No. 785,324. PATENTED MAR. 21, 1905.

R. A. NORLING.

PNEUMATIC HAMMER.

APPLICATION FILED AUG. 19, 1904.

4 SHEETS—SHEET 1.

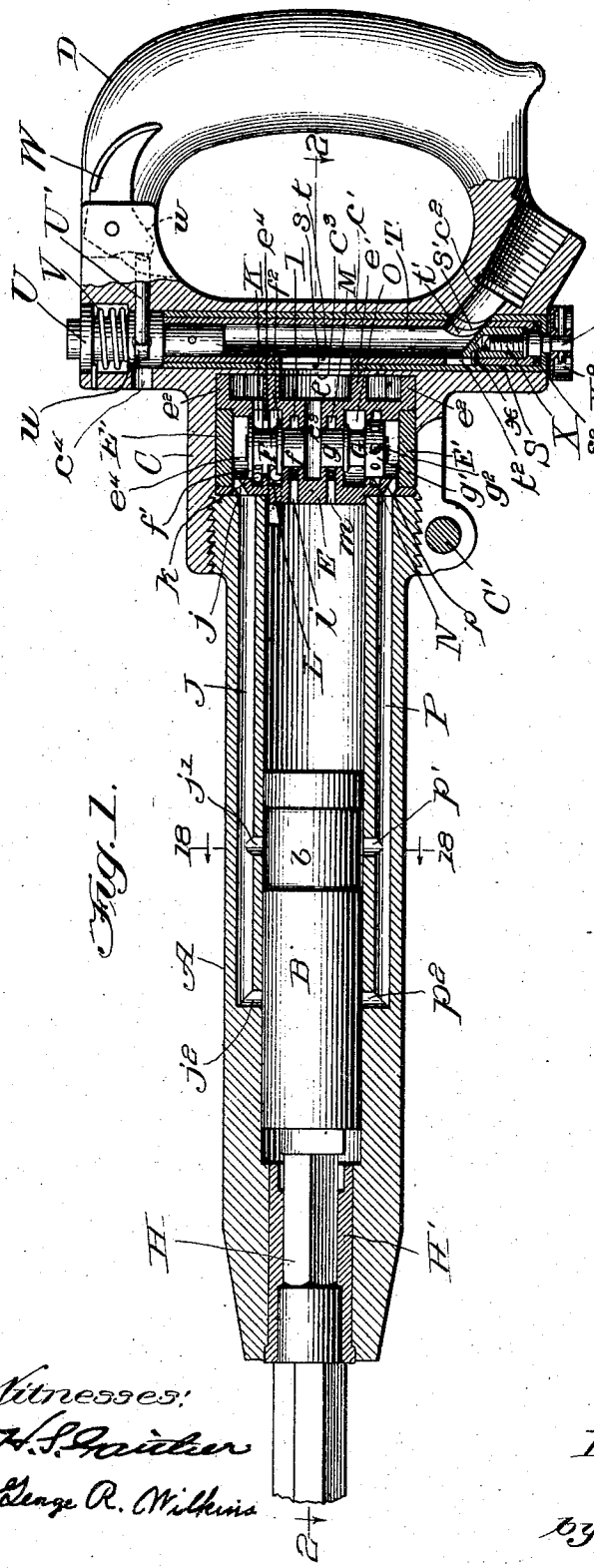


Fig. 1.

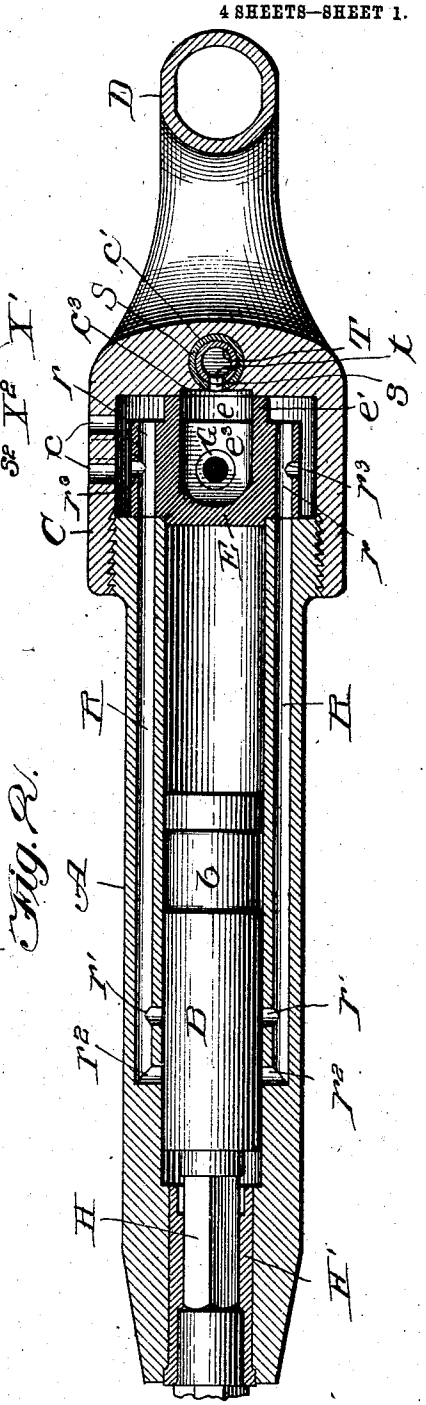


Fig. 2.

Witnesses:
H. S. Gaither
George R. Wilkins

Inventor:
Reinhold A. Norling
by Poole & Brown
Attorneys

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 785,324. PATENTED MAR. 21, 1905.

R. A. NORLING.

PNEUMATIC HAMMER.

APPLICATION FILED AUG. 19, 1904.

4 SHEETS—SHEET 2.

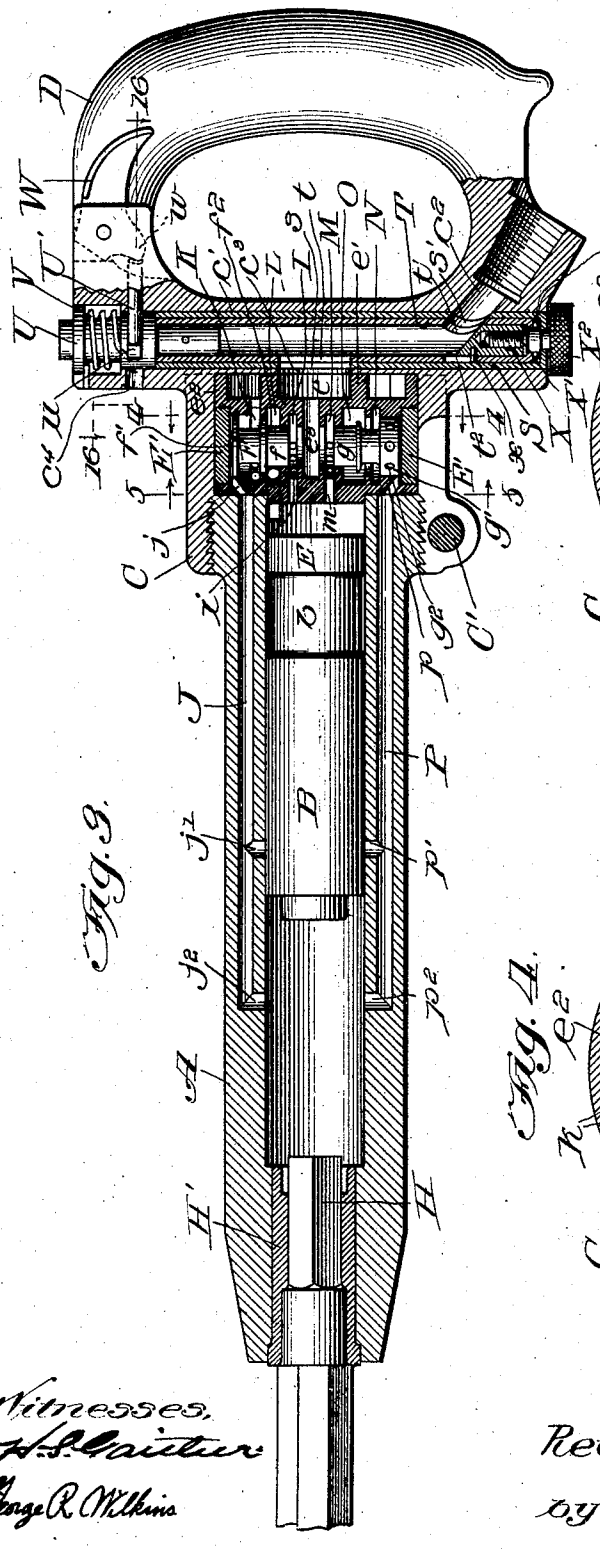


Fig. 3.

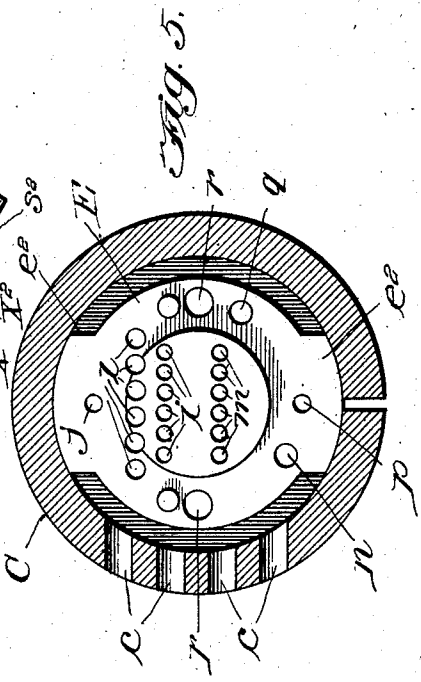


Fig. 5.

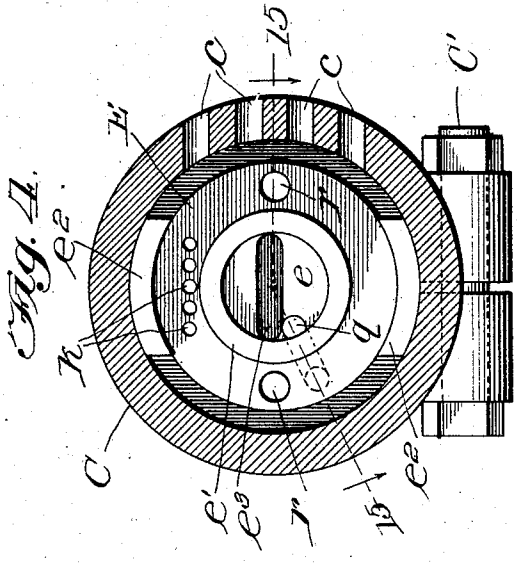


Fig. 4.

Witnesses,
H. S. Gaither
George R. Wilkins

Inventor:
Reinhold A. Norling
by Poole & Brown
attorneys

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 785,324. PATENTED MAR. 21, 1905.

R. A. NORLING.

PNEUMATIC HAMMER.

APPLICATION FILED AUG. 19, 1904.

4 SHEETS—SHEET 3.

Fig. 9.

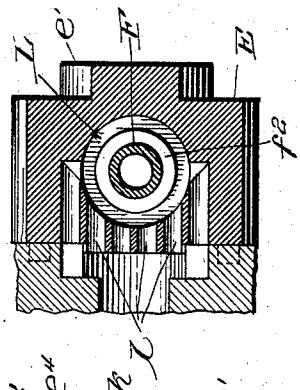


Fig. 13.

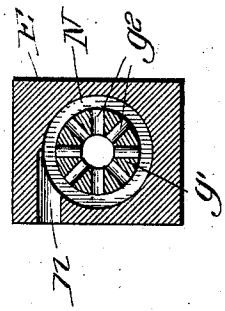


Fig. 8.

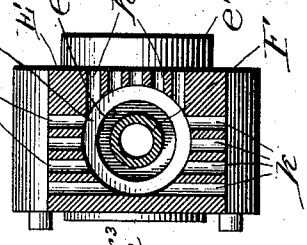


Fig. 12

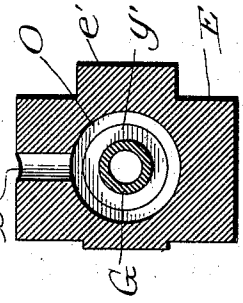


Fig. 7.

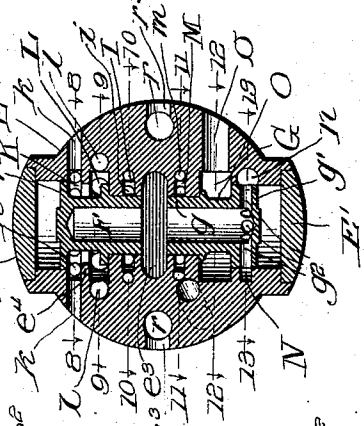


Fig. 11.

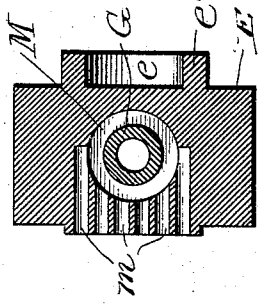


Fig. 6.

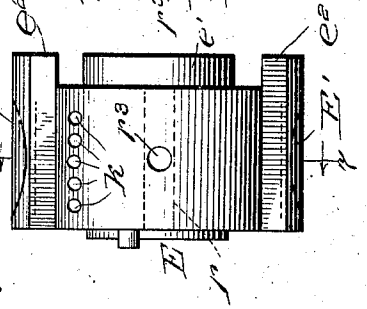
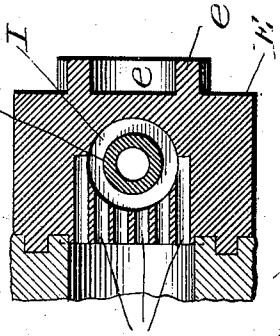


Fig. 10.



Witnesses:

H. S. Gaither

George R. Wilkins

Inventor:

Reinhold A. Norling.

by Poole & Brown

Attorneys

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

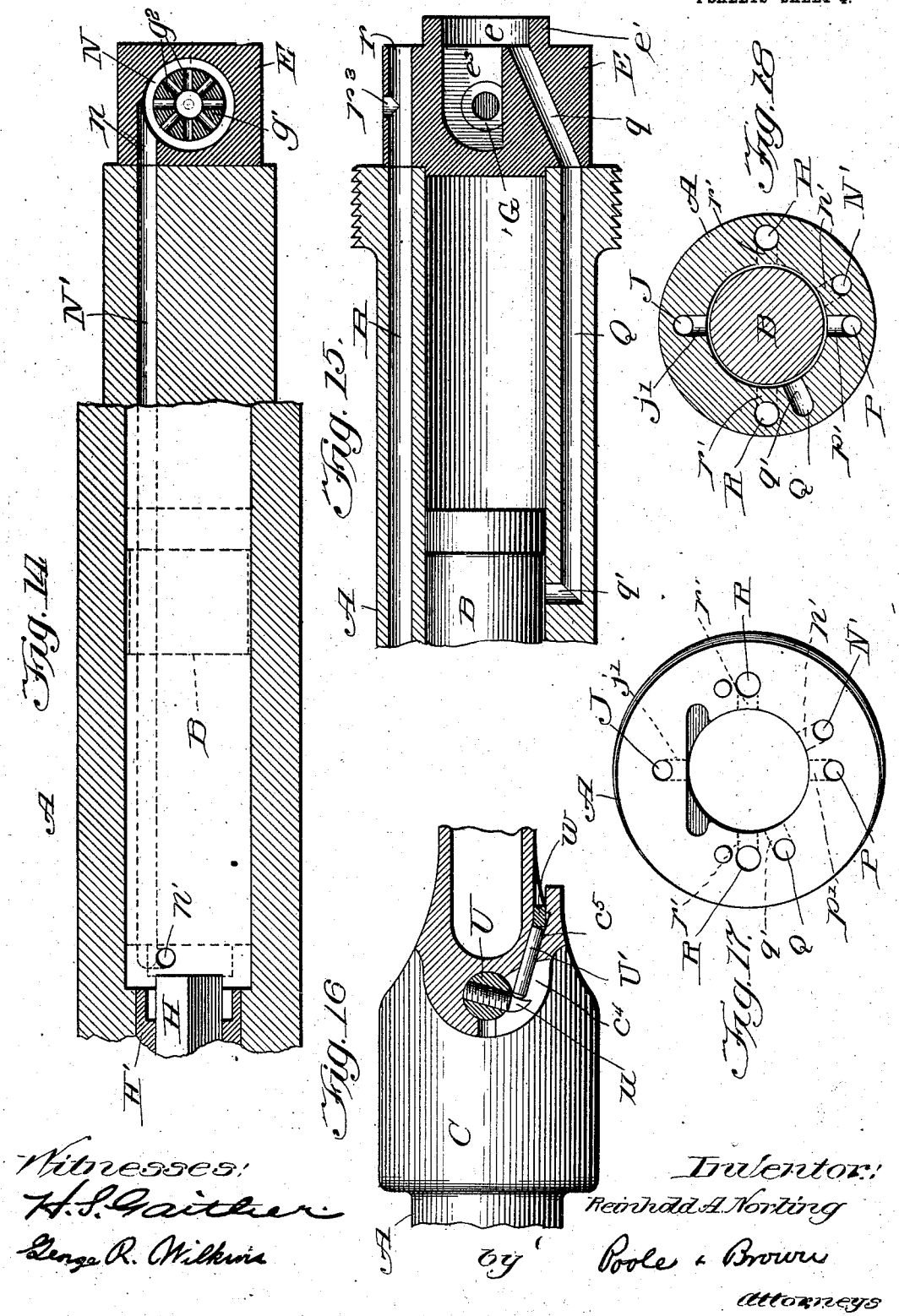
No. 785,324. PATENTED MAR. 21, 1905.

R. A. NORLING.

PNEUMATIC HAMMER.

APPLICATION FILED AUG. 19, 1904.

4 SHEETS—SHEET 4.



Witnesses:
H. S. Gaither
George R. Wilkins

Inventor:
Reinhold A. Norling
by Poole & Brown
Attorneys

PHOTO-LITHOGRAPHED BY SACKETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 785,324. Patented March 21, 1905.

UNITED STATES PATENT OFFICE.

REINHOLD A. NORLING, OF AURORA, ILLINOIS, ASSIGNOR TO AURORA AUTOMATIC MACHINERY COMPANY, OF AURORA, ILLINOIS, A CORPORATION OF ILLINOIS.

PNEUMATIC HAMMER.

SPECIFICATION forming part of Letters Patent No. 785,324, dated March 21, 1905.

Application filed August 19, 1904. Serial No. 221,404.

To all whom it may concern:

Be it known that I, REINHOLD A. NORLING, a citizen of the United States, and a resident of Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Pneumatic Hammers; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to a pneumatic tool in the nature of a portable pneumatic hammer or device of that class embracing a barrel or cylinder, a piston or plunger adapted to slide therein, and a controlling-valve through which the air or other fluid under pressure is admitted to and permitted to escape from the opposite ends of the cylinder to give reciprocatory movement to the plunger in the barrel.

The tool illustrated in the accompanying drawings is designed for use as a chipping-hammer; but the same features of construction illustrated in said drawings and herein claimed may be employed in a tool used for other purposes, as for riveting or the like.

The invention consists in the matters hereinafter described, and pointed out in the appended claims.

As shown in the accompanying drawings, Figure 1 is a view in central longitudinal section of a tool embodying my invention, taken through the central axis of the piston-controlling valve and of the throttle-valve. Fig. 2 is a central longitudinal section of the same, taken on the line 2 2 of Fig. 1. Fig. 3 is a sectional view corresponding with Fig. 1, showing the controlling-valve in a changed position. Fig. 4 is an enlarged detail section taken upon line 4 4 of Fig. 3. Fig. 5 is an enlarged detail cross-section taken upon line 5 5 of Fig. 3. Fig. 6 is a detail view, in side elevation, of the valve-block removed from the body of the tool. Fig. 7 is a view in cross-section of said valve-block with its contained valve, taken on line 7 7 of Fig. 6. Fig. 8 is a detail section taken upon line 8 8 of Fig. 7. Fig. 9 is a detail section taken upon line 9 9 of Fig. 7, showing an adjacent part of the barrel. Fig. 10 is a detail section taken upon line 10 10 of Fig. 7, also showing the adjacent part of the barrel. Fig. 11 is a detail section taken upon line 11 11 of Fig. 7. Fig. 12 is a detail section taken upon line 12 12 of Fig. 7. Fig. 13 is a detail section taken upon line 13 13 of Fig. 7. Fig. 14 is a fragmentary longitudinal section of the barrel, valve-block, and controlling-valve, taken in part through the central axis of the barrel and in part on the plane indicated by line 13 13 of Fig. 7. Fig. 15 is a detail longitudinal section through the valve-block and part of the barrel, taken on line 15 15 of Fig. 4. Fig. 16 is a detail view, partially in side elevation and partially in section, of the head or cap of the tool, the section being taken on the plane indicated by the line 16 16 of Fig. 3. Fig. 17 is a detail end view of the inner end of the barrel. Fig. 18 is a section of the barrel, taken on line 18 18 of Fig. 1.

As shown in said drawings, A indicates the working cylinder or barrel of the tool, B the sliding piston therein, and C a hollow cylindric head attached to the inner end of the barrel and provided with a handle D, which is shown as made integral with the head C.

E is a valve-block located within the head C in contact with the open inner end of the barrel A, and F and G represent endwise-sliding valve-pistons located therein and constituting, with the valve-block, the controlling-valve of the tool.

H is a tool-carrying spindle which is mounted in the outer end of the barrel and projects into the same in position for contact with its inner end of the plunger B. Said tool-spindle H is shown as being arranged to slide in a guide-aperture formed in a bushing H', which is secured in a cylindric aperture in the outer end of the barrel, said spindle having a limited endwise sliding movement in said bushing, as common in like tools.

The cylindric head C is adapted to receive the adjacent or inner end of the barrel and is connected therewith by means of internal screw-threads on the head, which are engaged

with external screw-threads on the barrel, the head being longitudinally split at one point in its circumference and provided with a clamp-screw C′, by which the head may be rigidly clamped upon the barrel. Said head C is shaped to provide adjacent to the inner end of the barrel a recess or chamber, preferably of cylindric form, within which is contained the valve-block E, which latter rests in contact with the margin of the barrel at the inner end of the same and is clamped between said inner margin of the barrel and an opposing surface formed on or by the end wall of the said head. A space or chamber is formed between the said valve-block and the surrounding wall of the head C, which forms an exhaust-passage, and said space is connected with the outer air by means of a plurality of exhaust-openings *c c*, as clearly seen in Figs. 2, 4, and 5.

Within the head C, in the part thereof which forms the end wall of the head, and at the base of the handle D is formed a transverse bore or passage *c′*, in which is located a throttle-valve and one end of which communicates with a transverse inlet-passage c^2, formed in the head at one end of the handle D and the outer end of which is screw-threaded or otherwise constructed for connection with an air-supply pipe, through which air or other gaseous fluid under pressure is supplied to the tool. The bore or passage *c′* contains parts constituting a throttle-valve, as hereinafter described, and said bore or passage communicates, by means of a centrally-arranged port or opening c^3 in the end wall of the head C, with a chamber *e*, formed in the adjacent face of the valve-block E and which is separated from the exhaust-space within the head by means of the surrounding portion of said block E, which reaches to and has bearing contact with the said end wall of the head. Within the said valve-block E is formed a transverse valve chamber or recess containing the two valve-pistons F and G. The end portions of the valve-block adjacent to the ends of the said valve-chamber are extended into contact with the side walls of the head C and have close-fitting contact therewith, and the ends of the valve-chamber are closed by means of two cap plates or disks E′ E′, that are somewhat larger in diameter than the adjacent ends of the valve-chamber and are fitted at their margins in rabbets or annular recesses formed in the valve-block around the ends of said valve-chamber. The external surfaces of the said cap-plates E′ E′ are curved to conform to the inner surface of the head C, as clearly seen in Fig. 7, and are adapted to have close-fitting contact with the inner surface of the head, so that when said cap-plates are inserted in place in the said valve-block and the latter is placed within the head said plates will be closely confined in place within and will tightly close the ends of the valve-chamber. The marginal or lateral parts of the said valve-block are cut away or removed between the projections at the ends of the valve-chamber, so that the main part or body of the block is of less diameter than the head C, thereby leaving between the sides of the block and the wall of the head lateral spaces constituting the exhaust chamber or passage, hereinbefore referred to. The end of the valve-block which is in contact with the barrel A has close-fitting contact therewith throughout the entire circumference of the barrel and is preferably provided with a central extension or projection which extends a short distance into the barrel and forms an annular shoulder by which the valve-block is held accurately in central position relatively to the barrel. The opposite or outer face of the valve-block, which contains in the recess *e*, hereinbefore referred to, is rabbeted or cut away in its parts exterior to said recess, so as to form a projecting annular flange *e′*, which surrounds said chamber and which bears endwise against the end wall of the head C, so as to leave a space between the face of the block exterior to said flange *e′* and the adjacent face of said end wall, which space is in communication with the spaces at the side of the valve-block and constitutes a part of the exhaust-passage, hereinbefore referred to. At the end portions of the valve-block or the parts thereof adjacent to the ends of the valve-chamber the metal at the outer face of the block is cut away in a manner to form two grooves, as seen in Figs. 4 and 6, thereby leaving at such end portions of the block two diametrically opposite flanges e^2 e^2, Figs. 4 and 6, which extend to and have bearing contact with the inner face of the end wall of the head, as clearly seen in Figs. 1 and 5.

Near the center of the valve-block is formed an opening or port e^3, which extends inwardly from the central recess *e* and communicates with the center of the valve-chamber, in effect dividing such valve-chamber into two parts, each of which constitutes a seat for one of the valves F and G. At its inner end the valve-piston F has a cylindric portion *f*, which fits and slides in a cylindric seat formed in the valve-block adjacent to the central recess e^3 and provided in its inner surface with a central groove I, which communicates with the interior of the barrel by means of a plurality of ports or openings *i i*, Fig. 10, extending from said groove I through the inner face of the block E. At its outer end the said valve-piston F is provided with an annular flange *f′*, which is considerably larger in diameter than the inner part *f* of the piston and which fits and slides in a cylindric seat formed in the outer end of the valve-chamber. The space between the said flange *f′* and the adjacent end of the valve-chamber communicates, by means of a port *j*, Figs. 1 and 3, with a passage J, which leads endwise through the wall of the barrel A and communicates

with the interior of the barrel by means of transverse ports or openings j' j^2. On said valve-piston F, between the inner cylindric part f and the flange f', is formed an intermediate flange f^2, and the valve-chamber is provided with an annular groove or recess K, which is in communication with the exhaust-space of the head C by means of passages k k, Fig. 8, and adjacent to the seat for the part f of the valve with an annular groove L, which communicates with the interior of the cylinder by means of ports or passages l l, Fig. 9. The grooves or recesses K and L are separated from each other by means of an annular flange e^4 of the same internal diameter as the flange f^2 of the valve-piston F. These parts are so arranged that when the said piston F is at the inner limit of its movement, as seen in Figs. 1 and 7, communication between the central passage e^3 and the recess I is cut off, while the passages K and L are in communication with each other, and when the said piston-valve is at the outward limit of its movement said passage e^3 will be in communication with the recess I, while communication between the recesses K and L will be cut off.

The valve-piston G has an inner cylindric portion g, adapted to fit and slide in a cylindric seat formed in the valve-block adjacent to the central recess e^3. In said cylindric seat is formed an annular groove M, which communicates with the interior of the barrel by means of holes or ports m m in the valve-block. At its outer end the said piston G is provided with a portion g', considerably larger in diameter than the portion g and which fits and slides in a cylindric seat formed in the outer end of the valve-chamber. The enlarged part g' of said valve-piston G is made of considerable width, and said valve is hollow or provided with a central bore, and the said enlarged part g' of the valve is provided with a series of radial passages or openings g^2, Fig. 7, communicating with said bore. In the face of the said cylindric seat is formed an annular groove N, which communicates by a port n, Figs. 13 and 14, with a passage N' in the wall of the barrel leading to the outer end of the said barrel and communicating therewith with the interior thereof by means of a port n'. Between the cylindric seats for the inner and outer ends of the piston G is formed an annular recess O, which communicates with the exhaust-space of the head C by means of a laterally-directed port o in the block E, Fig. 12. These parts are so arranged that when the valve-piston G is at the inward limit of its movement, as shown in Figs. 1 and 7, communication between the central port e^3 and the recess M will be cut off and communication between the valve-recesses M and N will likewise be cut off, while communication will be established through the hollow interior of the said piston-valve and the radial openings g^2, between the said central passage e^3 and the annular recess N.

The space at the end of the valve-chamber between the piston g' and the adjacent outer end of said chamber is connected, by means of a port or passage p in the valve-block, with a longitudinal passage P in the wall of the barrel, which passage communicates with the interior of the barrel by means of transverse ports p' p^2, arranged at the same distances from the inner end of the barrel as the ports j' and j^2.

q, Figs. 4 and 15, is a port or passage which leads diagonally through the block E from the central recess e^3, Fig. 15, and communicates with a longitudinal passage Q, formed in the barrel and opening into the latter by a port q', located at the same distance from the inner end of the barrel as the ports j' and p', hereinbefore referred to. The valve-block E is also provided with two holes r r, extending from the outer to the inner face thereof and communicating with two longitudinal passages R R in the wall of the barrel. These passages communicate with the interior of the barrel by ports r' r^2, arranged at such distances from the outer end of the barrel that they will be uncovered by the plunger B when the latter is at the inward limit of its stroke, but will be covered and closed by the said plunger when the latter is at the outer limit of its stroke. Said passages R R are in constant communication at their inner ends with the exhaust space or passage of the head C through the holes r r in the valve-block and transverse holes r^3, Fig. 2, which open from the holes r r through the sides of said block.

The piston or plunger B is provided near its inner end with an annular groove or recess b, which when the said plunger is at the outer limit of its movement stands opposite the ports j', p', and q' and establishes communication between said passage Q and the passages J and P. Said passages J and P, as before stated, communicate with the opposite or outer ends of the valve chamber or seats for the valve-pistons F and G.

The operation of the valve described is as follows: Air under pressure is admitted from the throttle-valve through the port e^3 to the central chamber e and the recess e^3 between the valves. So long as the throttle-valve is open constant air-pressure is maintained in the said passage e^3, which tends to hold the valve-pistons F and G at the outward limit of their movement or throw them outwardly. Air under pressure also passes through the port q and the passage Q to the port q'. When the parts are in the position shown in Figs. 1 and 7, with the plunger at the outer or lower end of the barrel and ready to go up or move inwardly, the live air passes through the passages Q and the port q' around the recess b in the plunger to the ports j' and p' and thence

through the passages J and P to the outer ends of the valve-chamber, wherein it acts upon the outer and larger parts f' g' of the two valve-pistons and forces the same inward against the air-pressure on their smaller inner ends. At this time access of live air to the inner end of the barrel through the recesses I and M and ports i and m will be cut off, the exhaust-ports l at the inner end of the barrel will be in communication with the outer air through the exhaust-ports l l, the grooves L and K, the holes k, and the exhaust-passage in the head, while at the same time live air to drive the plunger backwardly or inwardly will be supplied from the recess e^3 through the central bore of the valve-piston G, the radial passages g^2, the annular recess N, the port n, passage N', and port n', Fig. 14. When the outer end of the plunger in its inward movement passes and opens the ports r' r^2, pressure on the outer ends of the valve-pistons will be released, as the ports j^2 p^2 of passages J and P, leading to the outer ends of the valve-chamber will then be in communication with the outer air through the passages R R, Fig. 2. As soon as the pressure on the outer ends of the valve-pistons is thus released the air-pressure in the central passage c^3, acting on the smaller inner ends of the pistons, forces the same outward and into the position shown in Fig. 3. At this time the live air passes from the central passage c^3, through the grooves I and N and ports i n, to the inner end of the barrel and acts to drive outwardly the plunger. At this time the exhaust-ports l at the inner end of the barrel will be closed through the interposition of the flange f^2 of the piston between the grooves K and L, and at the same time the passage of the exhaust from the lower end of the cylinder will be permitted, through the port n', the passage N', the groove N, the groove O, and port o, to the atmosphere through the openings c c in the head C.

Important advantages gained by the use of two separate valve-pistons are that such valve-pistons may be made very small and light, while at the same time affording the necessary area for the admission of the air with a movement of the pistons through the short distance. By reason of their light weight said valve-pistons will work with a minimum hammering action and will possess great strength and durability. Moreover, as each valve will need to have a very short stroke to give the required admission their action will be very quick and the machine may be run with great speed. An advantage gained by employing two valve-pistons arranged to move in opposite directions at the same time is that vibration due to the reciprocatory movement of the piston is counterbalanced, and the action of the valves will not tend to produce any vibration in the tool while running. By arranging the valve-pistons as described, so that both pistons control inlet-ports admitting air to the inner end of the cylinder, a large air-supply is afforded to drive the plunger outward in its working stroke, while each valve-piston has a relatively short stroke.

Now referring to the throttle-valve hereinbefore referred to the same, as herein illustrated, embraces features of construction as follows: The bore or passage c', formed in the head C as hereinbefore described, opens at its ends through opposite sides of the head, and within the same is located a cylindric bushing S, which is fixed immovably in the head and extends from the side thereof at which the inlet-passage c^2 is located nearly to the opposite end of the said bore or passage. Within the bushing S is located a rotative valve-tube T. The bushing S is provided with an aperture s, coinciding with the opening c^3, while the valve-tube T is provided with an opening adapted to register with the said opening s. The bushing S is also provided with an aperture s', coinciding with the inlet-passage c^2, while the valve-tube T is provided with a port t', adapted to register with the port s', but which when the valve is turned will be carried out of register with said port, so as to partially or entirely cut off the passage of air from the supply-passage c^2 to the interior of the said valve-tube. Preferably the port t is made wide enough to afford constant communication of the interior of the tube with the central space e of the valve-block, so that when the tube T is turned into position to bring the port t' out of register with the port s' the air-supply will be cut off at a point adjacent to the inlet-passage c^2 and no pressure will exist in the interior of the tube T. Leakage of air from said tube when the throttle-valve is closed is thus prevented. At its end remote from the supply-passage e^2 the valve-tube T is attached to a rotative plug U, which closes the end of the tube and through which the same is turned or oscillated. Said plug U fits and turns within the adjacent end of the bore c' of the head C, and a spring V is applied to act on said plug U in such manner as to turn the valve-tube in a direction to close the valve. Said spring V is shown in the drawings as having the form of a coiled spring which surrounds a reduced part of the said plug U and is engaged at one end with a shoulder on the head C and at its opposite end with the plug. Secured in the said plug U is a radial arm u, adapted to swing or move in a slot c^4, Figs. 1 and 16, formed in the head C. An actuating-lever W is mounted on the head C at one side of the handle D in proper position for contact therewith of the thumb of the operator when the hand grasps said handle. An endwise-sliding actuating-rod U' is mounted in a guide-passage c^5, formed in the head C near the base of the handle D, in such position that one end will rest or bear against a laterally-extending arm w of the actuating-lever, Fig. 1. The opposite end of said rod

rests or bears against the stud u. From the construction described it is manifest that when the actuating-lever W is pressed downwardly or inwardly the sliding actuating-pin U′ will act on the stud u to turn the plug U against the action of the spring V, thereby rotating the valve-tube T in a direction to open the valve. Upon releasing the lever the spring turns the said tube in a direction to close the valve.

In connection with a rotative throttle-valve made as above described I provide means for varying the quantity of air delivered to the machine when the throttle-valve is opened, the same being constructed as follows: Within the outer end of the valve-tube T, or that adjacent to the supply-passage c^2, is located an endwise-sliding valve-plug X, which fits closely in the said tube and the inner end of which is adapted to overlap to a greater or less extent the port t of the valve-tube T when said plug is moved inwardly. Said plug is held from turning or rotating in the said tube T by means of a guide-pin x, affixed in the plug and sliding in a longitudinal slot t^2, formed in the tube T. For giving endwise movement to the plug a screw-shaft X′ is provided. The adjacent end of the valve-tube T is closed by an end wall, and the said screw-shaft X′ has screw-threaded engagement with the plug and passes through the said end wall of the valve-tube and also through the outer end of the bushing S. Said screw-shaft is provided outside of the bushing with a milled disk or head X^2. Said screw-shaft X′ is held from endwise movement with respect to the valve-tube T by suitable bearing-shoulders engaging the end wall of the valve-tube. To provide for a tight joint between the outer end of the valve-tube T and the closed end of the bushing S, a packing-ring s^2 is inserted between the head of the bushing and the adjacent end of the sleeve S, said packing being adapted to also bear against a cylindric surface of the screw-shaft X′.

From the above description it will be manifest that when the adjusting-screw X′ is turned to carry the plug X inwardly, so that it will partially overlap and close the port t', the supply of air to the machine may be regulated or controlled separately from its control by the turning of the valve-tube through the actuating-lever.

I claim as my invention—

1. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and communicating with the inner end of the barrel by two admission-ports and two valve-pistons in said valve-chamber both of which control the admission of air to the inner end of the barrel through said admission-ports, and means for actuating said valve-pistons.

2. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and communicating with the inner end of the barrel by two admission-ports, two valve-pistons in said valve-chamber which severally control the admission of air to the inner end of the barrel through said admission-ports, and means for giving endwise reciprocatory movement to the valve-pistons simultaneously in opposite directions.

3. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and which is connected with the inner and outer ends of the barrel by admission and exhaust ports or passages and two valve-pistons in said valve-chamber both of which control the admission of air to the inner end of the barrel, one of which controls the exhaust from the inner end of the barrel and the other of which controls both the admission of air to and the exhaust of air from the outer end of the barrel, and means for actuating said valve-pistons.

4. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and which is connected with the inner and outer ends of the barrel by admission and exhaust ports or passages, two valve-pistons in said valve-chamber, both of which control the admission of air to the inner end of the barrel, one of which controls the exhaust from the inner end of the barrel, and the other of which controls both the admission of air to and the exhaust of air from the outer end of the barrel, and means for giving endwise reciprocatory movement to the said valve-pistons simultaneously in opposite directions.

5. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and which is connected with the inner and outer ends of the barrel by admission and exhaust ports or passages, and two valve-pistons in said valve-chamber both of which control the admission of air to the inner end of the barrel, and means controlled by the movement of said plunger for giving endwise movement to said valve-pistons.

6. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, and with admission and exhaust ports including two admission-ports located at opposite sides of the air-supply passage and leading to the inner end of the cylinder, two endwise-sliding piston-valves which severally control the passage of air from the air-supply passage to said admission-ports, and means controlled by the movement of said plunger for giving endwise movement to said valve-pistons simultaneously in opposite directions to effect the simultaneous opening and closing of said admission-ports.

7. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, and with admission and exhaust ports connected with the inner and outer ends of the barrel, two endwise-sliding piston-valves which control said admission and exhaust ports, the outer ends of which are larger in diameter than their inner ends, and the inner ends of which are subject to constant air-pressure from the said air-supply passage, and means for connecting the spaces at the ends of said valve-chamber, exterior to the larger outer ends of said valve-pistons, alternately with said air-supply passage and with the outer air.

8. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, and with admission and exhaust ports, including two admission-ports located at opposite sides of the air-inlet passage and leading to the inner end of the barrel, two endwise-sliding valve-pistons which are larger in diameter at their outer than their inner ends, and the smaller inner ends of which are subject to constant air-pressure from said air-inlet passage, and means for connecting the spaces in the outer ends of said valve-chamber, exterior to the said larger outer ends of the valve-pistons alternately with the said air-inlet passage and with the outer air.

9. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with admission and exhaust ports connected with the inner and outer ends of the barrel, two endwise-sliding valve-pistons located in said valve-chamber, said pistons being of larger diameter at their outer than at their inner ends, and having their inner ends subject to constant pressure of air from the said air-supply passage, and means for alternately connecting the spaces at the outer ends of said valve-chamber, exterior to the larger outer ends of the valve-pistons, with the air-supply passage and with the outer air, comprising passages connected with the said spaces, with the air-supply passage and with the outer air, and which communicate with the interior of the barrel by ports which are controlled by the plunger in its endwise movement.

10. The combination with a barrel and a plunger therein, provided with a recess or groove between its ends, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with admission and exhaust ports connected with the inner and outer ends of the barrel, two endwise-sliding valve-pistons located in said valve-chamber, said pistons being of larger diameter at their outer than at their inner ends, and having their inner ends subject to constant pressure of air from the said air-supply passage, and means for alternately connecting the outer ends of said valve-chamber, exterior to the larger outer ends of the valve-pistons, with the air-supply passage and with the outer air, comprising passages and ports in the wall of the barrel controlled by the plunger in its endwise movement, said passages including a passage leading from the air-supply passage through the wall of the barrel and opening into the same between its ends, two passages leading from the opposite ends of said valve-chamber and communicating with the interior of the barrel by ports located between its ends, said groove or recess in the plunger being adapted to establish communication between said air-passages in the wall of the barrel.

11. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with admission and exhaust ports communicating with the inner and outer ends of the barrel, two endwise-sliding valve-pistons located in said valve-chamber, said pistons being of larger diameter at their outer than at their inner ends, and having their inner ends subject to constant pressure of air from said air-supply passage, and means for alternately connecting the spaces at the outer ends of said valve-chamber exterior to the larger outer ends of the valve-pistons with the air-supply passage and with the outer air, comprising two passages in the wall of the barrel which are severally connected with the said spaces at the outer ends of the valve-chamber and which open into the interior of the barrel through ports that are uncovered when the plunger is at the inward limit of its movement and a passage in the wall of the barrel which communicates with the outer air and which opens into the interior of the barrel by a port which is also uncovered when the plunger is at the inward limit of its movement.

12. The combination with a barrel and a plunger therein, provided with a recess or groove between its ends, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with admission and exhaust ports connected with the inner and outer ends of the barrel, two endwise-sliding valve-pistons in said valve-chamber, said pistons being of larger diameter at their outer than at their inner ends and having their inner ends subject to constant pressure of air from said air-supply passage, and means for alternately connecting the outer ends of said valve-chamber exterior to the larger outer ends of the valve-pistons, with the air-supply passage and with the outer air, comprising two passages in the wall of the barrel which are severally connected with the outer ends of the said valve-chamber and each of which opens into the barrel through two ports, one of which is uncovered by the plunger when the latter is at the inward limit of its movement,

and the other of which communicates with said groove or recess in the plunger when the latter is at the outer limit of its movement, a passage in the wall of the barrel which communicates with the said air-supply passage and opens into the interior of the barrel by a port located in position to communicate with the said groove or recess in the plunger when the latter is at the outer limit of its movement, and a passage in the wall of the barrel which communicates with the outer air and is connected with the interior of the barrel by means of a port located in postion to be uncovered by the plunger when the same is at the inner limit of its movement.

13. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, with two admission-ports located at opposite sides of said air-supply passage and leading to the inner end of the barrel, with an exhaust-port communicating with the inner end of the barrel, and with an admission and exhaust port communicating with the outer end of the barrel, and two endwise-sliding piston-valves, the inner or adjacent parts of which control the passage of air from the air-supply passage to the said admission-ports leading to the inner end of the barrel, one of which controls the exhaust-passage leading from the inner end of the barrel and the other of which controls the passage of air from said air-supply passage to the outer end of the barrel, and also controls the exhaust from the outer end of the barrel.

14. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, and with two annular recesses located at either side of said air-supply passage and communicating by admission-ports with the inner end of the barrel, said valve-chamber also having between one of said annular grooves and one end of the valve-chamber two annular exhaust-grooves, one of which communicates by an exhaust-port with the inner end of the barrel and the other by an exhaust-port with the outer air, and two endwise-movable valve-pistons in said chamber, the inner ends of which control the passage of air from said air-supply passage to the said admission grooves and ports, one of said valve-pistons having a flange by which the communication between said exhaust-grooves for the inner end of the barrel is alternately opened and closed in the endwise movement of said valve-piston.

15. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage, with two admission-ports located at opposite sides of said air-supply passage and leading to the inner end of the barrel, with an exhaust-port leading from the inner end of the barrel, and with an admission and exhaust port communicating with the outer end of the barrel, and two endwise-sliding piston-valves, the inner or adjacent parts of which control the passage of air from the air-supply passage to the said admission-ports leading to the inner end of the barrel, one of which controls the exhaust-passage leading from the inner end of the barrel and the other of which controls the passage of air from said air-supply passage to the outer end of the barrel and also controls the exhaust from the outer end of the barrel, said second valve-piston being larger in diameter at its outer than at its inner part and provided with a central passage opening through its inner end and with radial openings in said larger outer part, said openings being adapted for communication with the said admission and exhaust port leading to the outer end of the barrel when the piston is at the inward limit of its movement and to be closed by the surrounding wall of the chamber when the piston is at the outward limit of its movement.

16. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with two annular recesses located at either side of said air-supply passage and communicating by admission-ports with the inner end of the barrel, said valve-chamber also having between one of said annular grooves and the end of the barrel two annular exhaust-grooves, one of which communicates by an exhaust-port with the inner end of the barrel and the other by an exhaust-port with the outer air, said valve-chamber also having between the other of said air-admission grooves or recesses and the opposite end of the barrel, an annular admission and exhaust groove communicating by a passage with the outer end of the barrel and an adjacent annular exhaust-groove communicating with the outer air, and two valve-pistons in said chamber, the inner ends of which control the passage of air from said air-supply passage to the said admission-grooves connected with the inner end of the barrel, one of said valve-pistons having a flange by which the communication between said exhaust-grooves for the inner end of the barrel is alternately opened and closed, and the other end of said pistons having its outer part larger than at its inner part and being provided with a central passage opening through its inner end and with radial passages in its said larger outer part.

17. The combination with a barrel and a plunger therein, of a controlling-valve comprising a valve-chamber provided with an air-supply passage and with two admission-ports located at opposite sides of the air-supply passage and leading to the inner end of the cylinder, said chamber also having an exhaust-

port leading from the inner end of the barrel into said chamber, an exhaust-port leading from said chamber to the outer air, an admission and exhaust passage communicating with the outer end of the barrel and an exhaust-passage, adjacent to said admission and exhaust port, leading to the open air, and two valve-pistons in said chamber, the inner ends of which control the passage of air from said air-supply passage to the admission-passage adjacent thereto and which are subject to the constant air-pressure from said air-supply passage, and the outer ends of which are made of larger diameter than their inner parts and are adapted to slide in the outer ends of said chamber, one of said valve-pistons controlling the exhaust-port from the inner end of the barrel, and the other of said valve-pistons controlling the admission of air from said central supply-passage to the outer end of the cylinder, and also the exhaust from the outer end of the cylinder, and means for bringing the outer ends of the said valve-chamber exterior to the larger ends of the valve-pistons alternately into communication with the said air-supply passage and with the outer air.

18. The combination with a barrel, and a plunger therein, of a head attached to the inner end of the barrel, a valve-block located within said head in contact with the inner end of said barrel, said valve-block being provided with a valve-chamber and in its outer face with a central air-supply passage communicating with said chamber; said block having two admission grooves or recesses located at either side of said central air-supply passage, and a plurality of admission-ports leading from each of said grooves or recesses through the inner face of the block, and two endwise-sliding valve-pistons located in said valve-chamber at the opposite sides of said central air-supply passage and which operate to control the passage of air from said air-supply passage to the said admission-ports.

19. The combination with a barrel, and a plunger therein, of a head attached to the inner end of the barrel, a valve-block located within said head in contact with the said inner end of the barrel, said valve-block being provided with a valve-chamber and, in its outer face, with a central air-supply passage in communication with said valve-chamber; said block having two admission grooves or recesses located at either side of said air-supply passage, and a plurality of ports leading from each of said admission grooves or recesses through the inner face of the block, and two endwise-sliding valve-pistons located in said valve-chamber at the opposite sides of said central air-supply passage and which operate to control the passage of air from said air-supply passage to the said admission-ports, said valve-block being provided also with two adjacent annular exhaust grooves or recesses, one of which communicates with the interior of the barrel by a plurality of ports, and the other of which communicates with an exhaust-space within the head by a plurality of ports.

20. The combination with a barrel and a plunger therein, of a head attached to the inner end of the barrel, a valve-block located within said head in contact with the said inner end of the barrel, said valve-block being provided with a valve-chamber and, in its outer face, with a central air-supply passage and having two admission grooves or recesses located at either side of said central air-supply passage, and a plurality of ports leading from each of said grooves or recesses through the inner face of the block, and two endwise-sliding valve-pistons located in said valve-chamber at the opposite sides of said central air-supply passage and which operate to control the passage of air from said central air-supply passage to the said admission-ports, said valve-block being provided also with two adjacent annular exhaust grooves or recesses, one of which communicates with the inner end of the valve-block by a plurality of ports, and the other of which communicates with a space within the head by a plurality of ports, and said valve-block also being provided with an admission and exhaust groove, connected with the outer end of the barrel, and with an exhaust-groove connected by a port with the space between the valve-block and the head, the valve-piston, which operates in connection with said admission and exhaust groove, being provided with a central passage which opens through its inner end, and with radial openings extending from said central passage through the outer surface of the piston.

21. The combination with a barrel, a plunger therein, and a hollow head attached to the plunger, of a valve-block located in said head between the end wall of the same and the inner end of the barrel, said block being provided with a valve-chamber which extends therethrough, cap-plates closing the ends of said chamber and held therein by contact with the opposite walls of the said head, and said valve-block being provided with a central air-supply passage, and with air admission and exhaust ports connected with the opposite ends of the barrel, and two endwise-sliding valve-pistons located in said valve-block for controlling the said air inlet and exhaust passages.

22. The combination with a barrel, a plunger therein, and a hollow head attached to the plunger, of a valve-block located in said head between the end wall of the same and the inner end of the barrel, said block being provided with a valve-chamber, with a central air-supply passage, and with air admission and exhaust ports connected with the opposite ends of the barrel, and two endwise-sliding valve-pistons located in said valve-block for controlling the said air admission and exhaust ports,

said valve-block being cut away at the sides of said chamber to form an exhaust-passage between the said valve-block and the head and said head being provided with exhaust-openings.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 15th day of August, A. D. 1904.

REINHOLD A. NORLING.

Witnesses:
W. H. PEASE,
CARRIE MUSCHLER.