C. H. JOHNSON.

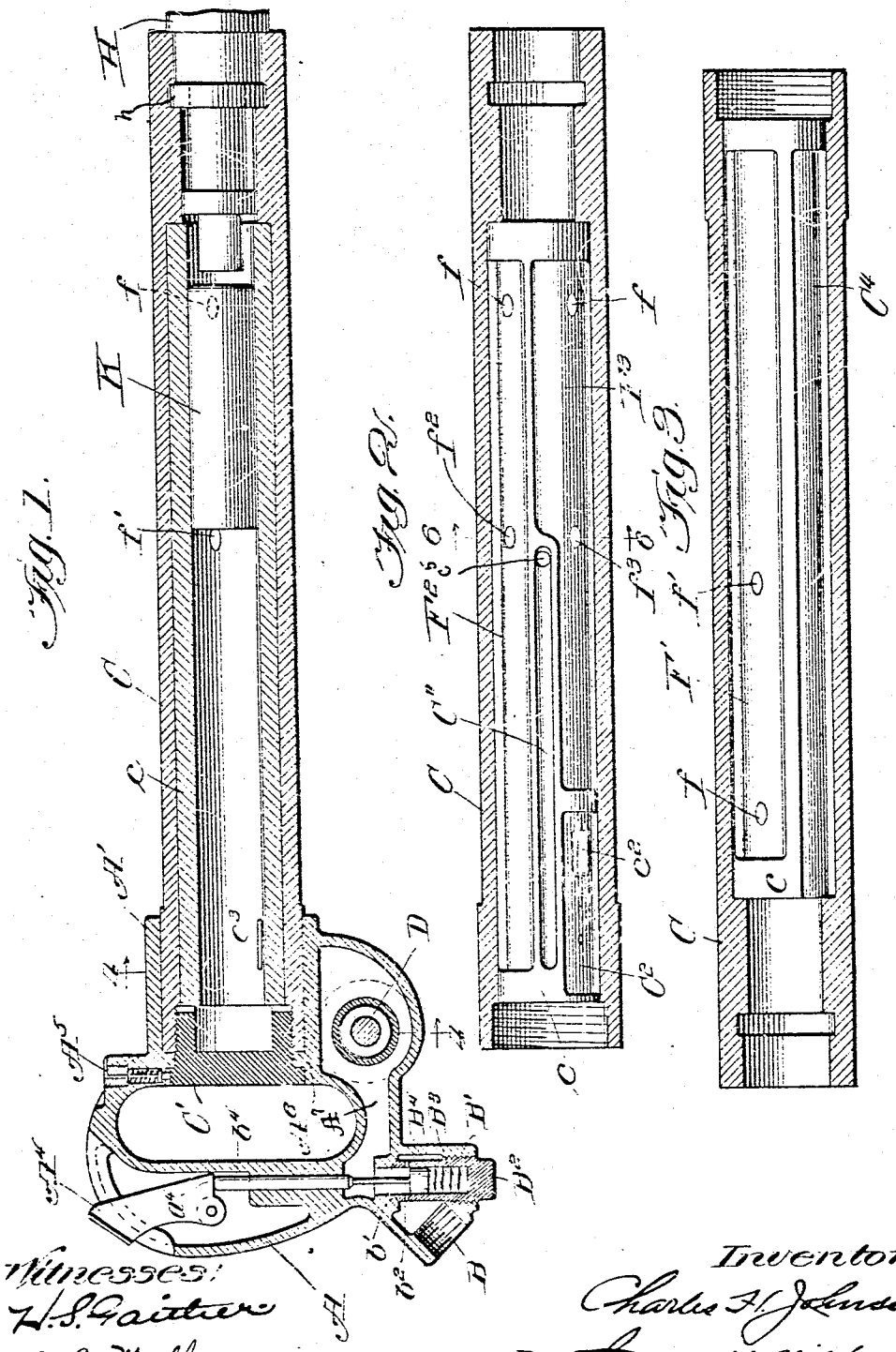
FLUID PRESSURE OPERATED TOOL.

APPLICATION FILED AUG. 16, 1905.

947,181.

Patented Jan. 18, 1910.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

Fig. 5.

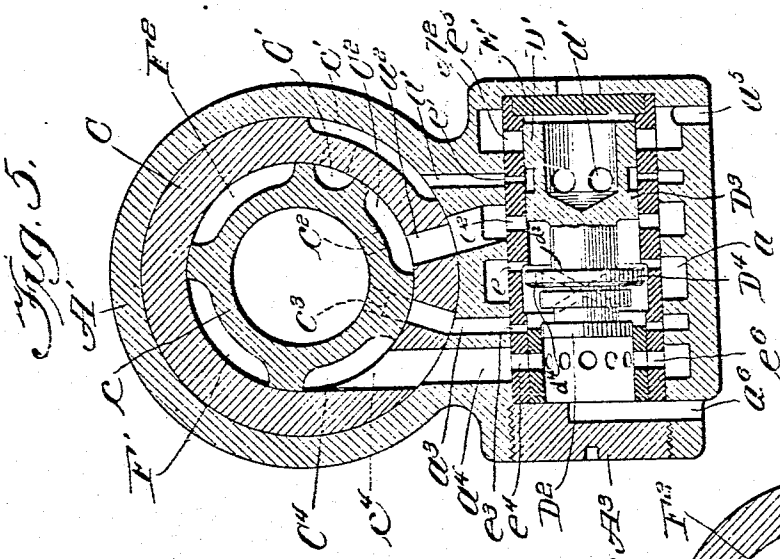


Fig. 6.

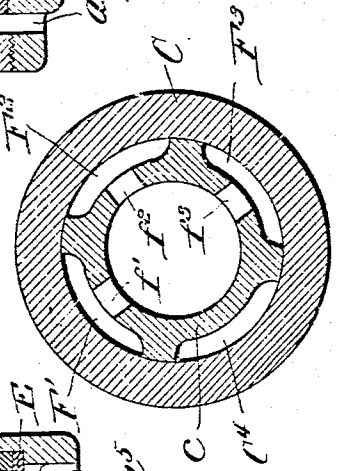
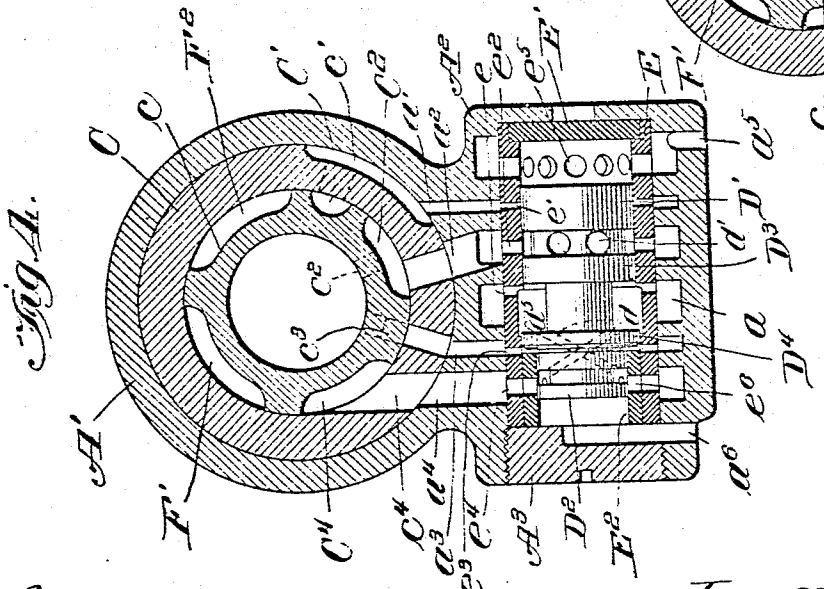


Fig. 4.



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UNITED STATES PATENT OFFICE.

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FLUID-PRESSURE-OPERATED TOOL.

947,181. Specification of Letters Patent. Patented Jan. 18, 1910.

Application filed August 16, 1905. Serial No. 274,498.

To all whom it may concern:

Be it known that I, CHARLES H. JOHNSON, a citizen of the United States, residing at Springfield, county of Sangamon, State of Illinois, have invented a certain new and useful Improvement in Fluid-Pressure-Operated Tools, and declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates in general to fluid pressure operated tools and more particularly to the type of such tools commonly known as pneumatic hammers.

In the operation of a pneumatic hammer having a piston valve for controlling the supply and exhaust of compressed air to and from the opposite ends of the cylinder, the valve is usually reciprocated by air passing from the cylinder to the valve casing. In order that the piston may be moved from the front to the rear of the cylinder, it is necessary for compressed air to flow through a passage uncovered by the piston slightly before reaching the limit of its forward stroke, to the valve casing to move the valve, and for live air to flow through a passage leading from the valve casing to the front end of the cylinder. Owing to the lag in the movement of the valve and the distance the air must pass from the cylinder to the valve casing to throw the valve and from the valve casing to the front of the cylinder, the return movement of the piston is slightly delayed and is accomplished entirely by live air.

The primary object of my invention is to provide a pneumatic tool in which the piston will be quickly moved from the front to the rear of the cylinder and primarily by the power of the air which drove the piston to the front of the cylinder.

A further object of my invention is to provide a fluid pressure operated tool in which the motive fluid which moves the piston toward the front of the cylinder will be stored in a reservoir and will be discharged therefrom to the front of the cylinder to impart an initial movement of the piston toward the back end of the cylinder.

A further object of my invention is to provide a fluid pressure operated tool which will be comparatively simple in construction and efficient in operation.

My invention will be more fully described hereinafter with reference to the accompanying drawings in which the same is illustrated as embodied in a convenient and practical form, and in which—

Figure 1 is a longitudinal vertical section; Fig. 2 an elevational view of one side of the bushing, the cylinder being shown in section; Fig. 3 an elevational view of the opposite side of the bushing, the cylinder being also shown in section; Fig. 4 a sectional view on line 4—4 Fig. 1 on an enlarged scale; Fig. 5 a view similar to Fig. 4, the valve being shown in position to admit fluid pressure to the rear end of the cylinder, and Fig. 6 a cross sectional view on line 6—6 Fig. 2.

The same reference characters are used to indicate the same parts in the several figures of the drawings.

Reference letter A indicates the handle of the tool which is provided with a tubular extension A′ surrounding the back end of the cylinder C. A lever A^4 is pivotally supported in the handle A and is provided with a lug a^4 adapted to engage the end of a valve stem b^4. The throttle valve is located within a cylindrical valve casing B^2 which is in screw threaded engagement with an opening B′ in the handle. A spring B^3 is interposed between the valve and the cylindrical valve casing and normally retains the valve in position to close the ports b^2 formed through the valve seat. A passage B is formed in the handle A and is adapted to be connected with a conduit leading from a source of fluid pressure. The cylinder C is provided with a bushing c one end of which is engaged by a cylinder head C′ which is secured within the end of the cylinder. The handle is retained upon the cylinder by means of an annular flange A^6 interposed between the end of the cylinder and a peripheral flange on the cylinder head C′. Any suitable means may be provided for preventing the disengagement of the cylinder head from the cylinder, such means being shown as consisting in a spring bolt A^5 which engages the periphery of the cylinder head and prevents the same from rotating with respect to the handle. The front end of the cylinder is adapted to receive a snap

or die II the shank of which projects into the path of movement of the piston. Any suitable means may be provided for retaining the snap within the end of the cylinder, such for instance as a ring *h* seated within an annular groove formed in the interior of the cylinder near the front end thereof.

A cylindrical valve casing A^2, preferably formed integrally with the handle A, is located transversely beneath the back end of the cylinder. The valve casing is provided with a series of annular grooves with which communicate ports a', a^2, a^3 and a^4 registering with ports and passages leading to the interior of the bushing *c* so as to reciprocate the piston K therein. The port a' communicates with the passage c' formed in the exterior of the cylinder and inclosed by the tubular extension A′ of the handle. The passage c' communicates through a hole formed through the cylinder with a longitudinal passage C″ formed in the exterior of the bushing *c* and communicating with the interior thereof at a point c^5 located a slightly greater distance from the front end of the cylinder than the length of the piston. The port a^2 communicates with a hole through the cylinder C leading to a chamber C^2 formed in the outer surface of the bushing. Ports c^2 lead from the chamber C^2 to the interior of the bushing near the back end thereof. A plurality of ports c^2 are preferably employed the front one of which is larger than the rear ones as clearly shown in Fig. 2. The port a^3 communicates with a hole through the cylinder leading to a port c^3 extending through the bushing at a point adjacent the rear end thereof. The port a^4 communicates with a hole c^4 through the cylinder and then with a passage C^4 formed in the exterior of the bushing and extending to the front end of the cylinder. Supply ports *a* are located near the center of the valve casing and communicate with a passage A^7 formed in the handle A and extending from a point above the throttle valve. The bushing E is located within the valve casing A^2 and is retained therein by means of the cap A^5 which closes the open end of the valve casing. One end of the bushing is closed by means of a disk E′ while the other end of the bushing is provided with a concentric interior portion E^2 which reduces the bore of the bushing. The bushing is provided within a series of ports *e*, *e′*, e^2, e^3, e^4, e^5, which register with the corresponding ports a', a^2, a^3, a^4 and a^5 formed in the valve casing. A differential piston valve D is located within the bushing and controls the ports therethrough. The end D′ of the valve is hollow and is provided with ports *d′* connecting an annular groove in the exterior surface thereof with the hollow interior. A shoulder D^2 is formed on the valve by reducing its diameter. An annular flange D^4 of slightly greater diameter than the shoulder D^2 is formed on the valve between such shoulder and the end D^3 of the valve. A series of passages *d* extend through the valve and connect the annular space between the shoulder D^2 and flange D^4 with an annular groove formed in the end D^3 of the valve. A restricted leakage port d^5 extends through the flange D^4.

The several parts of the valve mechanism may be readily assembled by inserting the valve in the bushing prior to placing the end cap E′ on the bushing and by then inserting the bushing with the valve thereof into the valve casing. The cap A^5 may then be secured within the open end of the valve casing A^2.

The exterior of the bushing *c* is cut away to form longitudinal chambers F′ and F^2 between the same and the cylinder C such chambers extending from points near the rear to points near the front of the bushing. A third chamber F^3 is formed between the exterior of the bushing and the cylinder and extends from a point in advance of the chamber C^2 to a point near the front of the bushing. The chambers F′, F^2 and F^3 communicate with the interior of the bushing through ports *f′*, f^2 and f^3 at points located a distance from the front of the bushing slightly greater than the length of the piston. The chambers F′, F^2 and F^3 also communicate with the interior of the bushing near the front end thereof by means of ports *f*. The distance between the ports *f′*, f^2, and f^3 and the ports *f* is less than the length of the piston in order that when the former ports are uncovered by the piston and the reservoirs charged, the pressure is prevented from passing back to the cylinder through the latter ports. The chambers F′, F^2 and F^3 constitute a reservoir in which motive fluid which moves the piston forwardly is stored and from which it passes to the front end of the bushing to drive the piston toward the back of the cylinder.

The operation of my invention is as follows: The lever A^4 is forced forwardly and thereby oscillated about its pivot so that the lug a^4 thereon through the interposed valve stem depresses the throttle valve uncovering the ports b^2. Fluid under pressure then flows from the source thereof through the coupling B, thence through the ports b^2 to the passageway A^7 which communicates with the annular supply port *a* located near the center of the valve casing a^2. When the valve is in the position indicated in Fig. 5 fluid pressure flows from the supply port *a* through the ports *e* in the bushing, around the reduced portion of the valve, then through the ports e^2 in the bushing, the ports a^2, thence to the chamber C^2 through the first of the series of ports c^2 into the back end of the cylinder. As the piston successively un-

covers the ports in the series c^2 the impetus of the piston is accelerated owing to the ports in the series c^2 being gradually larger in diameter.

When the valve is in the position shown in Fig. 5 its ends are exposed to atmospheric pressure, D^2 directly through ports a^6 and D' through the front end of the cylinder by way of ports and passages d', e', a', c', C'', c^5, interior of bushing c, C^4, c^4, a^4, e^4 and a^6, while the shoulder D^2 and radial surfaces d^3 and d^4 are all exposed to the same pressure and consequently the valve is retained in this position owing to the area of the radial surface d^4 being greater than the difference in area between the shoulder D^2 and the radial surface d^3. When the piston has nearly reached the limit of its forward stroke the port c^3 is uncovered and fluid pressure then flows through the passage communicating with said port to the port c', thence through the port a' in the valve casing, the ports e' in the bushing, through the ports d' to the hollow interior of the end D' of the valve. The valve is consequently moved from the position shown in Fig. 5 to that shown in Fig. 4. This movement of the valve takes place owing to the area of the end D' thereof being greater than the resultant area exposed to pressure in the opposite direction. The valve is retained in such position by reason of the surface d^4 being exposed to the atmosphere through the ports and passages c^5, a^3, e^3, c^2, C^2, a^2, e^2, d' and a^5. The surface d^3 being greater in area than the area of the shoulder D^2, the valve is held in the position shown in Fig. 4.

When the valve is in the position indicated in Fig. 4, the back end of the cylinder is placed in communication with the exhaust through the following ports and passages: c^2, C^2, e^2, e^2, d' and a^5. Fluid pressure is then admitted to the front end of the cylinder to move the piston toward the handle through the following ports and passages: a, e, d, e^4, a^4, and c^4, which communicates with passage C^4 leading to the front end of the cylinder. When the piston in its stroke away from the tool passes the series of ports c^2 it is cushioned by the air compressed in the back end of the cylinder. The valve is moved from the position shown in Fig. 4 to that shown in Fig. 5 by fluid pressure passing through the restricted leakage port d^5 to the opposite side of the annular flange D^4 where it is exerted upon the radial surface d^4 which is then no longer exposed to the atmosphere as the ports c^2 are closed by the piston and consequently as the area of the radial surface d^4 is greater than the difference in area between the radial surface d^3 and the shoulder D^2 the valve is moved to the position shown in Fig. 5 inasmuch as the opposite ends of the valve are exposed merely to atmospheric pressure directly through ports a^5 and a^6. While a leakage groove d^5 is shown the same may be omitted without interfering with the operation of the valve as the leakage around the annular flange D^4 is sufficient to effect the reverse movement of the valve from the position shown in Fig to that shown in Fig. 5.

When the valve is in the position shown in Fig. 5 the live air passes to the back of the cylinder, not only through the port c and communicating ports, but also around the annular flange D^4 which is of slightly less diameter than the space within the bushing around the same, to the port c^3 and thence through the port c^5, consequently the piston is moved toward the front of the cylinder by live air admitted through the port c^3 as well as to the port c^2.

When the piston in its stroke toward the snap uncovers the ports f', f^2 and f^3 motive fluid passes to the reservoir composed of the chambers F', F^2 and F^3. Immediately upon the piston striking the shank of the snap it recoils sufficiently to cover the ports f', f^2 and f^3 and to uncover the ports f so that the motive fluid passes from the reservoir to the front of the cylinder and thereby imparts to the piston an initial movement toward the back of the cylinder. The completion of the movement of the piston away from the tool is effected by live air admitted through the passage C^4 as above described. The power derived from the compressed air stored in the reservoir is, however, sufficient to not only impart to the piston an initial movement, but to almost complete the back stroke of the piston thereby rendering it necessary to use only a small quantity of live air for the purpose of producing the back stroke of the piston.

It will be noted by reference to Fig. 2 that the control port c^3 is uncovered by the piston slightly before it uncovers the ports leading to the reservoir chambers, but owing to the lag in the movement of the valve and the rebound of the piston after striking the shank of the snap, the air passes to the reservoir chambers and is confined therein by the piston before the valve has moved into position to connect the rear end of the cylinder with the exhaust.

I do not in this application claim the differential valve shown in this application, as the same forms the subject matter of my copending application Serial No. 131,948 filed November 19, 1902. I have merely illustrated such form of valve herein in order that my present improvement may be clearly understood.

The invention which forms the subject of the claims of this case is the storing of the motive fluid which drives the piston toward the front of the cylinder in a reservoir and utilizing the same to drive the piston toward the back of the cylinder.

This invention may obviously be used in connection with various forms of pneumatic tools. I do not therefore wish to be understood as limiting my invention to use in connection with a pneumatic tool such as that herein illustrated and described.

Having now fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, means for admitting fluid pressure into one end of the cylinder to move the piston in one direction, a reservoir for fluid pressure, means for connecting said reservoir with the opposite end of the cylinder to impart an initial movement to the piston in the opposite direction, and means for connecting the first mentioned end of the cylinder to atmosphere before the piston begins said initial movement.

2. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, means for admitting fluid pressure into one end of the cylinder to move the piston in one direction, a reservoir for fluid pressure, means for charging said reservoir, means for connecting said reservoir with the opposite end of the cylinder to impart an initial movement to the piston in the opposite direction, and means for connecting the first mentioned end of the cylinder to atmosphere before the piston begins said initial movement.

3. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, means for admitting fluid pressure into one end of the cylinder to move the piston in one direction, a reservoir for fluid pressure, means for charging said reservoir with fluid pressure from the aforesaid end of the cylinder during the aforesaid movement of the piston, means for connecting said reservoir with the opposite end of the cylinder to impart an initial movement to the piston in the opposite direction, and means for connecting the first mentioned end of the cylinder to atmosphere before the piston begins said initial movement.

4. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir, means for charging said reservoir with fluid pressure, means for connecting said reservoir with one end of the cylinder to impart a movement to the piston, and means for admitting fluid pressure from a source thereof to complete the movement of the piston.

5. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir, means for charging said reservoir with fluid pressure from the cylinder during the movement of the piston in one direction, means for connecting said reservoir with the cylinder to impart a movement of the piston in an opposite direction, and means for admitting fluid pressure from a source thereof to complete the movement of the piston in said direction.

6. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir carried by said cylinder, said cylinder having a port leading to said reservoir slightly farther away from one end of the cylinder than the length of the piston and a second port leading from said reservoir adjacent to said end of the cylinder, means for supplying fluid pressure to the opposite end of the cylinder to move the piston in one direction and means for connecting the latter end of the cylinder to atmosphere after the piston has completed its movement in said direction.

7. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a valve for controlling the supply and exhaust of motive fluid to and from the opposite ends of said cylinder, a reservoir, means for charging said reservoir with fluid pressure from the cylinder during the movement of the piston in one direction, and means connecting said reservoir with said cylinder to impart a movement to the piston prior to the admission of fluid pressure through the valve to said end of the cylinder.

8. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a valve for controlling the supply and exhaust of motive fluid to and from the opposite ends of said cylinder, a reservoir, means for charging said reservoir with fluid pressure from the cylinder during the movement of the piston toward the tool, and means for connecting said reservoir with the front end of said cylinder to impart a movement of the piston away from the tool prior to the admission of fluid pressure through said valve to said end of the cylinder.

9. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, said cylinder having longitudinal chambers formed therein and having ports controlled by said piston whereby pressure is admitted to the chambers from the cylinder and from the chambers to the cylinder to impart a movement to the piston away from the tool, and means for subsequently admitting fluid pressure from a source thereof to complete the movement of the piston.

10. In a fluid pressure operated tool, the combination with a cylinder, of a bushing within said cylinder, said cylinder and bushing being spaced apart to form a reservoir, a reciprocating piston within said bushing

controlling the admission of pressure to said reservoir from the cylinder and also controlling the discharge of pressure from said reservoir to the front end of the cylinder to impart a movement of the piston away from the tool, and means for subsequently admitting fluid pressure from a source thereof to complete said movement of the piston.

11. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir, means for charging said reservoir with fluid pressure, means for connecting said reservoir with one end of the cylinder to impart movement to the piston, and means for admitting fluid pressure from a source thereof to said end of the cylinder.

12. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir, means for admitting compressed fluid to one end of said cylinder to move the piston in one direction, a reservoir, means for charging said reservoir when the piston approaches the end of its movement in the aforesaid direction, means for connecting said reservoir to the opposite end of the cylinder, and means for admitting fluid pressure from the source thereof to said latter end of the cylinder.

13. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, means for admitting fluid pressure into one end of the cylinder to move the piston in one direction, a reservoir for fluid pressure, means for connecting said reservoir with the opposite end of the cylinder, and means for exhausting the one end of the cylinder when the other end is connected to said reservoir.

14. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston within said cylinder, a reservoir, means for admitting fluid pressure in one end of said cylinder to move the piston in one direction, means for connecting said reservoir to the other end of the cylinder, and means for exhausting the first mentioned end of the cylinder.

In testimony whereof, I sign this specification in the presence of two witnesses.

CHARLES H. JOHNSON.

Witnesses:
JESSIE J. NETTLETON,
W. J. AURELIUS.