No. 750,836. PATENTED FEB. 2, 1904.

F. K. FASSETT.

PNEUMATIC HAMMER.

APPLICATION FILED AUG. 20, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 7.

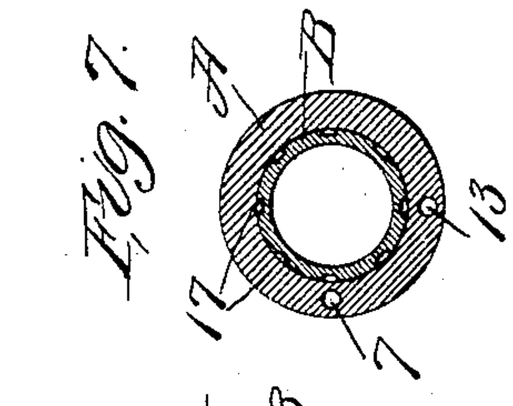


Fig. 6.

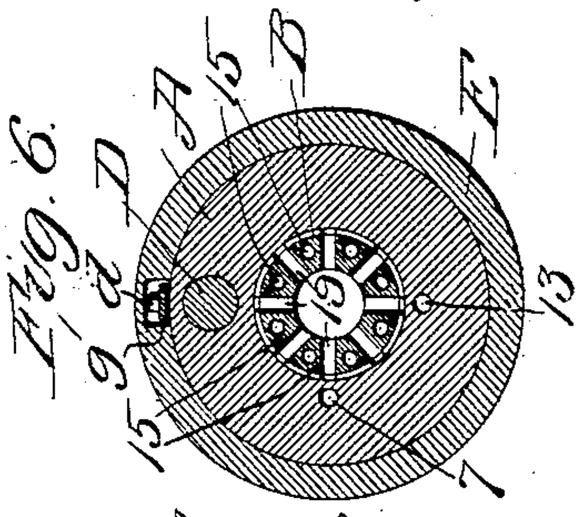


Fig. 5.

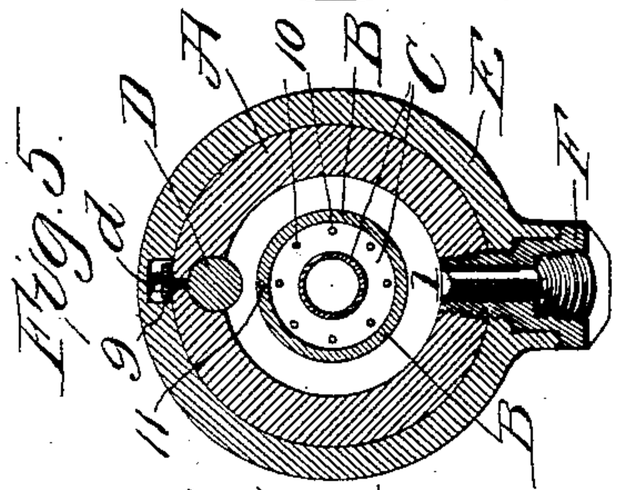


Fig. 4.

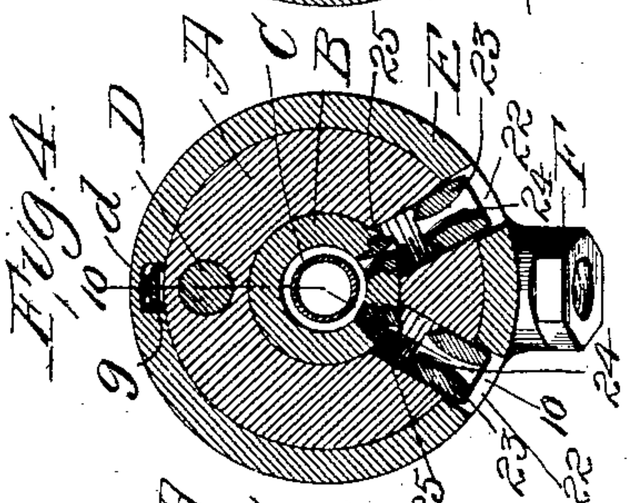


Fig. 3.

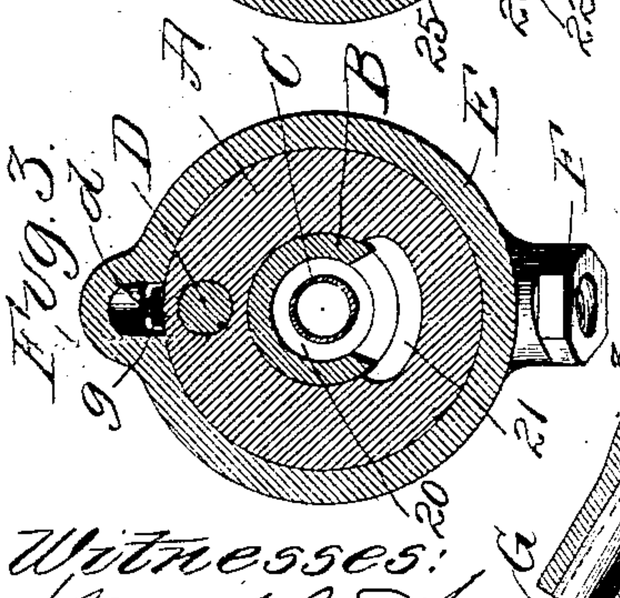


Fig. 1.

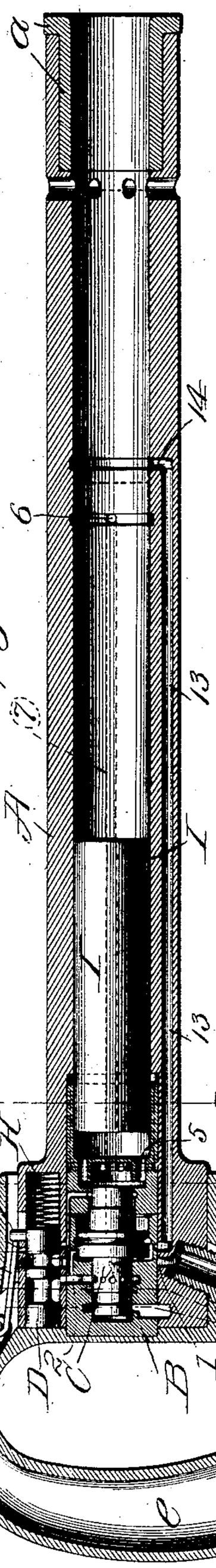
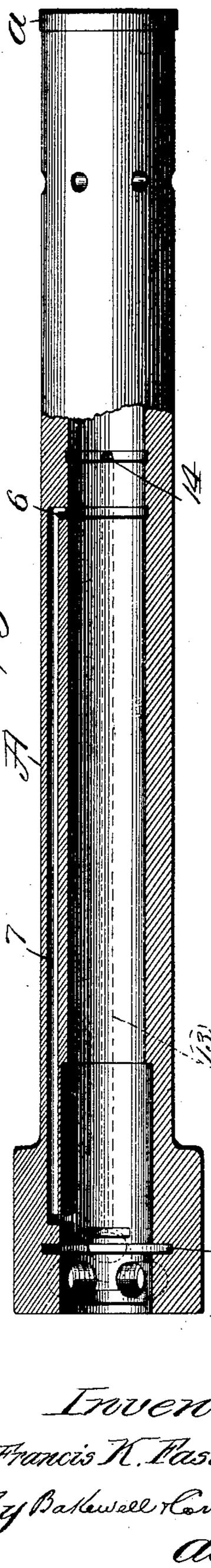


Fig. 2.



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PNEUMATIC HAMMER.

APPLICATION FILED AUG. 20, 1902.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 8.

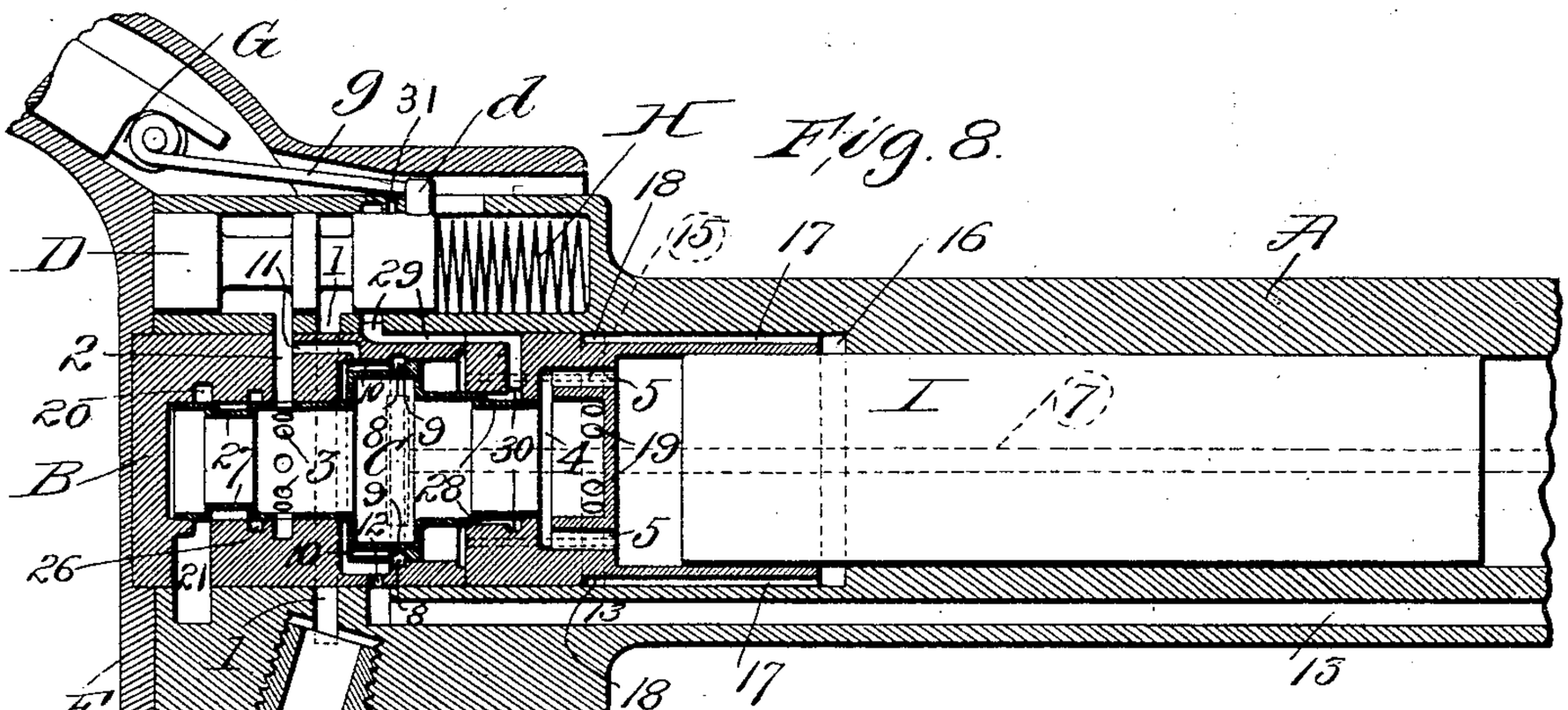

Fig. 9.

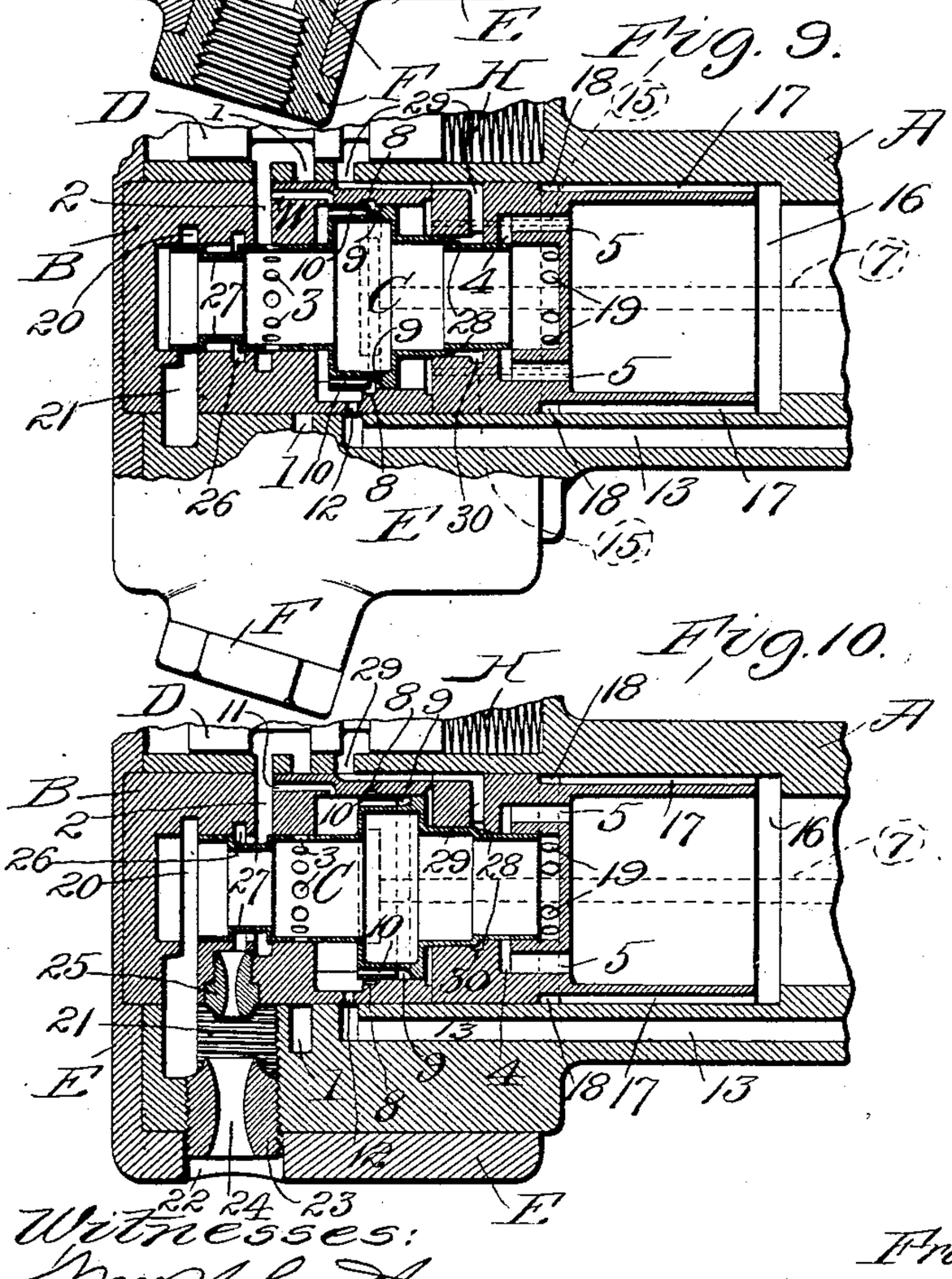

Fig. 10.

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No. 750,836. Patented February 2, 1904.

UNITED STATES PATENT OFFICE.

FRANCIS K. FASSETT, OF ST. LOUIS, MISSOURI, ASSIGNOR TO LEO EHRLICH, OF ST. LOUIS, MISSOURI.

PNEUMATIC HAMMER.

SPECIFICATION forming part of Letters Patent No. 750,836, dated February 2, 1904.

Application filed August 20, 1902. Serial No. 120,332. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS K. FASSETT, a citizen of the United States, residing at the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Pneumatic Hammers, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a longitudinal vertical sectional view through my improved long-stroke pneumatic hammer. Fig. 2 is a detail view of the barrel or cylinder partly, in vertical section and partly in elevation. Fig. 3 is a sectional view on line 3 3, Fig. 1. Fig. 4 is a sectional view on line 4 4, Fig. 1. Fig. 5 is a sectional view on line 5 5, Fig 1. Fig. 6 is a sectional view on line 6 6, Fig. 1. Fig. 7 is a sectional view on line 7 7, Fig. 1. Fig. 8 is an enlarged fragmentary vertical sectional view showing the parts in normal position ready for operation. Fig. 9 is a similar view showing the throttle-valve open and the valve for the piston slightly advanced from the position shown in Fig. 8, and Fig. 10 is a similar view showing the valve for the piston in its forward position.

This invention relates to a new and useful improvement in pneumatic hammers of that type known as "long-stroke" hammers. The tool is designed to be operated by compressed air led to the tool through a flexible supply-pipe. In operation the device is held in the hands of an operator, the reciprocations of the piston being utilized to drive rivets, head rivets, calk boilers, &c.

My present invention contemplates a construction wherein the piston is moved forward by live pressure controlled by a valve preferably located in a suitable casing in the rear end of the barrel or cylinder. Upon the piston reaching its forward position the valve referred to is by suitable arrangement of ports shifted, so as to cut off the supply of live pressure behind the piston and permit the pressure trapped behind the piston to escape. To facilitate the escape of this trapped pressure and also to return the piston to the rear end of the barrel or cylinder, I introduce an ejector-nozzle supplied by live pressure and which directs the blast into and through the escape-port for the trapped pressure behind the piston, whereby not only is the trapped pressure facilitated in its escape, but the said ejector-nozzle exhausts the air from the space behind the piston to such an extent that the partial vacuum created will cause the piston to move rearwardly. This ejector device is only in operation when the piston has reached its forward position, the live pressure being cut off therefrom when the piston is restored to its rear position and in readiness to receive live pressure, by which it is again driven forward. It is obvious that by regulating the size of the opening in the ejector-nozzle and of the escape-port the length of time consumed by the piston in its rearward movement may be regulated.

Referring now to the drawings, A indicates the barrel or cylinder, which is preferably counterbored in its forward end to receive a bushing *a*. The rear end of the cylinder is also counterbored and receives a valve-block B, containing the main controlling-valve C. The walls of the cylinder at its rear end are preferably increased in thickness in order that a chamber may be formed therein for containing a throttle-valve D.

E indicates a handle-base which is introduced over the enlarged rear end of the cylinder for the purpose of holding the valve-block in position and also forming one of the end walls of the chamber containing the throttle-valve. In order that the parts may be securely locked together, a nipple F is introduced through the handle-base and threaded into the thickened rear end of the cylinder. This nipple-lock serves to hold all of the parts in proper position with relation to each other, and by this simple device I avoid the necessity for threading the handle-base on the cylinder.

e indicates a handhold extension of the handle-base E, which for the sake of lightness is preferably made hollow. In the shank or neck portion of this extension is arranged a plunger G, provided with a suitable head or

button at its outer end and at whose inner end is pivoted an extension *g*, coöperating with a pin or projection *d* on the throttle-valve D. When plunger G is moved inwardly, the throttle-valve is moved forwardly against a spring H. It is necessary to hold the throttle-valve in its forward position during the operation of the hammer, and this is usually done by the operator keeping his thumb on the button of plunger G. When plunger G is released, spring H serves to restore the same and the throttle-valve D to normal position.

I indicates the piston, which is preferably solid and cylindrical in shape. This piston is of uniform diameter throughout its length and operates in a bore or chamber in a cylinder of correspondingly-uniform diameter.

The above construction has been illustrated as one of the forms of my invention; but it is obvious that these details of construction can be changed in many particulars without departing from the nature and principle of my invention, and therefore I do not wish to be understood as limiting my invention to the particular construction hereinbefore described, except as such limitations may be expressed in the appended claims.

I will now describe the port arrangements which I employ for effecting the reciprocation of the piston and its controlling-valve.

In the position of the parts shown in Figs. 1 and 8 the throttle-valve is closed. This throttle-valve is preferably cylindrical and provided with two reduced annuli, forming, substantially, three connected heads. We will assume that a pipe is connected to the nipple F, through which compressed air is supplied to the device. This air entering through the nipple passes through a groove 1, preferably formed in the barrel, whence it is ported to the valve-chamber containing the throttle-valve. When the throttle-valve is closed, the port from the chamber 1 registers with the space between the middle and forward heads; but when the throttle-valve is moved forward, as shown in Figs. 9 and 10, the port from chamber 1 communicates with the space between the middle and rear heads of the throttle-valve, which space establishes communication between live-pressure chamber 1 and a passage 2, formed in the valve-block. The main controlling-valve C is formed hollow, and its chamber in the valve-block is of varying diameters, to which the external diameters of the several portions of this valve correspond. We will assume for the present that the valve C is in its rearmost position, in which openings 3, registering with the chamber 2, will admit pressure into the interior of the valve, and said pressure finding no point of escape through the rear end of the valve will at the forward end of said valve pass into a circular groove 4 in the valve-block and thence forwardly through suitable openings 5 into the space behind the piston. (See Fig. 6.) Under these conditions the piston will be moved forwardly in the cylinder until its rear end uncloses a port 6 in the cylinder just before the piston delivers its impacting blow. The position of the piston in delivering its impacting blow is indicated by dotted lines *x* and *y* in Fig. 1. Port 6 opens into a passage 7, formed in the cylinder, which passage communicates at its rear end with an annular groove or chamber 8 in the valve-block, which encircles the chamber, in which operates a large centrally-located head of the valve. This head, as clearly shown in Figs. 8, 9, and 10, is formed with an annular groove 9, designed when the valve is in its rearmost position to register with the groove 8, and from which groove 9 lead openings 10 to the rear face of the enlarged head of the valve. Thus when port 6 is opened to live pressure when the piston reaches the forward limit of its movement said live pressure is admitted behind the enlarged centrally-located head of the main valve, tending to move said valve forwardly, so as to close the ports which admit pressure behind the piston. As the piston may after delivering its blow rebound or start back upon its return movement, closing port 6 and other ports depending upon it for live pressure to hold the valve forward, I do not rely upon this port 6 for the constant admission of live air behind the enlarged head of the valve. On the contrary, the grooves 8 and 9, as shown, are narrow, and after the first impulse of air through port 6 said grooves pass out of registration, and even though the piston remains forward, so as to leave the port 6 unclosed, this source of supply would be shut off by this action. (See Fig. 9, wherein the valve is starting on its forward movement.) In view of these conditions I arrange a port 11, leading from the live chamber 2 to the enlarged bore of the valve-chamber, which port 11 when the valve moves forward so as to place grooves 8 and 9 out of registration is open, and live pressure is now directly admitted behind the enlarged head of the valve to insure a continuation of its forward movement to the full limit and also to hold said valve in its forward position.

12 indicates a port much larger than port 11, which leads from the space behind the enlarged head of the valve into a passage 13, formed in the cylinder and terminating in a port 14 in the cylinder slightly in advance of the port 6. When the piston moves forward to open port 6 to live pressure, port 14 is closed and remains closed during the time that the piston is delivering its impacting blow and for some time after the piston has started on its backward movement, said port 14 being opened by the forward end of the piston passing the same. When port 14 is thus opened, the live active pressure behind the enlarged head of the valve is relieved by reason of the fact that said pressure under the above-men-

tioned conditions blows through port 14, and while the valve is held in its forward position it is at the same time sensible to pressure in front of its enlarged head, which pressure is relied upon to move the valve rearwardly. The pressure for moving the valve rearwardly is obtained from the space behind the piston through ports 15, (see Fig. 6,) which are drilled through the valve-block, preferably alongside of but not communicating with ports 5. These ports at all times maintain communication with the space in front of the enlarged head of the valve and the space behind the piston. As means now about to be described are provided for cushioning the piston on its rear movement, said cushion being in the nature of trapped dead air, the cushioning-air passes through ports 15 to the space in front of the enlarged head of the valve and forces the valve rearwardly, so as to shut off the admission of live pressure through port 11 to the space behind said enlarged head and also to place grooves 8 and 9 into registration for another operation. Port 6 when the piston is in its rearmost position is open to atmosphere, and of course no pressure will pass therethrough tending to move the valve forwardly.

As shown in Fig. 8, when the valve is in its rear position to admit pressure behind the piston openings 3 register with the live-air chamber 2 and the forward end of the valve is behind the groove 4, so that said groove is open to permit live pressure to pass into the space behind the piston. About the time that the piston approaches the limit of its forward movement the valve is thrown to its forward position, as above described, in which event the openings 3 are moved out of registration with the live-pressure chamber 2 and the forward end of the valve closes the groove 4. The valve is in this forward position during the initial operation of the return or rearward movement of the piston and until such time as the cushioning pressure above described is produced, which is at or about the time the piston is in its rearmost position.

I will now describe the general exhaust for the pressure heretofore referred to as being trapped behind the piston.

By referring to Fig. 10, it will be noted that the valve-block at its forward end does not entirely fill the counterbore in the rear end of the cylinder, and thus an annulus 16 is formed. The periphery of the forward end of the valve-block is provided with longitudinally-disposed grooves 17, (see also Fig. 7,) which communicate with the groove 16 and with a groove 18. Openings 19 (see Fig. 6) extend inwardly from groove 18 in front of the forward edge of valve C. Valve C never closes these openings 19. The rear end of the valve coöperates with an annular groove 20, which, as shown in Figs. 3 and 10, communicates with an exhaust-space 21. 22 represents openings formed through the handle-base and the rear end of the cylinder, said openings communicating with the exhaust-space 21 and the cylinder portion of said openings being threaded, so as to receive plugs 23. These plugs form additional means of securing the handle-base to the cylinder, as I preferably make them of such length that they extend outwardly into the openings in the handle-base. Each of the plugs referred to is provided with a contracted opening 24, through which the exhaust passes. While I have shown two of these exhaust-plugs in the drawings, it is obvious that one of such plugs may be employed, or more than two of such plugs may be employed, if desired.

When the valve is in its forward position, it is obvious that pressure behind the piston will find a ready means of escape through the exhaust openings and passages hereinbefore referred to, and this action would undoubtedly result in a natural way. I have provided means, however, for facilitating this exhaust and also for creating a partial vacuum behind the piston for restoring the same in readiness for another stroke. This means consists of an ejector nozzle or nozzles, preferably screwed into position and in axial alinement with the exhaust plug or plugs 23. (See Figs. 4 and 10.) The contracted nozzle-openings in these ejector-plugs 25 communicate with an annular groove 26, which groove when the valve is in its forward position by means of a reduced portion 27 in said valve is in direct communication with the live-pressure chamber 2. By this means when the piston reaches the forward extremity of its movement, as before described, the valve C will be moved forward to open the exhaust-passages for the escape of pressure behind the piston, and simultaneously live pressure will be admitted to the ejector-nozzles, which results not only in facilitating the escape of the exhaust, but in the creation of a partial vacuum behind the piston, which causes said piston to move rearwardly or be set in position for another operation. The speed of this rearward movement of the piston is preferably such that at or near its extremity the rear end of the piston will close the groove 16, thus shutting off the means of exhaust of pressure from behind the piston, and the momentum gathered by the piston in its rearward movement is such that the air trapped in the forward end of the valve-block (at a point behind the groove 16) will be compressed. This trapped air in the forward end of the valve-block not only provides a cushion for the piston on its rearward stroke, but also provides a means for operating the valve C, (through openings 15,) moving said valve rearwardly in position to again admit pressure behind the piston.

Upon throwing the throttle-valve when the valve C is in position to admit pressure behind the piston it is obvious that the engine will start irrespective of the position of the piston. If, however, the valve C were in a

forward position, as shown in Fig. 10, it is obvious that the only work being done by the pressure is in connection with the ejector device, and if the piston should occupy a position so close to the groove 16 or be located within the pocket in the front end of the valve-block, so that no momentum could be built up to form a cushion to actuate the valve C and move it rearwardly, the engine would not start and its point would have to be depressed, so as to permit gravity to act on the valve and piston, moving them forwardly, resulting in loss of time. To obviate this difficulty, I provide a shoulder 28 on the valve, which shoulder is designed when the throttle-valve is moved forward from its home position to receive pressure for a short period of time and throw the valve rearwardly. By referring to Fig. 8 it will be observed that the space between the middle and forward heads of the throttle-valve is such that said valve in its forward movement will temporarily establish communication between the pressure-port 1 and a port 29, which leads to an annular groove 30 in front of the head or shoulder 28. In its forward movement the throttle-valve will admit pressure in front of the shoulder 28 and until the middle head of the throttle-valve has closed the live passage 1. A continued forward movement of the throttle-valve will open said live passage 1 and establish communication therebetween and the live chamber 2 and close port 29 against live pressure. Port 29, however, while closed to pressure is in this forward position of the throttle-valve opened to atmosphere via port 31, opening into the chamber containing the throttle-valve-operating plunger. Thus displacement of air in front of shoulder 28 is taken care of.

It will be noticed that the rear face of the enlarged head of the valve C has a larger area than the front face of said enlarged head. This is made necessary from the fact that when the valve is in its rearmost position, as shown in Fig. 8, and pressure is admitted to the space behind the piston said pressure will also act against the reduced front face of the valve-head through the ports 15. When port 6 is open and live pressure is admitted behind the head, the rear face having the greater area, said pressure admitted through port 6 will preponderate and move the valve forwardly until the port 11 is open, which, as before described, will cause the valve to continue its forward movement notwithstanding the presence of pressure in front of the enlarged head.

In order to get the valve C, with its enlarged centrally-located head, in the valve-block, I preferably form said valve-block in two parts, the line of separation being at the forward end of the chamber containing the enlarged head.

32 indicates openings formed in the cylinder or barrel opposite the point where the forward end of the piston strikes the shank of the tool or chisel. These openings 32 serve for the displacement of air due to the movement of the piston in the cylinder. It will thus be seen that there is nothing in front of the piston to retard its movement until the piston strikes the shank of the tool. I rely upon no pressure in front of the piston to restore the same, as will be evident from the foregoing description, and consequently there is no forward wall or cylinder-head with appropriate port arrangements to admit and exhaust pressure therebetween and the forward face of the piston to drive the piston rearwardly. Furthermore, as the shank of the tool is not relied upon in my construction to form the front wall of the cylinder to hold pressure in the cylinder, as is done in some cases, it is obvious that the tool may be fitted loose in the front end of my cylinder and be perfectly free to move, so as to receive and transmit the full force of the impacting blows of the piston. In such constructions referred to where the shank of the tool is fitted snugly in the forward end of the barrel to make an air-tight joint and serve as an end wall for the cylinder it is obvious that when the piston moves forwardly the air in advance thereof is compressed to an extent that the full force of its blow is not delivered upon the shank of the tool. On the contrary, the cushion in front of the piston materially decreases the force of the blow of the piston. When the piston is about to deliver its blow, in some constructions, the pressure is admitted in front thereof to lift the piston when it rebounds from its blow. The admission of this pressure is controlled by a valve actuated by the cushion, and the pressure of this cushioning-air must be sufficient to throw said valve, and to this extent the effectiveness of the blow of the piston is decreased.

So far as I am aware I am the first to arrange displacement-openings in front of the piston of a long-stroke hammer which will accommodate the movement of the piston, but do not contribute in any way to returning said piston rearwardly. I am also the first to provide means acting only on the rear face of the piston for actuating said piston.

I am aware that many minor changes in the construction, arrangement, and combination of the several parts of my device can be made and substituted for those herein shown and described without in the least departing from the nature and principle of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A pneumatic hammer comprising a cylinder, a piston, a handle-base, and a nipple-plug introduced through an opening in the handle-base and into the cylinder for locking the parts together; substantially as described.

2. A pneumatic hammer comprising a cylin-

der, a piston, a handle-base, a valve-block held in position by the handle-base, and a nipple-plug for securing the handle-base in position on the cylinder; substantially as described.

3. A pneumatic hammer comprising a cylinder, a piston, a handle-base, and a threaded plug for the attachment of a supply-pipe, said plug locking said handle-base in position on the cylinder; substantially as described.

4. A pneumatic hammer comprising a cylinder, a piston, a handle-base, and a plug passing through an opening in the handle-base and threaded into the cylinder, said plug being formed with an opening for the exhaust; substantially as described.

5. In a pneumatic hammer, the combination with a cylinder having a counterbore in its rear end, of a valve-block arranged in said counterbore and provided with a pocket in its inner end to receive and cushion the rear end of the piston, and means for holding said valve-block in position; substantially as described.

6. In a pneumatic hammer, the combination with a cylinder, of a piston of uniform diameter throughout its length, said cylinder having a counterbore in its rear end, and a valve-block arranged in said counterbore and provided with a pocket in its inner end having a diameter corresponding to the bore of the cylinder, whereby the piston is received in said pocket and cushioned; substantially as described.

7. In a pneumatic hammer, the combination with a cylinder and its piston, of a hollow valve for admitting pressure behind the piston, said valve being provided with an enlarged head, a groove 8 in the chamber containing said enlarged head, a passage 7 leading from said groove and terminating in a port 6 in the cylinder, which port is controlled by the piston, a groove 9 in the enlarged head of the valve, from which groove lead openings 10 to one side of said enlarged head, whereby, when port 6 is open to pressure, the valve is initially moved to shut off the admission of pressure behind the piston, such movement continuing while grooves 8 and 9 remain in registration, and a port 11 for admitting pressure to effect a continued movement of said valve, said port being opened by the valve when the grooves 8 and 9 pass out of registration; substantially as described.

8. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, a port controlled by the piston for effecting an initial movement of said valve, a port controlled by the valve for admitting pressure to effect a continued movement thereof, and an escape-port controlled by the piston, whereby the pressure which actuates the valve is permitted to blow through to relieve the valve; substantially as described.

9. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, said valve having an enlarged head, a port under control of the piston for admitting an impulse of pressure behind the enlarged head to move the valve, said valve in such initial movement opening a port for admitting live pressure behind said head, and a passage leading from the chamber behind the enlarged head of the valve to a port in the cylinder located in advance of the first-mentioned port, whereby, when the piston is in a forward position, the first-mentioned port is opened and the last-mentioned port closed, said last-mentioned port being opened by the piston when said piston is in position on its rearward stroke to relieve the pressure behind the enlarged head of the valve and render the same sensitive to action under opposing pressure; substantially as described.

10. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting and exhausting pressure to and from the space behind the piston, means controlled by said piston for effecting the movement of said valve in one direction to close the ports which admit pressure behind the piston, means controlled by the piston for relieving the valve of pressure which holds it in its closed position, and ports for conducting air under pressure developed by the momentum of the piston on its rearward movement for throwing the valve in the opposite direction to open the admission-ports; substantially as described.

11. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve-block having a live-pressure chamber and an exhaust-chamber, and a hollow valve arranged in said block for controlling ports leading to said chambers, said valve-block having a pocket formed in its forward end to receive the rear end of the piston; substantially as described.

12. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve-block having a pressure-chamber 2, and a hollow valve having ports 3 designed in certain positions of the valve to register with such pressure-chamber, said valve-block also having an annular groove 4 and openings 5, communication between the interior of the cylinder and said groove being controlled by the position of said valve; substantially as described.

13. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve-block having an exhaust-chamber formed therein, a hollow valve through which the exhaust passes, a space in said valve communicating with the exhaust-chamber in certain positions of the valve, said valve-block having passages 17 and 18 communicating with the cylinder and at all times in communication with the space inside of the hollow valve; substantially as described.

14. In a pneumatic hammer, the combination with a source of constant air-supply, a cylinder and its piston, means for admitting pressure behind the piston to drive the same forwardly, and means for exhausting the pressure behind the piston to draw the piston rearwardly; substantially as described.

15. In a pneumatic hammer, the combination with a source of constant air-supply, a cylinder and its piston, means for admitting pressure behind the piston to drive the same forwardly, and means for creating a partial vacuum behind the piston for drawing the same rearwardly; substantially as described.

16. In a pneumatic hammer, the combination with a source of constant air-supply, a cylinder and its piston, a valve for intermittently admitting pressure behind the piston, and means controlled by said valve for creating a partial vacuum behind the piston; substantially as described.

17. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve operated by the piston, said valve in one position admitting pressure behind the piston, and means controlled by the valve in its other position for creating a partial vacuum behind the piston; substantially as described.

18. In a pneumatic hammer, the combination with a cylinder and its piston, of means for admitting pressure behind the piston to drive the same forwardly, and an ejector which is operative when the piston reaches its forward limit for creating a partial vacuum in the space behind the piston; substantially as described.

19. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, an ejector-nozzle, and a port controlled by said valve for admitting pressure to said ejector-nozzle, whereby, when the valve is operated to cut off all pressure behind the piston, the blast issuing from said ejector-nozzle becomes effective to create a partial vacuum to move the piston in an opposite direction; substantially as described.

20. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, means controlled by said piston for effecting a movement of said valve, and a plurality of ejector-nozzles to which pressure is admitted by the valve when said valve is moved to a position to cut off the admission of pressure behind the piston, whereby said nozzles act to create a partial vacuum behind the piston to restore the piston; substantially as described.

21. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, a shoulder on said valve, a port for admitting pressure against said shoulder, and a throttle-valve for establishing communication between said port and live pressure upon its initial movement from its home or closed position, said throttle-valve in its open position closing said port; substantially as described.

22. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind the piston, a throttle-valve, a port controlled by said throttle-valve for moving the first-mentioned valve into operative position, and means controlled by the throttle-valve for establishing communication between said port and atmosphere after said valve has been actuated; substantially as described.

23. In a pneumatic hammer, the combination with a cylinder and its piston, of a valve for admitting pressure behind said piston, a shoulder on said valve, a port for admitting pressure against said shoulder, and a throttle-valve for temporarily admitting pressure through said port and against said shoulder, said throttle-valve, by a continued movement, opening said port to atmosphere, so as to accommodate displacement of air resulting from a subsequent operation of the valve; substantially as described.

24. In a long-stroke pneumatic hammer, the combination with a cylinder, of a piston whose stroke exceeds its length, means for admitting pressure only to the rear face of the piston for forcing the piston forwardly, and means for creating the partial vacuum behind the piston only for causing the piston to move rearwardly; substantially as described.

25. In a long-stroke pneumatic hammer, the combination with a cylinder, of a piston wholly contained in the cylinder and whose stroke exceeds its length, openings in the front end of the cylinder for accommodating the displacement of air resulting from the movement of the piston, and means acting on the rear face only of the piston for operating the piston; substantially as described.

26. In a long-stroke pneumatic hammer, the combination with a cylinder, of a piston wholly contained therein and whose stroke exceeds its length, said cylinder being provided with openings to atmosphere about the point where the piston delivers its impacting-blow upon the shank of the tool, a valve for admitting pressure to drive the piston forwardly, and means controlled by said valve for creating a partial vacuum behind the piston to retract the same; substantially as described.

In testimony whereof I hereunto affix my signature, in the presence of two witnesses, this 15th day of August, 1902.

FRANCIS K. FASSETT.

Witnesses:
GEORGE BAKEWELL,
G. A. PENNINGTON.