F. L. HENIG.

PNEUMATIC TOOL.

APPLICATION FILED JULY 14, 1919.

1,352,191.

Patented Sept. 7, 1920.

3 SHEETS—SHEET 1.

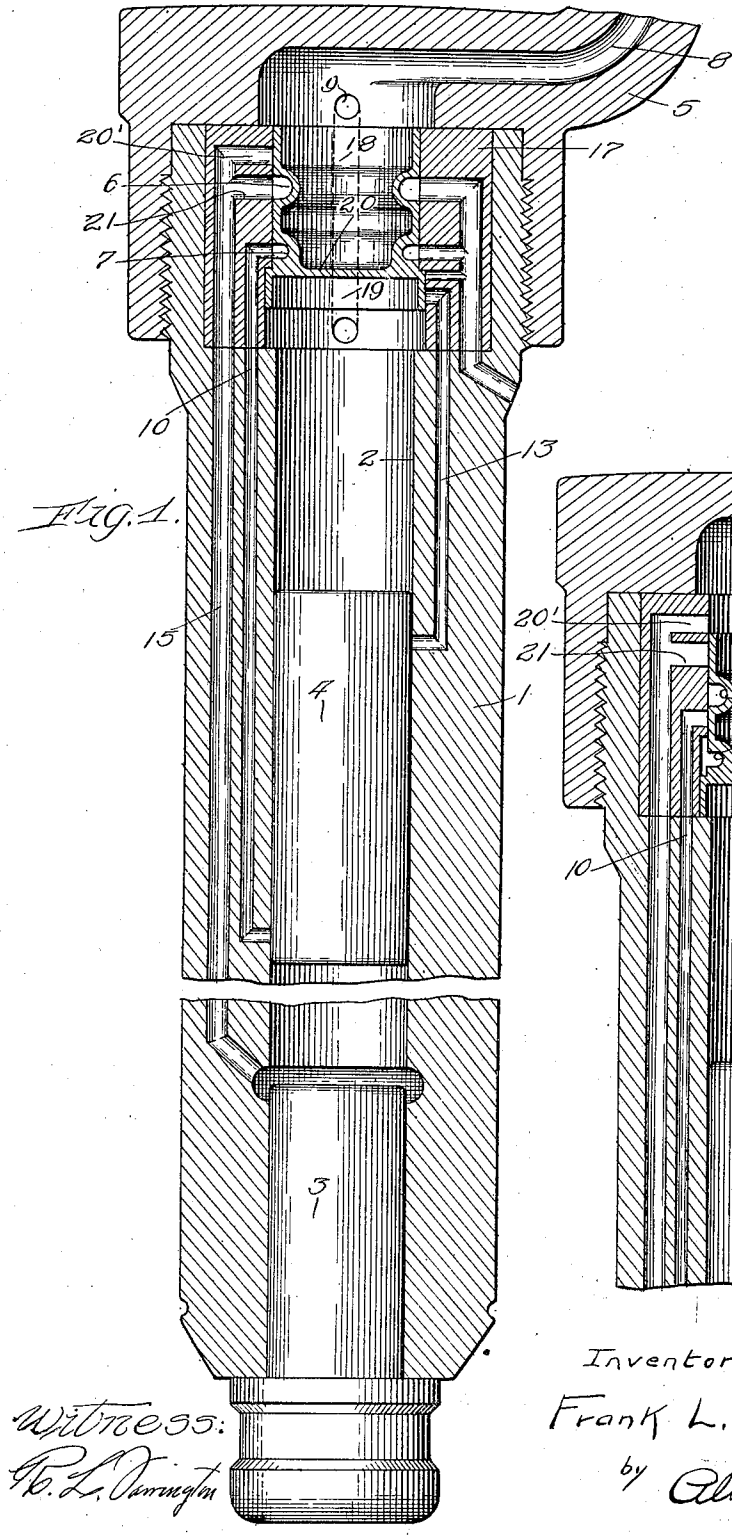
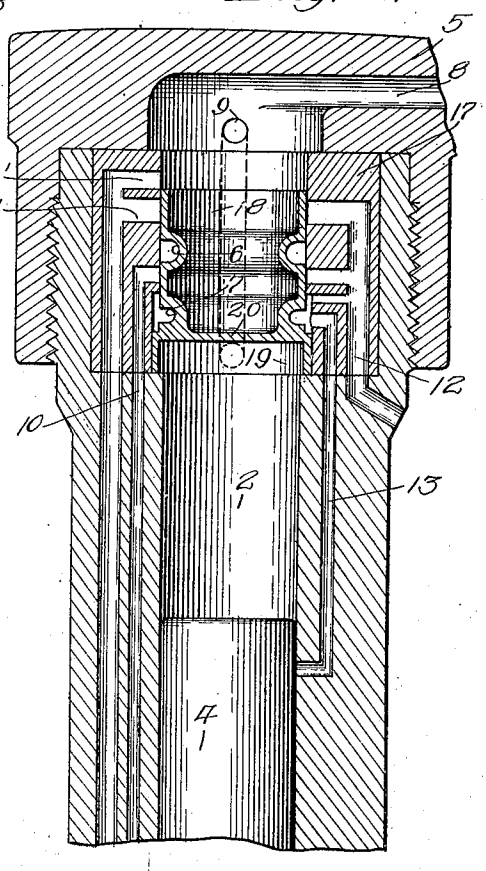


Fig. 1.

Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3

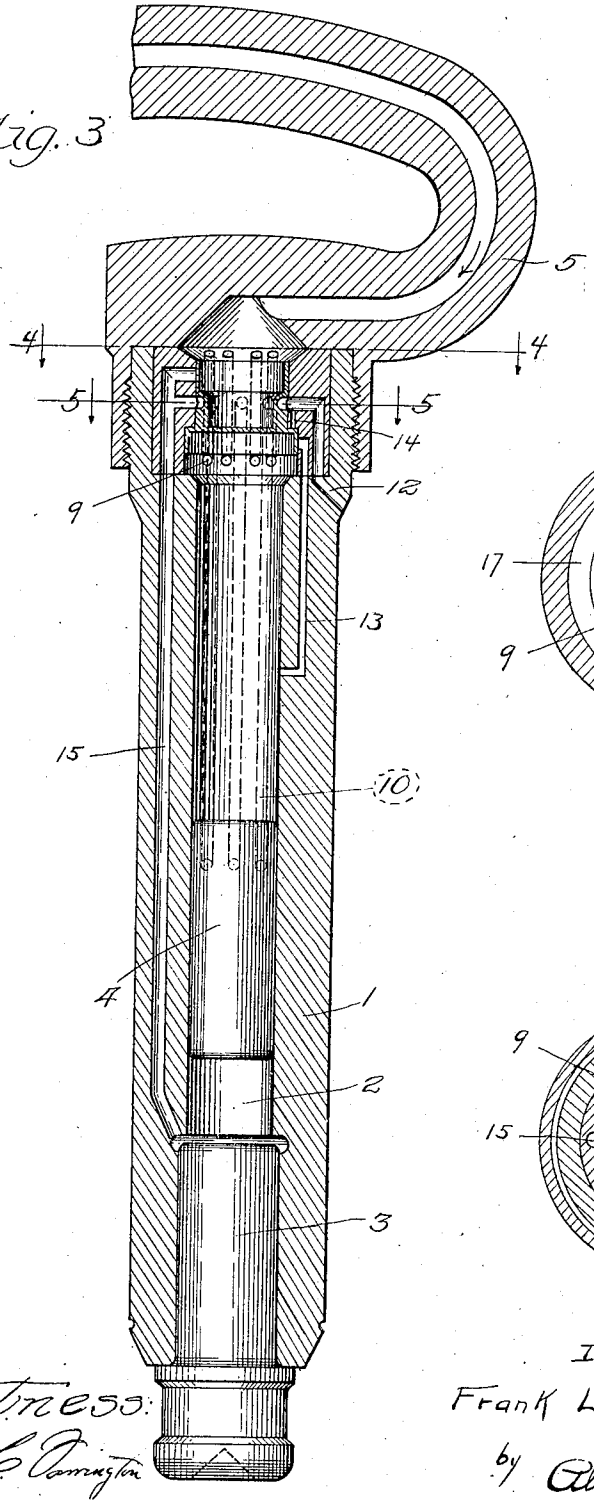


Fig. 4.

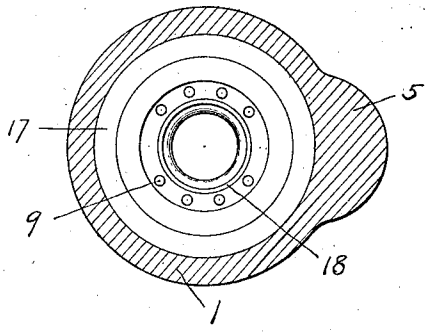
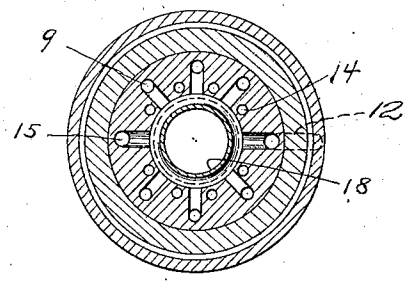


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

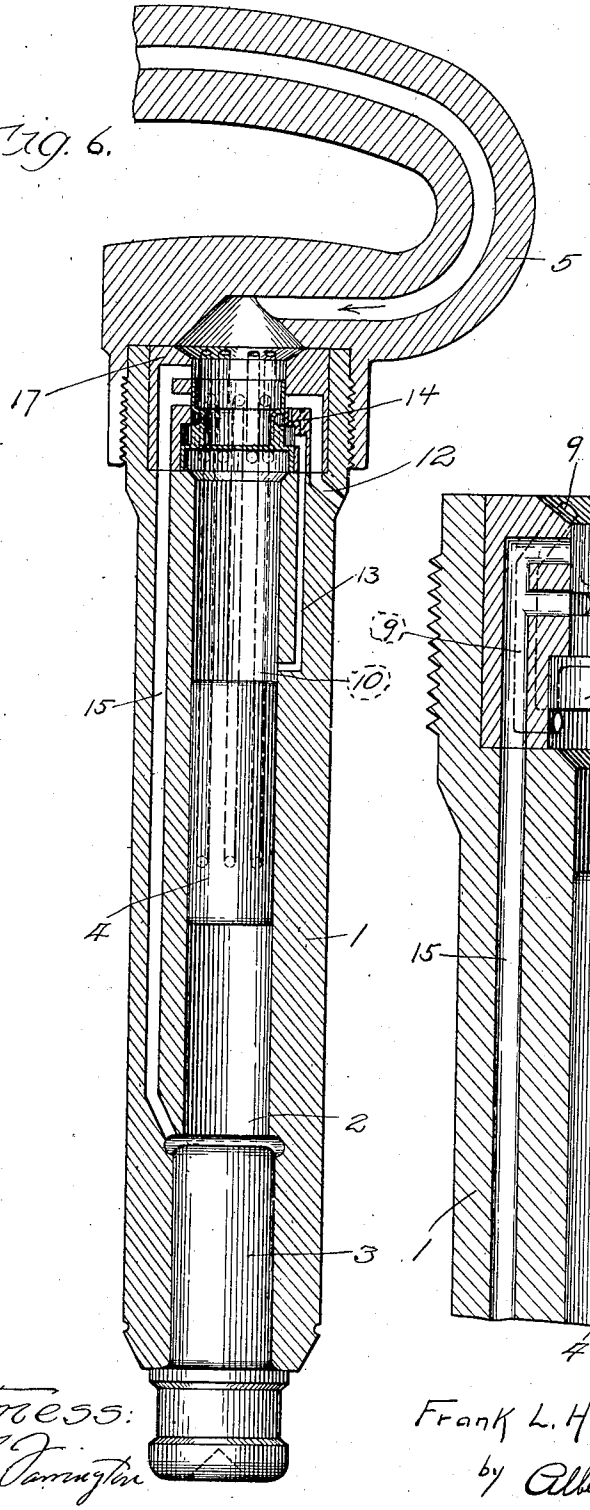
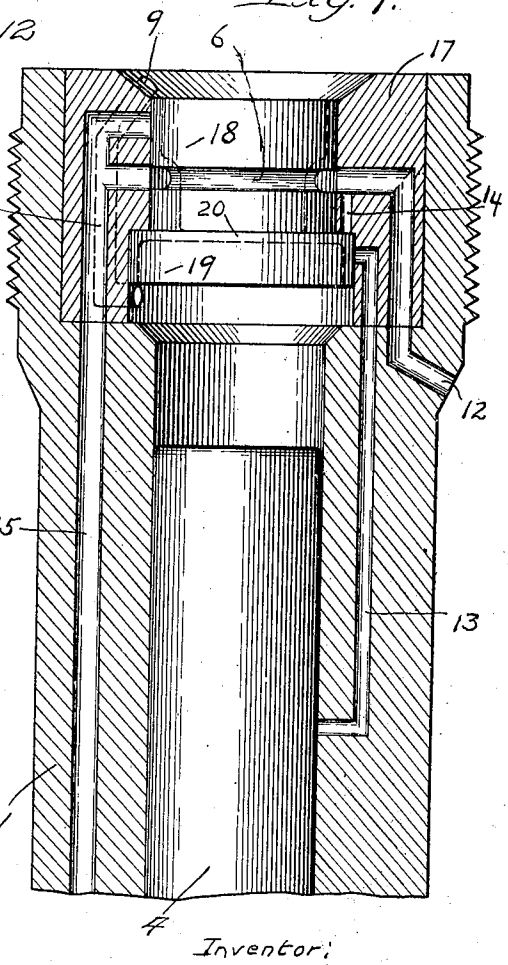


Fig. 7.



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UNITED STATES PATENT OFFICE.

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PNEUMATIC TOOL.

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To all whom it may concern:

Be it known that I, FRANK L. HENIG, citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pneumatic Tools; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to fluid-operated percussive tools, such as pneumatic hammers, one of its general objects being to provide a tool of this class which will be simple and cheap in construction, which will have a relatively low recoil; and one which can readily be operated both with wide variations in the pressure of the fluid and with wide variations in speed. Furthermore, my invention aims to provide a tool of this general class in which the admission, exhaust and cushioning of the fluid are all controlled partly by the movement of the piston and partly by a single and relatively light valve member; in which the valve member is semi-balanced and hence responsive in movement to slight pressure variations; in which continuous operation at a high degree of efficiency may be obtained without a high degree of accuracy in the machining of the parts, and in which the operating efficiency of the appliance may therefore be well maintained even after the parts show wear as the result of prolonged service. Furthermore, my invention aims to provide a tool of the class described in which the effective action can easily be varied, thereby permitting a ready adjustment of the tool for different conditions, and one in which the weight and movement of the valve member are both so slight as to render the same practically noiseless. Still further objects will appear from the following specification, and from the accompanying drawings, in which drawings

Figure 1 is a central and longitudinal section through the barrel and part of the handle of a pneumatic riveting hammer embodying my invention, showing the position of the parts during the initial part of the forward stroke of the piston.

Fig. 2 is a fragmentary section showing the valve in its forward position while the piston is traveling rearwardly.

Fig. 3 is a longitudinal and central section through another embodiment of my invention, namely one in which the valve member has only a single groove.

Fig. 4 is a transverse section through the tool of Fig. 3, looking forwardly from the rear end of the main cylinder, or from the line 4—4 of Fig. 3.

Fig. 5 is a transverse section through the same tool taken along the line 5—5 of Fig. 3, with the valve in the same position as in Fig. 4.

Fig. 6 is a longitudinal section similar to Fig. 3, but showing the position of the parts when the piston is approximately at the middle of its return stroke.

Fig. 7 is an enlargement of a part of Fig. 6, with some of the fluid passages omitted to avoid confusion.

In the embodiment of Figs. 1 and 2, the tool of my invention includes a cylinder 1 having a main bore 2 enlarged at its forward end to house the shank 3 of a rivet setting tip. The main bore 2 slidably houses a piston 4 and this bore is desirably enlarged at its rear end to house a sleeve 17 which has portions of numerous entrance and exhaust passages formed in it, this separate sleeve being employed for the convenience in manufacturing the tool. The sleeve 17 has a bore which slidably houses a single valve member controlling the entrance and exhaust passages, as hereafter more fully described. Threaded upon the cylinder 1 at the rear end of the latter is a handle 5 having a bore 8 through which compressed air is supplied for operating the tool. This handle desirably has the end of its threaded bore arranged for abutting against the rear end of the sleeve 17, so that the handle clamps this sleeve firmly in its normal position.

The valve member desirably consists of a hollow cylinder having a transverse web 20 intermediate its ends and having a forward groove 7 between the main rear portion 18 and the forward portion 19 of the cylinder, the latter portion being somewhat enlarged in diameter. The smaller diametered main portion 18 also has another peripheral groove 6 which controls exhaust connections

as hereafter described. Thus arranged, the cylinder 1 and the sleeve 17 together form the barrel of the tool, which barrel is provided with passages duplicated in the barrel to any desired number to afford the required total cross section, only one of each of the passages being shown in the sectional views of Figs. 1 and 2, to avoid confusion in reading the drawings. Thus, the sleeve 17 has an entrance passage 9 opening at its rear end into the bore 8 of the handle and opening at its forward end into the main bore 2 of the barrel at a point slightly forward of the valve member when the latter is in its rearward position. This passage 9 therefore affords an inlet for the compressed air to the rear of the barrel or behind the piston 4. Likewise, the passage 15 leading from the forward end of the bore 2 to a point near the rear end of the sleeve will afford means for admitting the compressed air to the forward end of the bore 2, but this passage 15 has an inlet portion 20 which extends radially inward of the sleeve and which is closed by the cylinder part 18 when the valve is in its rearward position. The passage 15 also has another connecting portion 21 which alines with the groove 6 of the valve member when the latter is in its rearward position, so that this groove connects the passage 21 with an outlet duct 12 opening to the outer air and having one of its inlets in alinement with the passage 21. Consequently, when the valve is in its rearward position, the forward end of the bore 2 is connected through the passages 15 and 21, and through the rear groove 6, with the outlet duct 12, thereby affording an exhaust passage for the forward end of the cylinder. At the same time, the forward groove 7 of the valve member affords another connection to the outlet 12, namely to the intermediate exhaust passage 10 which opens into the bore 2 at a point somewhat ahead of the piston when the latter is at its starting point. Initially, the piston will therefore be moved forwardly by the compressed air entering through the passage 9, and the air in front of the piston will be expelled through both the passages 10 and 15.

While this is occurring, the valve member is maintained in its rearward position by the compressed air itself, since this air presses against both faces of the web 20 and the larger diameter of the forward end of the valve member produces a differential effect tending to move this member toward the rear and therefore holding it in its rearmost position. The valve is therefore held firmly in position, while the piston travels forward. In moving forward, the piston first shuts off the connection from the forward end of the bore 2 to the intermediate exhaust passage 15, and when the piston has entirely passed the forward end of this passage 10, the latter is automatically connected to the part of the main bore behind the piston. Consequently, the compressed air which still enters through the inlet 9 can exhaust through the passage 10 as soon as the piston has moved entirely beyond the forward end of the passage 10. When this occurs, the exhausting of the air behind the piston reduces the pressure in front of the web 20, while the rear of the web is still continuously subjected to the full operating pressure of the compressed air. As soon as the drop in pressure in front of the web is sufficient to overbalance the differences in diameters of the forward and rear faces of the valve member, the actuating air will move the valve member forwardly to the position of Fig. 2, thereby bringing the groove 6 out of alinement with any of the passages in the barrel and therefore disconnecting the outlet 12 from the passage 15 leading to the forward end of the bore 2.

As the valve moves forward, its rear end exposes the terminal portion 20′ of the passage 15, so that the actuating air from the bore of the handle can flow through the passages 20 and 15 to the extreme forward end of the bore 2, thereby admitting live air in front of the piston. At the same time, the forward groove 7 has moved out of alinement with the intermediate exhaust 10 and into alinement with the rear end of a compression-controlling passage 13. Likewise, the shoulder at the juncture of the two differentially diametered portions of the valve member has moved away from its stop and the smaller diameter of the portion adjacent to the groove 7 coöperates with the latter in connecting the passage 13 with the outlet 12, as shown in Fig. 2. This passage 13 therefore affords an exhaust outlet for the rear of the cylinder, while the original inlet 9 is shut off by the forward portion of the valve member.

With the valve in this forward position, the pressure of the live air admitted through the passage 15 forces the piston rearwardly, and the air back of the piston exhausts freely through the passage 13 until the piston itself closes the entrance to this latter passage and thereby entraps the residual air between the rear end of the piston and the valve member. As the piston continues its rearward movement, this entrapped air is compressed, and as soon as the resulting pressure overbalances the pressure of the live air on the rear face of the valve member, the valve is moved rearwardly to its initial position, after which the above described cycle of operation is resumed.

However, while I have heretofore described my invention in an embodiment in which the valve member has two grooves,

one of which governs the compression-controlling passage 13, I do not wish to be limited to this or other details of the construction and arrangement here described, it being obvious that the same might be modified in many ways without departing from the spirit of my invention. For example, instead of employing the forward groove on the valve for connecting the compression-controlling passage 13 with the outlet passage 12, I may employ a bore 14 in the sleeve 17, which bore extends longitudinally of the tool against the shoulder at the juncture of the differentially diametered valve portions, as shown in Figs. 3 to 7 inclusive. In this case, the said shoulder closes the connecting bore 14 while the valve is in its initial position, while the groove 6 connects the passage 15 with the outlet 12 (as shown in Fig. 7) and the inlet 9 acts as in the first described embodiment. When the piston has entirely passed the mouth of the intermediate passage 10, this connects the groove 6 with the rear portion of the bore 2, and the groove in turn affords a connection to the outlet 12. Consequently, the air behind the piston exhausts through this outlet, thereby reducing the pressure on the forward face of the valve until the pressure of the live air on the rear face of the valve slides the latter forward into the position of Fig. 6.

When the valve has thus moved forward, its larger diametered portion exposes both the upper outlet of the compression-controlling passage 13 and the lower end of the bore 14, so that the air behind the piston can exhaust through this bore 14 after the piston has closed the inlet to the intermediate passage 10. However, when the piston during its rearward stroke also passes the inlet of the passage 13, the exhaust for the rear of the cylinder is shut off and the entrapped air is then compressed between the piston and the valve until the resulting pressure moves the valve back to its initial position of Figs. 3 and 7. This shuts off the supply of compressed air to the forward end of the cylinder and restores the initial air supply and exhaust connections for the cylinder. The cycle of operations is then resumed, the rate of reciprocation being governed by the pressure at which the air is supplied, and by the distance which the piston has to move before closing the inlets from it to the passages 10 and 13.

It will be obvious from the above that with both of the described embodiments no complicated shape whatever is required for the piston, as a simple solid cylinder suffices for this, and that the valve member can be quite light and easily constructed since it has no bores whatever through the same. It will also be obvious that by increasing or decreasing the number of the ports, and by shifting the connections of the passages 10 and 13 to the cylinder longitudinally of the latter, I can readily vary the operation of my appliance, including the extent to which the entrapped air is compressed by the piston during its rearward stroke. So also, with a completely manufactured tool, I can effect a considerable variation by simply plugging up a part of the ports, as for example by the simple expedient of slipping nails into the rear ends of the passages 9.

Moreover, since the valve member is subjected on both faces to the pressure of the actuating fluid during almost the entire forward stroke of the piston, the tendency for fluid to leak past this valve is practically negligible, so that I do not require an exact fit and am able to operate the tool of my invention successfully even after the parts have shown considerable wear. So also, since the shoulder on the piston when in its rearward position is pressed tightly by the air pressure against the corresponding shoulder in the sleeve 17, I make it difficult for the exhaust to leak around the valve when the valve is in its rearward position, and hence do not require an exact fitting at these points. Furthermore, by employing a plurality of ports arranged about the axis of the main cylinder, I am able to use relatively small bores for each and can therefore work with a quite short longitudinal movement of the valve member. Then, since this valve member is nearly balanced by the pressures against its opposite faces, and since I can readily employ a hollow and therefore light valve member, the motion imparted to it is relatively gentle, so that the valve is practically noiseless and not liable to cause undue wear by impact against the stop formations which limit its travel in both directions. So also, because of the slight movement required and the low inertia of the valve, I can operate the tool of my invention even with pressures very much lower than those commonly required as the minimum for operating pneumatic tools, namely with pressures running down to only one or two pounds.

I claim as my invention:

1. In a pneumatic tool, a cylinder, a piston therein, an inlet for the cylinder, a single exhaust outlet, an exhaust and an intermediate passage in the cylinder, a compression-controlling passage in the cylinder, and a valve having means whereby in one position to connect said exhaust outlet and intermediate passage to the cylinder and in a second position to connect the compression-controlling passage to said exhaust outlet.

2. In a pneumatic tool, a cylinder having a piston therein, an exhaust outlet, a pair of passages in the cylinder leading to the

forward end and to an intermediate point in the cylinder, a third passage leading into the cylinder rearwardly of the intermediate point, and a valve in the cylinder having two grooves arranged for connecting the exhaust outlet respectively with said pair of passages in one position of the valve and in a second position to have one of its grooves connect the third passage with the exhaust outlet.

3. In a pneumatic tool, a barrel having a piston reciprocating in the bore of the barrel, an exhaust outlet, the barrel having a pair of passages leading respectively to the forward end and to an intermediate point of the said bore, means whereby to convey fluid to the piston to return same to initial position, and a slidable valve having two grooves disposed for connecting the exhaust outlet respectively with the said passages in one position of the valve and in a second position to render said means operative.

4. In a pneumatic tool, a cylinder, a piston therein, said cylinder having an exhaust outlet, and further having a pair of passages leading respectively to the forward end and to an intermediate point in the cylinder, and a third passage rearwardly of the pair of passages, and a valve for controlling the passages and having means whereby in one position to connect the pair of passages to the exhaust outlet and in a second position to disconnect said pair of passages from the exhaust outlet and to connect the third passage to the exhaust outlet.

5. In a pneumatic tool, a cylinder, a piston therein, a sleeve having a longitudinal inlet passage opening at its ends into and adjacent the sleeve ends, an exhaust in the cylinder and sleeve, an exhaust outlet in the cylinder and sleeve, means whereby to convey fluid to the piston to return same to initial position and a slidable valve in the sleeve formed when in its rearmost position to connect the exhaust and exhaust outlet and to render said means inoperative and when in its forward position to close the forward end of the inlet passage and render said means operative.

6. In a pneumatic tool, a cylinder, a piston therein, a sleeve having a longitudinal inlet passage opening at its ends into and adjacent the sleeve ends, an exhaust in the cylinder and sleeve, an exhaust outlet in the cylinder and sleeve, an intermediate passage in the sleeve and cylinder, means whereby to convey fluid to the piston to return same to initial position and a slidable valve in the sleeve formed when in its rearmost position to connect the exhaust and exhaust outlet and when in its forward position to close the forward end of the inlet passage and to effect communication between the intermediate passage and the exhaust outlet and render said means operative.

7. In a pneumatic tool, a cylinder, a piston therein, a valve having an enlarged forward end and having a pair of spaced peripheral grooves, an exhaust passage and an exhaust outlet in the cylinder, and an intermediate passage and a rear passage in the cylinder arranged and related to the valve grooves so that when the latter is in its rearmost position the exhaust and intermediate passages will be connected by the respective pair of grooves to the outlet and when the valve is in its forward position the rear passage will be connected to the outlet by one of said grooves.

8. In a pneumatic tool, a cylinder, a piston therein, an exhaust outlet, a compression controlling passage, an exhaust passage and an intermediate passage all formed in the cylinder, and a valve control formed for connecting the exhaust and intermediate passages to the exhaust outlet in one position of the valve and in a second position of the latter to connect the compression-controlling passage to the said outlet.

9. In a pneumatic tool, a cylinder, a piston therein, an inlet passage leading at one end into the cylinder, a valve slidable between the ends of the inlet passage and formed in one position to cover said end of the passage, an exhaust and intermediate passage leading into the cylinder, an outlet for the cylinder and a pair of peripheral groove passages formed in the valve to connect the exhaust and intermediate passages to the outlet in one position of the valve, and means controlled by the valve to convey fluid to the piston to return same to initial position in a second position of the valve.

10. In a pneumatic tool, a cylinder, a piston therein, an exhaust and an intermediate passage in the cylinder having lateral terminals, an exhaust outlet having a pair of lateral terminals, means whereby to convey fluid to the piston to return same to initial position, and a slidable valve having a pair of peripheral grooves which in one position of the valve register with the respective lateral terminals and in a second position render said means inoperative and bring said grooves and terminals out of register.

11. In a pneumatic tool, a cylinder, a piston therein, an exhaust and an intermediate passage in the cylinder, an exhaust outlet in the cylinder, a compression-controlling passage in the cylinder, means whereby to convey fluid to the piston to return same to initial position and a valve control which in one position connects the exhaust and intermediate passages with the exhaust outlet and in a second position connects the

compression-controlling passage to the exhaust outlet and renders said means operative.

12. In a pneumatic tool, a cylinder, a piston therein, an exhaust passage leading to the forward end of the cylinder, an exhaust outlet leading to the outer air, means whereby to convey fluid to the piston to return same to initial position and a valve control having a peripheral groove, both the passage and outlet terminating opposite to the peripheral groove of the valve control so as to connect same in one position of the valve control and said valve being formed so as to render said means operative in a second position of the valve.

Signed at Chicago, Illinois, July 1, 1919.

FRANK L. HENIG.