No. 870,651. PATENTED NOV. 12, 1907.

H. H. VAUGHAN.

FLUID PRESSURE OPERATED TOOL.

APPLICATION FILED SEPT. 20, 1901.

2 SHEETS—SHEET

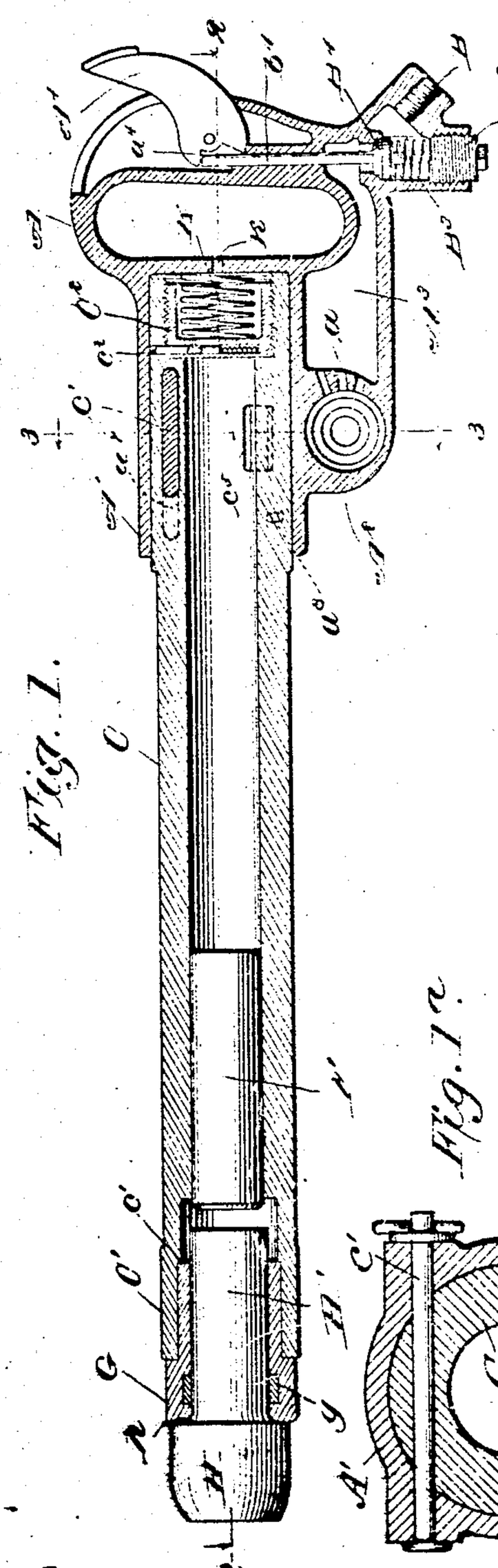

Fig. I.

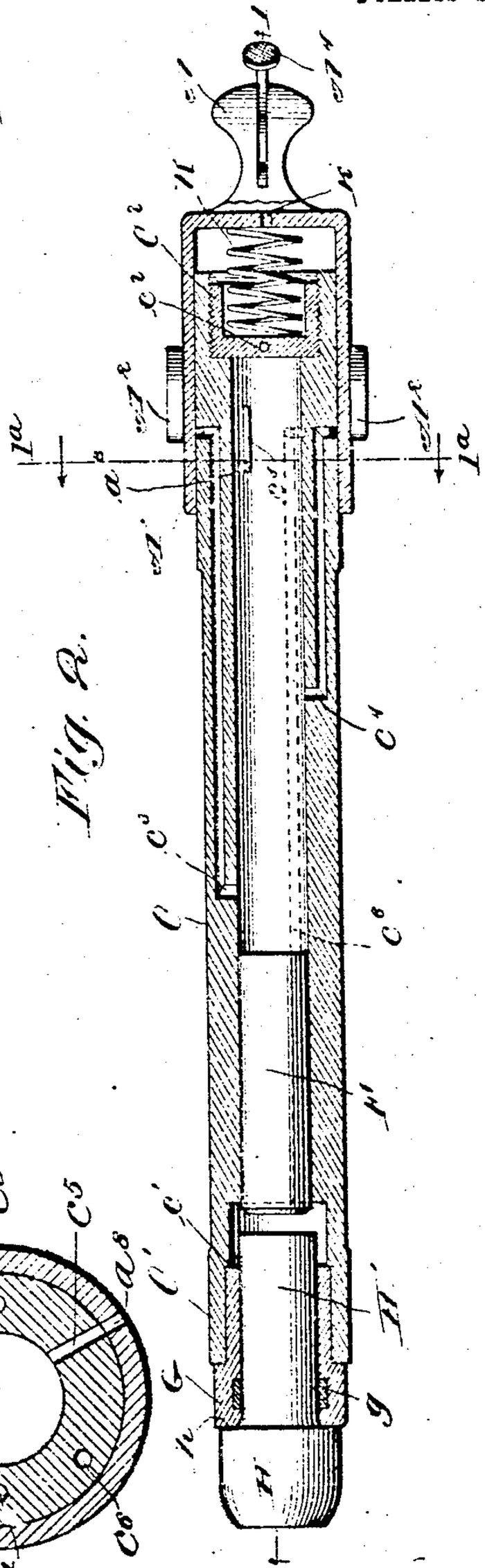

Fig. II.

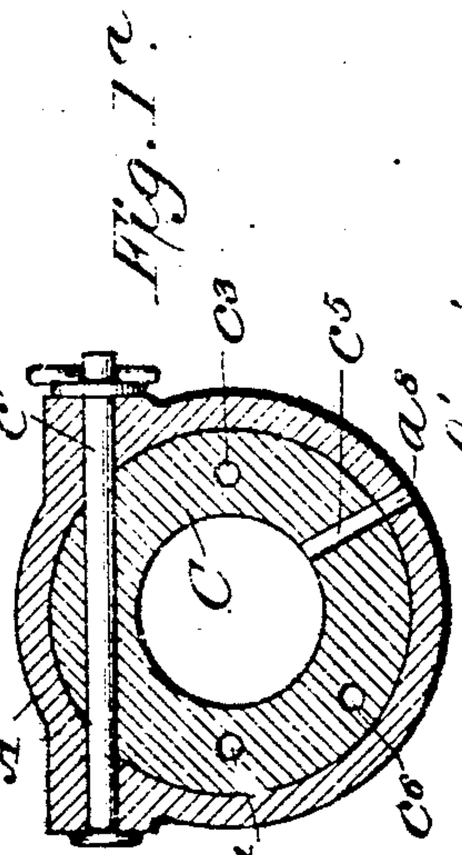

Fig. IV.

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2 SHEETS—SHEET 2.

Fig. 4.

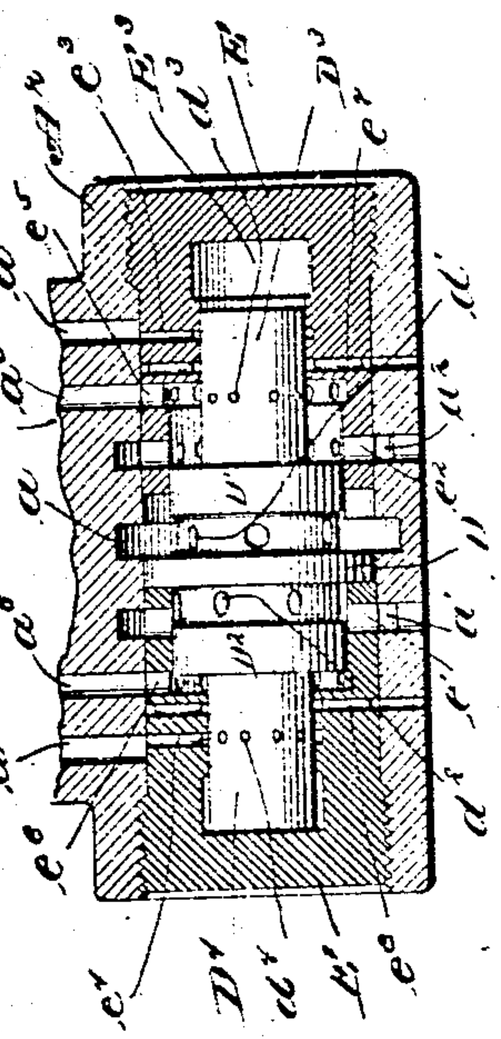


Fig. 5.

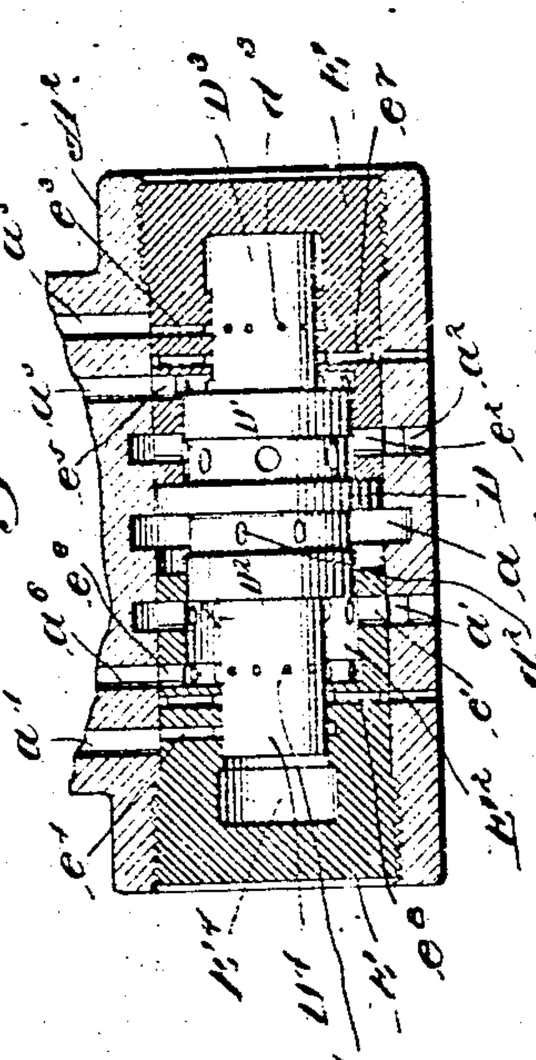


Fig. 7.

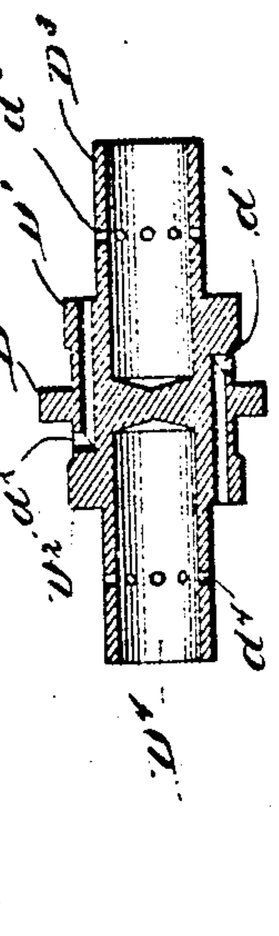


Fig. 3.

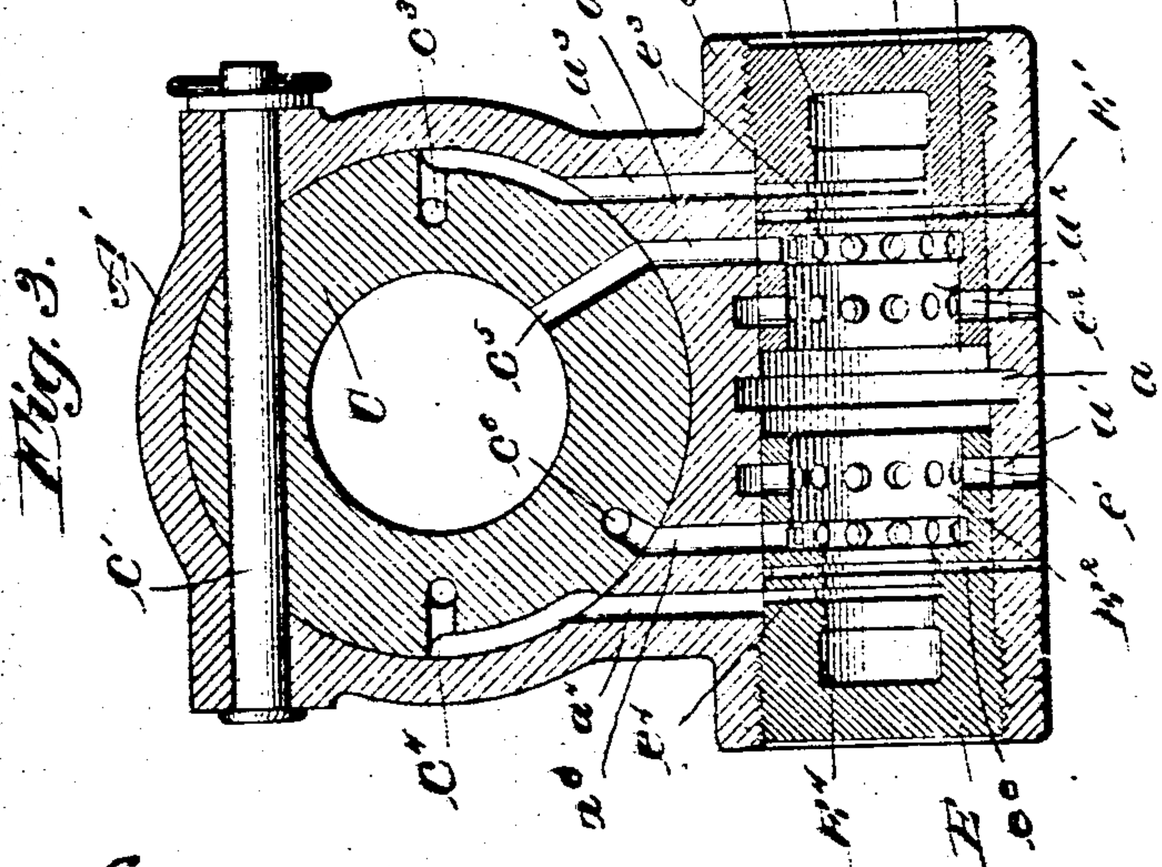
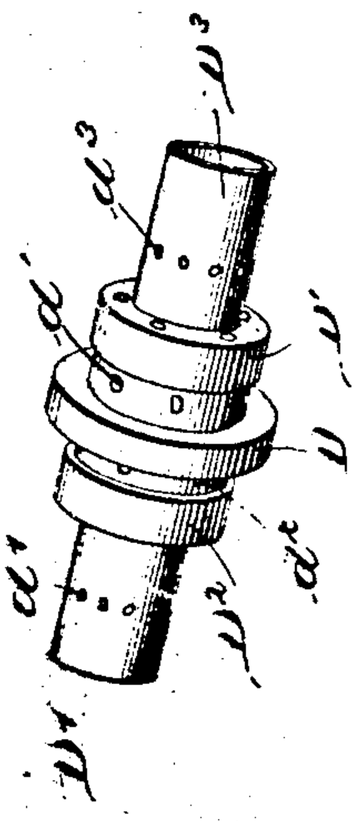


Fig. 6



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UNITED STATES PATENT OFFICE.

HENRY H. VAUGHAN, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE PITTSBURG PNEUMATIC COMPANY, OF CANTON, OHIO, A CORPORATION OF NEW JERSEY.

FLUID-PRESSURE-OPERATED TOOL.

No. 870,651. Specification of Letters Patent. Patented Nov. 12, 1907.

Application filed September 20, 1901. Serial No. 75,975.

To all whom it may concern:

Be it known that HENRY H. VAUGHAN, a citizen of the United States, residing at Chicago, county of Cook, 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 actuated motors, and more particularly to the type of such motors known as pneumatic hammers or riveters, in which a snap or die is adapted to receive the impact of a reciprocating piston.

In fluid pressure motors it is desirable that the valve controlling the supply and exhaust of pressure to the ends of the cylinder should be operated to cut off the supply from the respective sides of the piston before it reaches the end of its stroke, and it is also desirable that the valve should be quickly shifted from one position to the other, and when shifted, positively held by a preponderance of pressure in each position until the piston reaches the predetermined point in its stroke, when the supply and exhaust of fluid pressure to the respective ends of the cylinder should be reversed.

Fluid pressure operated tools of the character referred to are of such power that if the throttle valve is open when the snap or die is out of contact with the object being worked upon, the snap will be violently ejected from the cylinder and thrown a considerable distance owing to the impact of the piston therewith. It is therefore desirable that the reciprocation of the piston should be automatically prevented when the snap is not in contact with an object.

An object of my invention is to provide a fluid pressure motor in which the supply and exhaust of pressure to the respective ends of the cylinder are controlled by a piston valve, the reciprocation of which to its controlling positions will be quickly and certainly accomplished and which when shifted will be firmly held in each position until again shifted by the piston reaching the proper predetermined point in its throw.

A further object of my invention is to construct a fluid pressure operated tool of the character referred to in which the front end of the cylinder is automatically connected with the atmosphere when the snap is not in contact with an object, thereby preventing the reciprocation of the piston towards the snap.

A still further object of my invention is to provide a fluid pressure motor of the type referred to which will be comparatively simple in construction and efficient in operation.

My invention generally stated consists in a cylinder within which a piston is reciprocated by the supply and exhaust of pressure to its opposite sides, the supply and exhaust of pressure being controlled by a differential piston valve having radial surfaces, the shifting of the valve from one position to the other being accomplished by exposing two of its radial surfaces to pressure in one direction, while a third radial surface of less area than the sum of the two surfaces is exposed to pressure in the opposite direction, the valve when shifted being held in proper position by pressure upon one radial surface of greater area than a radial surface exposed to pressure in the opposite direction.

My invention further consists in a fluid pressure operated tool in which a sleeve surrounds the front end of the cylinder and is automatically moved relatively thereto whenever the snap is disengaged from an object, thereby bringing an exhaust port into register with the port in the front end of the cylinder so that the pressure which impels the piston into contact with the snap is relieved.

The 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 of my invention taken on line 1—1, Fig. 2, the parts being shown in the positions they assume when the snap is in contact with an object; Fig. 1ª a sectional view on line 1ª—1ª Fig. 2. Fig. 2 a horizontal sectional view of my invention taken on line 2—2, Fig. 1, looking in the direction of the arrows, the parts being in the positions they assume when the snap is disengaged from an object; Fig. 3 an enlarged cross sectional view on line 3—3, Fig. 1; Fig. 4 a sectional view of the valve casing and showing the valve in elevation in the position which it assumes when pressure is being admitted to the rear end of the cylinder; Fig. 5 a view similar to Fig. 4, the valve being shown in the position in which pressure is admitted to the front end of the cylinder; Fig. 6 a perspective view of the piston valve; and Fig. 7 a longitudinal section of the valve.

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′ which surrounds the front 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 latter being connected to a throttle valve B^4. A spring B^3 retains the throttle valve against its seat formed in the handle A, the opposite end of such spring being supported upon a plug B^2 screwed within a socket formed in the handle in alinement with the valve seat. A passage B, which may be screw threaded,

is formed in the handle A and is adapted to be connected with a conduit leading to a source of fluid pressure.

A transverse cylindrical valve casing A^2 is formed in the valve handle, preferably beneath the tubular extension A' thereof. The valve casing A^2 is provided with a series of passage-ways, a^3, a^4, a^5 and a^6, adapted to communicate with ports in the outer surface of the front end of the cylinder. The valve casing A^2 is also provided with annular passages a, a' and a^2, the former of which communicates through a series of radial passages with a chamber A^3 in the handle A, while the annular passages a' and a^2 located at either side of the passage a communicate with the atmosphere through exhaust ports. A port a^8 is provided in the tubular extension A' near the end thereof for a purpose subsequently to be described.

The front end of the cylinder C is located within the tubular extension A' to which it is secured by means of a flat key c', the outer ends of said key passing through elongated slots a^7 in the tubular extension so as to permit a relative movement between the handle A and the cylinder. Any suitable means may be used to retain the key in proper position, as for instance a head at one end thereof and a dowel pin passing through the other end as shown in Fig. 3 of the drawings.

A series of passages, c^3, c^4, c^5 and c^6, are provided in the cylinder C, the ends of which terminate in ports in the outer periphery of the cylinder, such ports registering with the passages a^3, a^4, a^5 and a^6 in the valve casing A^2 when the handle A is in the position indicated in Fig. 1 of the drawings. The passage c^5 leads directly to the interior of the front end of the cylinder, while the passage c^6 leads to the rear end of the cylinder, such passages c^5 and c^6 affording communication between the supply of fluid pressure and the opposite sides of the piston. The passage c^3 leads to the interior of the cylinder at a point a distance from its rear end slightly greater than the length of the piston, while the passage c^4 communicates with the interior of the cylinder at a point located a distance from the front end of the cylinder slightly greater than the length of the piston.

The rear end C' of the cylinder has an interior diameter slightly greater than that of the cylinder, an annular shoulder c' being formed at the point where the interior diameter of the cylinder terminates and that of the end C' commences. A ferrule G is supported within the rear end of the cylinder by means of a reduced portion of a diameter substantially equal to the interior diameter of the end portion C' within which it fits and rests against the shoulder c'. A snap or die H is supported within the rear end of the cylinder by means of a reduced portion H' fitted within the opening through the ferrule G. The snap is retained within the ferrule by any suitable means, such for instance as a spring ring g which is seated within an annular groove formed in the interior surface of the ferrule near the rear end thereof.

The front end of the cylinder is closed by means of a hollow screw threaded head C^2 which is prevented from rotation within the end of the cylinder by any suitable means, such for instance as a spring actuated bolt c^2. A spring K is interposed between the closed end of the cylinder head C^2 and the handle A and serves to relatively move the handle and cylinder apart the distance permitted by the elongated slots a^7 in the tubular extension A' whenever the snap is disengaged from an object. An air vent k leads to the interior of the cylinder head C^2 through the adjacent wall of the handle A.

Within the opposite ends of the valve casing A^2 are located bushings E having closed outer ends and also having chambers formed therein for the piston valve, suitable ports e^3, e^4, e^5 and e^6, leading from such chambers to the passages a^3, a^4, a^5 and a^6, respectively formed in the handle A and communicating with the interior of the casing A^2. A series of ports e^1 and e^2 extend through the inner ends of the bushings E and register with the annular passage-ways a' and a^2 respectively formed in the inner periphery of the valve casing A^2. Shallow annular grooves e^7 and e^8 may be formed in the interior surfaces of the bushings E intermediate of the ports e^3 and e^5, and e^4 and e^6 respectively.

The piston valve comprises a radial projecting central flange D on either side of which are formed shoulders D' and D^2 of less radius than the centrally projecting flange, such shoulders being formed by reducing the ends D^3 and D^4 of the valve which fit within chambers E^3 and E^4 in the bushings E. The end portions of the valve are hollow, being separated by a partition arranged substantially in alinement with the radial projecting flange D. A series of ports d^3 and d^4 extend through the reduced hollow end portions of the valve. A series of passage-ways d^2 extend from points adjacent to one side of the flange D beneath the surface of the valve and terminate in the vertical face of the shoulder D', while corresponding passages d' extend from the other side of the central flange D to the vertical face of the shoulder D^2. Shallow annular grooves may be formed in the valve at either side of the radial projecting flange D.

The operation of my invention is as follows; When the snap in the end of the tool is out of contact with an object, the spring K expands and relatively moves the handle and cylinder apart as indicated in Fig. 2, and thereby brings the exhaust port a^8, through the tubular extension A', into register with the end of the passage-way c^5 which leads to the interior front end of the cylinder, consequently should the throttle valve be held open when the tool is out of contact with an object, the fluid pressure would flow from the front end of the cylinder to the atmosphere and thereby prevent the piston from being thrown into engagement with the snap. When the tool is to be used and the snap thereof is forced against an object, the handle slides upon the front end of the cylinder the distance permitted by the elongated slots a^7 which surround the key c', such movement of the handle compressing the spring K, the air between the handle and the hollow cylinder head C^2 escaping through the port k in the handle. The exhaust port a^8 passes beyond and out of register with the passage c^5, thereby cutting off the front end of the cylinder from communication with the atmosphere. The lever A^4 when oscillated unseats the throttle valve B^4 and permits the fluid pressure to flow from the source of supply through the opening B into the chamber A^3 in the handle, and thence through radial ports into the annular passage a formed at the center of the valve casing A^2. If the valve is in the position illustrated in Fig. 4, the pressure will flow through the passages d', thence through the ports e^6 formed through the bushing E, thence to the passage a^6 in the handle, thence to the end of the passage c^6 located upon the

periphery of the cylinder, thence through the passage c^6 to the end of the cylinder adjacent to the snap. The piston F would therefore be forced towards the handle of the tool, the pressure in the front end of the cylinder being exhausted through the passage c^5, thence through the passage a^5, thence through the ports c^5 in the bushing E, thence through the ports c^2 in the bushing to the exhaust port a^2 extending through the valve casing to the atmosphere. The valve is retained in the position described by reason of the annular flange D, which is exposed to pressure from the source of supply, being of a greater area than the vertical surface of the shoulder D^2 which is exposed to the pressure passing therethrough to the end of the cylinder. When the piston F passes the end of the passage-way c^4, pressure is admitted through such passage-way to the passage a^4, thence through the series of ports d^4 formed through the hollow end D^4 of the valve and is exerted against the area of the end D^4 of the valve, consequently the valve is thrown from the position indicated in Fig. 4 to that indicated in Fig. 5, owing to the sum of the areas of the shoulder D^2 and the end D^4 of the valve being greater than the area of the annular flange D which alone is exposed to pressure from the source of supply acting to hold the valve in the position shown in Fig. 4.

When the valve has been shifted to the position indicated in Fig. 5, it is retained in such position by the pressure from the source of supply engaging the left vertical face of the annular flange D, such surface as above explained being greater in area than the vertical face of the shoulder D' which is exposed to the pressure passing to the front end of the cylinder by way of the passage a^5. In this position of the valve, the ports c^4, which communicate through the passages a^4 with the passage c^4, are closed by the end D^4 of the valve just as the ports c^3 were closed by the opposite end D^3 of the valve when it was in the position indicated in Fig. 4, consequently when the piston F passes the end of the passage c^3 when moving towards the handle, no pressure can escape from the rear end of the cylinder through such passage c^3. With the valve in the position indicated in Fig. 5 pressure flows through the series of passages d^2 from the source of supply which communicates with the annular passage a, to the passage a^5, thence to the passage c^5 into the front end of the cylinder, thereby throwing the piston towards the snap which it violently contacts with to perform the work desired. The end of the cylinder opposite to the snap at such time communicates with the exhaust ports a^2 by means of the passage c^6 in the cylinder and the passage a^6 in the valve casing, the ports c^6 in the bushing, thence through the ports c' to the exhaust ports a'. When the piston F passes the end of the passage-way c^3 pressure flows through such passage-way into the passage-way a^3, thence through the ports c^3 in the bushing E, thence to the series of ports d^3, through the hollow end D^3 of the valve and acts upon the area of the end D^3 of the valve, which together with the pressure upon the shoulder D^1 overbalances the pressure acting in the opposite direction upon the vertical surface of the annular flange D and shifts the valve back into the position indicated in Fig. 4. The shallow annular grooves formed on either side of the flange D afford means of escape of any pressure which may leak around the outer periphery of such flange when it occupies either of its positions, such shallow grooves being alternately in register with the ports c' and c^2 leading to the exhaust ports a' and a^2 respectively. Similar means may be provided for allowing the exhaust of any pressure which might leak past the end portions of the valve from the ports c^5 and c^6 in the bushings, such exhaust means comprising annular grooves c^7 and c^8 formed adjacent to the series of ports c^3 and c^4, and communicating with the exhaust passages formed through the bushings and registering with exhaust passages formed through the valve casing A^2.

While I have illustrated my improved piston valve as applied to a pneumatic tool I do not wish to limit myself to such use thereof, as it is obviously capable of use in connection with fluid pressure motors generally. I also contemplate using the features which relate essentially to a pneumatic tool, such for instance as the connection of the front end of the cylinder with the atmosphere when the snap is disengaged from an object, in pneumatic tools generally regardless of the particular arrangement of ports and particular means of controlling such ports for a reciprocating piston.

While I have described more or less precisely the details of construction I do not wish to be understood as limiting myself thereto, as I contemplate changes in form, the proportion of parts, and the substitution of equivalents, as circumstances may suggest or render expedient, without departing from the spirit of my invention.

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

1. In a device of the character described, the combination with a cylinder, of a reciprocating piston therein, a valve casing having supply and exhaust ports and ports leading to the interior of the cylinder, a differential piston valve located within said casing and controlling the ports communicating therewith, said valve having a central radial flange the opposite surfaces of which are alternately exposed to fluid pressure from the supply port, and means for permitting fluid pressure to flow from one side of said flange to a port leading to the cylinder from a point in said valve casing located on the opposite side of said flange.

2. In a device of the character described, the combination with a cylinder, of a reciprocating piston therein, a valve casing having supply and exhaust ports and ports leading to the interior of the cylinder, a differential piston valve located within said casing and controlling the ports communicating therewith, said valve having a central radial flange the opposite surfaces of which are alternately exposed to fluid pressure from the supply port, said valve also having passages therein leading from either side of said flange through which fluid pressure flows to the respective ends of the cylinder.

3. In a device of the character described, the combination with a cylinder having passages leading to its opposite ends and passages leading to points at predetermined distances from its ends, of a piston adapted to reciprocate within said cylinder, a differential piston valve having reduced ends, a central radially projecting flange and two radially projecting surfaces between the opposite sides of said flange and the reduced ends of the valve, a valve casing having a chamber communicating with the source of supply within which said flange reciprocates, such valve casing comprising chambers communicating with the passages leading to the opposite ends of the cylinder and within which the radial surfaces reciprocate, said valve casing also comprising chambers communicating with said passages leading to points distant from the ends

of the cylinder and within which the reduced ends of the valve reciprocate, substantially as described.

4. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a valve casing having supply and exhaust ports and ports communicating with the opposite ends of the cylinder, said valve casing having a central chamber, intermediate chambers of less bore than and communicating with the central chamber, and end chambers of less bore than and communicating with the intermediate chambers, and a differential piston valve located in said valve casing and controlling the ports communicating therewith.

5. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a valve casing having a central supply chamber and chambers of reduced bore located on either side of said supply chamber and communicating with exhaust ports and with passages leading to the opposite ends of the cylinder, a differential piston valve located in said valve casing and having a central radial flange adapted to reciprocate in said supply chamber and outwardly directed radial surfaces on either side of said central flange located in said chambers of reduced bore, said valve having passages therethrough leading from either side of said central flange to the radial surface on the opposite side thereof, and means for reciprocating said valve.

6. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a valve casing having a central supply chamber and chambers of reduced bore located on either side of said supply chamber and communicating with exhaust ports and with passages leading to the opposite ends of the cylinder, a differential piston valve located in said valve casing and having a central radial flange adapted to reciprocate in said supply chamber and outwardly directed radial surfaces on either side of said central flange located in said chambers of reduced bore, means for connecting the supply chamber on either side of said central flange with ports on the opposite sides of the flange leading to the interior of the cylinder, and means for reciprocating said valve.

7. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a valve casing having supply and exhaust ports and ports leading to the opposite end of the cylinder, a differential piston valve located in said casing and controlling the ports communicating therewith, said valve having a central radial flange the opposite surfaces of which are alternately exposed to pressure from the supply port to retain the valve in each position, said valve also having a plurality of radial surfaces on either side of said central flange, those on one side adapted to be exposed to fluid pressure flowing to and from the cylinder to move the valve against pressure exerted on the opposite side of the central flange.

8. In a device of the character described, the combination with a cylinder having pressure-admission passages and valve-controlling passages leading to the interior thereof, of a valve casing having chambers communicating with said valve-controlling passages and also having supply and exhaust ports, of a valve in said casing controlling the supply and exhaust of fluid pressure through said pressure admission passages; the ends of which control the communication between said valve-controlled passages and said chambers and between said chambers and exhaust ports, whereby when one valve-controlling passage is open to its communicating chamber the other valve-controlling passage is closed and the chamber communicating therewith connected with an exhaust port, substantially as described.

9. In a fluid pressure operated tool, the combination with a cylinder, of a reciprocating piston therein, a sleeve longitudinally movably mounted upon said cylinder and having a valve casing therein extending transversely to and located on one side of the axis of said cylinder and a valve in said casing adapted to control the supply and exhaust of fluid pressure to the opposite sides of said piston, substantially as described.

10. In a fluid pressure operated tool, the combination with a cylinder having passages leading to predetermined points within the same and terminating at the outer periphery thereof, of a reciprocating piston within said cylinder, a sleeve longitudinally movably mounted on said cylinder and having a valve casing therein extending transversely to the axis of the cylinder, said valve casing having ports adapted to register with the terminal of said passage on the periphery of the cylinder, and a valve within said casing controlling said ports, substantially as described.

11. In a fluid pressure operated tool, the combination with a cylinder having an exhaust port leading from one end thereof, of a sleeve mounted on said cylinder and movable longitudinally with relation thereto, said sleeve having an exhaust port adapted to register with said exhaust port from the cylinder when said sleeve occupies a given position relatively to the cylinder, means connecting said cylinder and sleeve to limit the relative longitudinal movement and to prevent a relative rotary movement thereof, said means comprising a key extending transversely through said cylinder and elongated slots in said sleeve surrounding the projecting ends of the key and engaged thereby, substantially as described.

12. In a fluid pressure operated tool, the combination with a cylinder having a port leading through one end thereof, of a reciprocating piston in said cylinder, a handle mounted on said cylinder and longitudinally movable with relation thereto, said handle having an exhaust port adapted to register with said port through the cylinder when the handle occupies a given position relatively to the cylinder thereby opening communication between an end of the cylinder and the atmosphere, substantially as described.

13. In a device of the character described, the combination with a cylinder having a passage leading to one end and a passage leading to a point at a predetermined distance from said end, of a piston adapted to reciprocate within said cylinder, a differential piston valve having radially projecting surfaces, a valve casing having supply and exhaust ports and ports communicating with the passages in the cylinder and controlled by said valve, one of said radial surfaces of the valve adapted to be exposed to pressure from the source of supply, while two other radial surfaces located on the side of the first radial surface opposite to the side thereof exposed to fluid pressure are adapted to be exposed to pressure passing to the working end of said cylinder and from the working end thereof when the piston uncovers said passage leading to the predetermined point of the end of said cylinder, the sum of the two latter surfaces being greater in area than that of the first, substantially as described.

14. In a fluid pressure operated tool, the combination with a cylinder having an exhaust port leading from one end thereof, of a reciprocating piston in said cylinder, a handle mounted on said cylinder and longitudinally movable with relation thereto, means actuated by said handle adapted to open said exhaust port by its movement away from the cylinder and to close said exhaust port by its movement towards the cylinder.

15. In a device of the character described, the combination with a cylinder, of a reciprocating piston in said cylinder, a valve casing, a differential piston valve in said casing, said valve casing having supply and exhaust ports leading to the cylinder through which motive fluid passes to reciprocate the piston which are controlled by the valve, said cylinder having passages controlled by the piston and which lead to the valve casing to reciprocate the valve, and said valve having a series of areas and controlling surfaces so related to said supply and exhaust ports and valve-controlling passages that the valve is held in one position by pressure from the supply port and when in such position is adapted to be reversed by exposure to pressure from the cylinder flowing through only one of said valve-controlling passages.

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

HENRY H. VAUGHAN.

Witnesses:
GEO. L. WILKINSON,
CLARA C. CUNNINGHAM.