piston on its working stroke, being supplemented as the piston moves forwardly by an increasing amount of live air through the inlet so that the impetus on the piston tending to move it on its working stroke is immediate and continuous. This differs from prior tools in that in the latter the first impetus to the piston on its working stroke is that given by the elasticity of the trapped air in the special cushioning chamber, while the real force or power for driving the piston is not exerted thereon until the piston has moved forwardly a sufficient distance to uncover the live air inlet.

Another object of the invention is to provide an improved construction which will insure a more prompt, rapid and positive shifting of the valve member than has been possible with tools heretofore known, and in which this desired action of the valve will be independent of whether the valve member fits quite tightly or rather loosely in its casing. This object is accomplished by so constructing the valve mechanism and the ports and passages in connection therewith that the effective working pressure tending to move the valve toward the desired position and hold it there will be quite high. By effective working pressure is meant the difference between the opposing pressures on the valve member acting upon the respective areas of the working faces of said member. The lower the opposing force, the greater is the corresponding effect of the moving and holding force. It is one of the aims of my invention to minimize the force opposing the movement of the valve in either direction and the maintenance of the valve in either position, so that the effective moving and holding force is greatly increased.

Another general object of the invention is to produce a tool which is simpler in construction, more efficient in operation and more durable than tools of this character now known.

A further object is to produce an improved tool which will deliver heavier and faster blows than tools now known. This object is accomplished by so constructing the tool that the force of the live motive fluid upon the piston in the forward movement thereof will follow the piston through a greater portion of its stroke than in prior tools, and so that the control valve will be shifted more promptly even with the increased time of maintenance of full working pressure on the piston.

While my invention is susceptible of embodiment in tools of many different constructions I have shown in the drawings and will herein describe in detail one particular embodiment of the invention which I prefer to use, but I would have it understood that I

do not thereby intend to limit the invention in any way to the present particular disclosure but aim to cover in the appended claims any modifications or equivalents falling within the scope of the invention.

In the accompanying drawings Figure 1 is a longitudinal central sectional view through a pneumatic hammer embodying the features of my invention.

Fig. 2 is a fragmentary sectional view on an enlarged scale, similar in all respects to Fig. 1 except that the valve is shown in another position.

Fig. 3 is a fragmentary sectional view of the valve casing taken in the plane of line 3 of Fig. 7, showing the venting port 27.

Fig. 4 is a transverse section on line 4—4 of Fig. 1.

Fig. 5 is a view similar to Fig. 1 but taken in a different axial plane through the tool.

Fig. 6 is an enlarged view similar to Fig. 5 but showing the valve in a different position.

Fig. 7 is a transverse section taken in the plane of line 7—7 of Fig. 6. The axial plane on which Figs. 1 and 2 are taken is designated by the line 2—2 in Fig. 7, while the plane of Figs. 5 and 6 is indicated by line 6—6.

Referring to the exemplary embodiment of my invention which I have chosen to disclose herein the tubular body or cylinder of the tool is designated by numeral 10 and the reciprocatory piston therein by numeral 11. In the forward end of the cylinder is fitted the usual rivet set or analogous working tool 12. At the rear end of the body is the usual handle 13 having a tubular head 14 which may be mounted on the body in any preferred manner, as by means of screw threads. The handle has the usual supply passage 15 for the live motive fluid which passage is controlled by a manually operated throttle valve, the lever of which is designated 16.

Within the rear end of the body 10 and the head 14 is a tubular valve casing 17 which in the present instance comprises a forward section 17^a fitting within a counter bore in the rear end of the body 10, and a rear section 17^b which interengages with the forward portion and lies between the latter and the end wall of the handle head 14, the two part valve casing being clamped securely in place by the handle, and being secured against rotation by a dowel pin 17^c (Fig. 3).

A tubular valve member 18 fits slidably within the valve casing and has a plurality of external annular flanges thereon forming shoulders against which the pressure of the motive fluid is exerted to move the valve member in opposite directions.

Surrounding the rear portion of the valve casing within the handle head is an annular chamber 19 which is constantly supplied with live motive fluid from the main inlet passage 15 in the handle. The valve casing is provided with a suitable inlet means 20 connecting the annular chamber 19 with the interior of the valve casing and the piston chamber, which inlet means in the present instance is in the form of a series of ports communicating at their inner end with a narrower annular groove. When the valve member 18 is in its forward position as shown in Fig. 1 the inlet 20 is exposed to admit live motive fluid into the piston chamber for driving the piston forwardly.

A suitable number of passages 21 (see Figs. 5 and 6) drilled longitudinally in the wall of the body 10 and in the valve casing communicate at their forward ends with the extreme forward end of the piston chamber and at their rear ends with an internal annular valve chamber 22 formed between the valve member and its casing, and this annular chamber, when the valve is in its forward position as seen in Fig. 5, is in communication with another annular chamber 23 which constantly communicates with the atmosphere through exhaust ports 24 in the valve casing and body 10, the outer ends of said ports opening into a space defined by the annular locking clip 14^a by which the handle is secured to the body 10.

It will thus be seen that when the valve member is in its forward position as seen in Figs. 1 and 5, live air will be admitted to the rear end of the piston chamber, and the previous charge of air will be exhausted from the forward end of said chamber through the passages 21, annular chambers 22 and 23, and ports 24 to the atmosphere.

The valve member has been moved to its forward position and is so held by pressure within a rear valve chamber 25 (Figs. 1 and 5) which is formed between the valve casing and the valve member, the forward wall of said chamber being provided by an external flange 26 on the valve member. The rear portion of this chamber is connected with the interior of the piston chamber at a point forward of the front end of the valve member by means of a passage 27 (Fig. 3) which in the present instance is formed partially in the valve casing and partially in the cylinder 10. The chamber 25 is also in constant communication with the source of live motive fluid by means of a port 28 (Fig. 3) which in the present instance leads in from the annular supply chamber 19 and communicates with the said valve chamber by opening into the passage 27.

A passage 29 which is formed in the body 10 and in the valve casing 17 communicates at its forward end with the piston chamber at about the mid-portion of the latter and at its rear end with an internal annular valve chamber 30 in which an external flange 31 on the valve member moves. Between its ends the passage 29 is connected

with the piston chamber by a port 32 which is considerably smaller than the inlet at the forward end of the passage 29. The purpose of this port 32 will presently appear.

The chamber 30 is in constant communication with the rear end of a passage 33 formed in the body and the valve casing, the forward end of said passage 33 communicating with the piston chamber near the forward end of the latter.

When the piston in its forward movement uncovers the port 32, live air leaks through said port into the passage 29 and thence flows into the chamber 30 and the passage 33 and starts to build up pressure in said passages and chamber. When the piston in its further forward movement uncovers the forward end of the passage 29 which is much larger than the port 32, the live air flows into the passage 29 and thence into the valve chamber 30. The point at which the valve shifts, however, is determined by the position of the forward end of the piston, because until the forward end of the passage 33 is covered by the piston the pressure in the large pressure chamber 30 is vented to the atmosphere through the forward passage 33, the forward piston chamber and the passage 21. Thus if, as is sometimes the case, an extremely short piston is used, so that the forward end of the passage 29 is uncovered before the forward end of the passage 33 is covered by the piston, the latter passage, acting to vent the large forward pressure area, prevents a premature shifting of the valve. Consequently the valve shifts only when the forward end of the piston is the proper distance from the rivet set 12. After the initial rearward movement of the valve has taken place, the extreme forward end thereof becomes exposed to the live pressure in the rear piston chamber and this high pressure accelerates the rearward movement of the valve.

As the valve shifts rearwardly the inlet 20 for the live motive fluid is closed and the exhaust chamber 23 in the valve casing is exposed to the piston chamber so that the motive fluid in the rear portion of the piston chamber may escape through the exhaust ports 24. The valve chamber 30 is connected by a port 34 with one of the exhaust ports 24, said port 34 leading from the rear end of said chamber and permitting the escape of any motive fluid therein so as to prevent interference with the rearward movement of the valve member.

As the motive fluid exhausts from the rear portion of the piston chamber through the ports 24, the fluid in the port 27 is also exhausted into the rear portion of the piston chamber and thence to the atmosphere thereby relieving pressure in the rear valve chamber 26 so as to facilitate the rearward shifting movement of the valve member. The port 27 is of larger size than the port 28, so as to provide substantially unrestricted communication between the chamber 26 and the piston chamber as compared with the relatively restricted communication provided by the port 28 between the source of motive fluid supply and said chamber 26. Accordingly, the pressure in the rear pressure chamber, is relieved in spite of the fact that the inlet port 28 is in constant communication therewith.

As soon as the exhaust ports 24 are opened to the piston chamber the motive fluid in the piston chamber escapes to the atmosphere, but the valve member in its rear position closes the rear end of the passage 29 so that the pressure fluid in the annular valve chamber 30 and in the passage 33 (which latter is at this time closed by the piston 11) is prevented from escaping to the piston chamber through the passage 29, and therefore the pressure fluid acting on the flange 31 of the valve member serves to hold the valve in its rear position.

In its rear position the valve member also uncovers a port 35 which connects the main motive fluid supply chamber 19 with the internal valve chamber 22 so that live motive fluid may pass through said port 35 and into and through the passages 21 to the forward end of the piston chamber to return the piston. The port 35, it will be observed, is of relatively small size so that the volume of pressure fluid admitted to the forward piston chamber is relatively small. The impact thereof on the piston, however, is sufficient to drive it rapidly to the rear end of the piston chamber. Also in this position of the valve, the pressure in the rear piston chamber exhausts to the atmosphere through the groove 23 and the ports 24 so that pressure upon the rear end of the valve is relieved. As a result the pressure trapped in the passage 33 and in the valve chamber 30 is sufficient to hold the valve in its rear position.

In its rearward or return movement the piston uncovers the forward end of the passage 33, and one of two things happens. If the valve member has a loose fit in its casing, some air will have leaked past the flange 31 and reduced the pressure in the passage 33 so that when this passage is uncovered the pressure in the forward piston chamber will be greater and some motive fluid will flow into the passage. But, if the valve member has a tight fit in the casing, the pressure in the passage 33 will have been maintained and it is probable that some of it will flow reversely into the forward piston chamber since the pressure therein supplied by the restricted port 35 is lower than the live pressure previously supplied to the passage 33 from the rear piston chamber. In either case, as the piston continues to travel

rearwardly this pressure, being supplied by the restricted port 35, becomes reduced by expansion and gradually lowers until the pressure in the valve chamber 30 is just sufficient to hold the valve in its rear position so that it offers a minimum force opposing the forward shifting of the valve at the proper time. This occurs when the piston covers the forward end of the passage 27 causing the pressure to build up in this passage and in the rear piston chamber until it is high enough to overcome the reduced pressure on the large pressure area in the chamber 30.

The operation of the tool may be briefly reviewed as follows:

Let it be assumed that the valve 18 is in its forward position as shown in Figs. 1 and 5 and that the piston is at the rear end of the piston chamber. The valve is held in its forward position by the pressure in the rear valve chamber 25 which is constantly maintained by live motive fluid through the port connection 27, 28, with the live motive fluid supply chamber 19. The live motive fluid entering the rear end of the piston chamber through the port 20, obviously acts upon the rear end of the valve member so as to assist in holding the valve member in its forward position. The inlet 20 being exposed, live motive fluid enters the rear end of the piston chamber through said inlet and drives the piston forwardly, the previous charge of spent motive fluid being exhausted from the front end of the piston chamber through the passages 21, the chambers 22 and 23, and the exhaust ports 24 to the atmosphere. In the forward movement of the piston, the port 32 and the front end of the passage 29 are successively uncovered by the rear end of the piston. The port 32 allows the pressure to begin to build up in the passage 29, chamber 30 and passage 33, such pressure being augmented when the forward end of the passage 29 is uncovered by the piston.

The provision of the port 32 which causes a preliminary building up of the pressure in the valve chamber 30, makes it possible to extend the passage 29 so as to communicate with the piston chamber at a point farther forward than would be possible without the provision of the port 32. It is highly advantageous to have the passage 29 extend as far forward as possible so that the full force of the charge of live motive fluid in the piston chamber may be exerted upon the piston during as much of the forward stroke as possible.

In tools of this character as heretofore manufactured, however, there has been a practical limit to the forward extent of a passage such as the passage 29 since it is necessary to allow time for the passage and the valve chamber to fill with motive fluid and build up pressure sufficient to shift the valve rearwardly. If the passage were carried farther forward than this practical limit, the result would be a reduction in the speed of reciprocation of the piston, and a very decided increase in the vibration of the tool with a resultant shock upon the operator's hand and arm.

With a tool build in accordance with my invention, the passage 29 may be carried forward as far as desired so as to utilize the power behind the piston to the full proportion of its travel, and not only will the speed of reciprocation of the piston not be slackened but it will be increased because the port 32 allows a preliminary building up of pressure in the valve chamber 30, leaving the final rise of pressure to be accomplished when the forward end of the passage 29 is uncovered. The ultimate result accomplished is that heavier blows are delivered by the piston at an increased rate of speed.

When the forward end of the passage 29 is uncovered, the forward end of the passage 33 being closed, the pressure in the valve chamber 30 will be sufficient to shift the valve member 18 rearwardly, but this cannot occur until the forward end of the passage 33 is closed by the front end of the piston to prevent the escape of motive fluid delivered to the chamber 30 by the passage 29. Thus the point at which the valve is shifted is determined by the position of the piston with respect to the forward end of the passage 33.

As soon as the front end of the valve member in its rearward movement exposes the chamber or groove 23 in the valve casing, the motive fluid in the rear portion of the piston chamber escapes through the exhaust ports 24 to the atmosphere, thus relieving the pressure upon the rear end of the valve member. The fluid in the rear valve chamber 25 also escapes through the passage 27 into the piston chamber and thence to the atmosphere so that the pressure in the rear valve chamber 25 is greatly reduced to speed up the movement of the valve.

When in its rear position, the valve member closes the live motive fluid inlet 20 and connects the port 35 with the chamber 22 and the passages 21 so that a restricted volume of live motive fluid passes from the annular supply chamber 19 through said port and passages to the forward end of the piston chamber so as to move the piston rearwardly.

When the rear end of the piston in its rearward travel closes the front end of the passage 27 the pressure in the rear valve chamber 25 builds up by reason of the supply of live motive fluid to such chamber through the port 28 so that the pressure overcomes the opposing pressure on the front flange 31, which pressure has been

minimized by the reduction of pressure in the forward piston chamber due to the expansion of the fluid and shifts the valve forwardly before the piston reaches the rear end of the piston chamber. Live motive fluid is thus immediately introduced into the rear end of the piston chamber so as to cushion the piston at the rear end of its stroke and immediately reverse the piston and move it on its working stroke again.

In pneumatic hammers as previously manufactured, it was found necessary to provide an auxiliary live motive fluid passage connecting the supply of live motive fluid with the front valve chamber 30 for the purpose of holding the valve in its rear position. The use of such auxiliary passage for live motive fluid for this purpose is objectionable but has heretofore been found to be necessary in order to maintain the pressure in the front valve chamber to a sufficient degree to hold the valve in its rear position. With the construction herein disclosed, the necessity for such auxiliary passage has been entirely eliminated and by arranging the valve member so that it closes the rear end of the passage 29 when the valve is in its rear position, I am able to maintain the valve in its rear position in a positive manner and yet with a minimum pressure so that it offers less resistance to the forward shifting of the valve when the time for such shifting arrives. The effective pressure which tends to move the valve forwardly is thereby greatly increased so that a more prompt, quick and positive shifting of the valve results and reliable action is insured whether the valve fits quite tightly in its casing or fits rather loosely. The result is that the extreme nicety of fit of the valve in its casing which has heretofore been indispensable is not necessary with the present construction, and the life of the tool is greatly lengthened since satisfactory operation is not interfered with by considerable wear on the valve member and its casing.

Similarly, in the shifting of the valve to its rear position, the pressure in the rear valve chamber 25 is greatly reduced by venting such chamber through the passage 27 so that the effective pressure tending to shift the valve rearwardly is materially increased which has the same effect as that above discussed of insuring promptness, speed and positiveness in the shifting of the valve, eliminating the necessity of extreme accuracy in the fitting thereof and adding life to the tool.

The result of the improved structure is that the efficiency of the tool as a whole is greatly enhanced because of the power always present for shifting the valve whether it fits tightly or loosely, and the durability of the tool is greatly increased because the valve will stand considerable wear with the resulting looseness in fit without effecting its operation injuriously. Furthermore, the structure as a whole is simplified so that it is cheaper to manufacture than prior tools.

I claim as my invention:

1. In a pressure fluid operated tool having a piston chamber and a piston reciprocable therein, a reciprocatory valve having a forward pressure surface, a chamber communicating with said surface, a passage connecting with said chamber and the piston chamber arranged to deliver motive fluid from the piston chamber to the pressure surface in the forward stroke of the piston, the rear end of said passage being closed by the valve member when in its rear position to prevent exhaust of a quantity of the pressure fluid thus admitted through said passage whereby to hold the valve member in its rear position, and means to relieve the pressure on said pressure surface in the return stroke of the piston.

2. In a fluid pressure actuated tool, in combination, a cylinder, a piston and a valve mechanism comprising a tubular casing and valve member through which the piston reciprocates, the valve mechanism having a chamber to receive motive fluid for shifting the valve member rearwardly which chamber is arranged to be placed in communication with the mid-portion of the interior of the piston chamber by means of a passage, the forward end of said passage being arranged to be uncovered by the piston in its forward travel so as to admit motive fluid through said passage to said chamber, the rear end of such passage being arranged to be closed by the valve member when in its rear position to prevent escape of the fluid from the chamber back through said passage so as to hold the valve member in its rear position, said valve chamber also communicating with a passage which is arranged to be filled with fluid from the valve chamber, the latter passage communicating with the forward portion of the piston chamber.

3. In a pressure fluid operated tool having a piston chamber and a piston reciprocable therein, a valve mechanism comprising a movable valve member in combination with a pressure chamber and a passage for supplying live motive fluid from the piston chamber to said pressure chamber in successive stages, said passage being cut off by the movable valve member in its rear position to prevent escape of the fluid from the chamber back through said passage, and means to relieve the pressure in said pressure chamber in the forward stroke of the piston.

4. In a pressure fluid operated tool having a piston chamber and a piston reciprocable therein, a valve mechanism comprising

a valve member and a pressure chamber in combination with means including a passage for admitting live motive fluid from the piston chamber to said pressure chamber in successive stages, and a second passage from said pressure chamber to the forward end of the piston chamber adapted to be closed by the piston in its forward position, said first mentioned passage being cut off by the movable valve member in its rear position to trap motive fluid in said pressure chamber and said second passage.

5. In a pressure fluid operated tool of the character described, the combination of a cylinder forming a piston chamber, a piston, a control valve, a large valve chamber for receiving pressure fluid to shift said valve, a passage connecting said valve chamber with the forward end of the piston chamber and adapted to be closed by the piston in its forward position, and means for admitting pressure fluid in successive stages from said piston chamber to said valve chamber for moving the valve in one direction.

6. In a pressure fluid operated tool of the character described, the combination of a cylinder forming a piston chamber, a piston, a control valve, a valve chamber adapted to receive pressure fluid to shift said valve in one direction, a passage connecting with said valve chamber, and means for admitting pressure fluid in successive stages from said piston chamber to said valve chamber and passage first to build up pressure in said chamber and passage and then to move the valve in one direction.

7. In a pressure fluid operated tool of the character described, the combination of a cylinder forming a piston chamber, a piston, a control valve, a valve chamber adapted to receive pressure fluid to shift said valve, a chamber connecting with said valve chamber, and means for admitting pressure fluid in successive stages from said piston chamber to said valve chamber and connecting chamber first to build up pressure in said chambers and then to move the valve in one direction, said valve in its movement operating to trap pressure fluid in said chambers.

8. A pressure fluid actuated tool having a cylinder forming a piston chamber, a piston reciprocable in said piston chamber, and means for controlling the movements of the piston including a movable valve member, a small pressure chamber and a large pressure chamber, a passage in constant communication with a source of pressure fluid supply establishing restricted communication between said small pressure chamber and the rear piston chamber under the control of the piston, a second passage arranged to discharge pressure fluid from the piston chamber to the larger pressure chamber as the piston approaches the forward end of its travel, and a third passage comunicating at one end with the forward piston chamber so as to be controlled by the piston and at its opposite end with said larger pressure chamber, said valve member being arranged to cut off communication between said second passage and the larger pressure chamber during the return stroke of the piston.

9. A pressure-fluid-actuated tool comprising a cylinder forming a piston chamber, a piston reciprocable therein, and means for controlling the movements of the piston comprising a movable valve member, means tending to hold the valve member in position to admit pressure fluid to the rear piston chamber, said means comprising a small pressure chamber in constant but restricted communication with a source of live pressure fluid, and a passage for gradually exhausting motive fluid from the small pressure chamber under the control of the piston, and means for reversing the position of the valve member and holding it in such position comprising a large pressure chamber, a passage controlled by the piston and in valve controlled communication with said large pressure chamber, and a third passage communicating at all times with the larger pressure chamber and with the forward piston chamber under the control of the piston.

10. In a pressure-fluid-operated tool, a valve mechanism comprising a movable valve member and means to actuate said valve including a pressure chamber adjacent said valve member, a live motive fluid supply chamber in constant communication with said pressure chamber, and a passage adapted gradually to exhaust motive fluid from said pressure chamber, said passage being under the control of the piston whereby in the forward travel of the piston the pressure in the small pressure chamber is relieved to facilitate the reversal of the valve member and in the rearward travel of the piston the pressure in the small pressure chamber is built up to effect the movement of the valve into its initial position.

11. In a pressure-fluid-operated tool, a valve mechanism comprising a movable valve member and having a pressure chamber for shifting said valve member, a live motive fluid supply chamber in constant communication with said pressure chamber, and a restricted passage adapted to exhaust motive fluid from said pressure chamber, said passage being under the control of the piston whereby in the forward travel of the piston the pressure in the small pressure chamber is relieved to facilitate the reversal of the valve member, means for effecting the reversal of the valve member including a large pressure chamber, and means tending to hold the valve member in its reversed position com-

prising a passage controlled by the piston when in its forward position and communicating with said large pressure chamber, said valve member being adapted in its initial position to control the discharge of a charge of motive fluid to the last mentioned passage and in its reversed position to trap such charge of motive fluid in said passage.

12. A pneumatic tool comprising a piston chamber, a piston reciprocable therein, and means for controlling the movements of the piston comprising a valve member, means tending to move and hold the valve member in position to admit a charge of motive fluid to the rear piston chamber, and means tending to move the valve member into and holding it in reverse position including a chamber, a passage opening into the piston chamber substantially centrally thereof and adapted to communicate with said pressure chamber in the initial position of the valve member, and a second passage communicating at all times with said pressure chamber and adapted to discharge into the forward piston chamber under the control of the piston whereby in the rearward travel of the piston the pressure in said pressure chamber may discharge into the forward piston chamber to permit the movement of the valve member into its initial position by the first mentioned means.

13. A pressure-fluid-actuated tool comprising, in combination with a piston chamber having a piston reciprocable therein, valve mechanism for controlling the movements of the piston comprising a valve casing, a valve member having a small pressure area and a large pressure area, means for constantly admitting live motive fluid to the small pressure area, means for admitting motive fluid from the piston chamber behind the piston to the large pressure area to shift the valve, said valve operating when shifted to trap a quantity of such fluid so as to maintain a holding pressure upon said large pressure area, means controlled by the piston in its forward travel for relieving the pressure upon the small pressure area, and means controlled by the piston in its rearward travel for relieving the pressure upon the large pressure area.

14. A pressure-fluid-actuated tool comprising, in combination with a cylinder having a piston and valve mchanism for controlling the piston, said valve mechanism comprising a small pressure chamber and a large pressure chamber, means for admitting constantly a restricted supply of live motive fluid to the small pressure chamber, means controlled by the piston in its forward movement for substantially relieving the pressure in the smaller chamber, and separate means controlled by the piston as it approaches the end of its forward movement for admitting pressure fluid from the piston chamber behind the piston to the larger pressure chamber whereby to shift the valve member.

15. A pressure-fluid-actuated tool comprising in combination with a cylinder having a piston and valve mechanism for controlling the piston, said valve mechanism comprising a small pressure chamber and a large pressure chamber, means for admitting constantly a restricted supply of live motive fluid to the small pressure chamber, means controlled by the piston in its forward movement for relieving the pressure in the small chamber, and separate means controlled by the piston in its forward travel for admitting a gradually increasing amount of pressure fluid from the piston chamber behind the piston to the larger pressure chamber whereby to shift the valve member.

16. A pressure-fluid-actuated tool comprising, in combination with a cylinder having a piston, valve mechanism for controlling the piston, said valve mechanism comprising a small pressure chamber and a large pressure chamber, means for admitting constantly a restricted supply of live motive fluid to the small pressure chamber, means controlled by the piston in its forward movement for relieving the pressure in the smaller chamber, and separate means controlled by the piston in its forward travel for admitting pressure fluid to the larger pressure chamber whereby to shift the valve member, said valve member being operable in such movement to trap a quantity of the motive fluid thus admitted whereby to hold the valve member in its shifted position.

17. A pressure-fluid-actuated tool of the type comprising a cylinder with a piston reciprocable therein, and valve mechanism for controlling the piston comprising a small pressure chamber communicating with a source of live motive fluid supply and having a passage constantly in communication therewith and adapted to exhaust into the piston chamber behind the piston when the piston is in its forward position, such exhaust of pressure fluid into the piston chamber being controlled by the piston, and a large pressure chamber having a passage communicating with the forward piston chamber whereby when the piston approaches its forward position the valve member is shifted.

18. A pressure-fluid-actuated tool of the type comprising a cylinder with a piston reciprocable therein, and valve mechanism for controlling the piston comprising a small pressure chamber communicating with a source of live motive fluid supply but adapted to exhaust into the piston chamber when the piston is in its forward position, and a large pressure chamber communicating with the forward piston chamber whereby when the piston approaches its forward position the valve member is shifted, said

valve member being adapted in such movement to trap a quantity of the pressure fluid employed in shifting whereby to hold it in its shifted position.

19. A pressure-fluid-actuated tool of the class described comprising a valve member having opposed pressure surfaces, means to admit live pressure fluid to the piston means for admitting live pressure fluid to one of the pressure surface means for gradually decreasing the pressure thereon as the piston travels in one direction, and means for gradually admitting a portion of the motive fluid utilized in thus actuating the piston to the larger pressure surface to shift the valve member.

20. In a pressure-fluid-actuated tool, the combination of means providing a piston chamber having a piston reciprocable therein, a valve mechanism having a pressure area, a passage communicating with the mid-portion of the piston chamber and with said pressure area to supply pressure fluid to said area, and a second passage also communicating with said pressure area and with the forward end of the piston chamber, said second passage being adapted to vent the pressure from said pressure area to the forward piston chamber until said second passage is closed by the piston, whereby to control the time of movement of the valve.

21. A pressure-fluid-actuated tool comprising, in combination, a piston chamber having a piston reciprocable therein, a controlling valve mechanism including a valve member, means controlled by the rear end of the piston as it moves forwardly whereby to supply pressure fluid to the valve member and separate means controlled by the front end of the piston as it approaches the forward end of the stroke to render the first mentioned means operative to shift the valve.

In testimony whereof, I have hereunto set my hand.

ERNEST H. SHAFF.