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PNEUMATIC HAMMER.

APPLICATION FILED APR. 1, 1902.

917,242. Patented Apr. 6, 1909.

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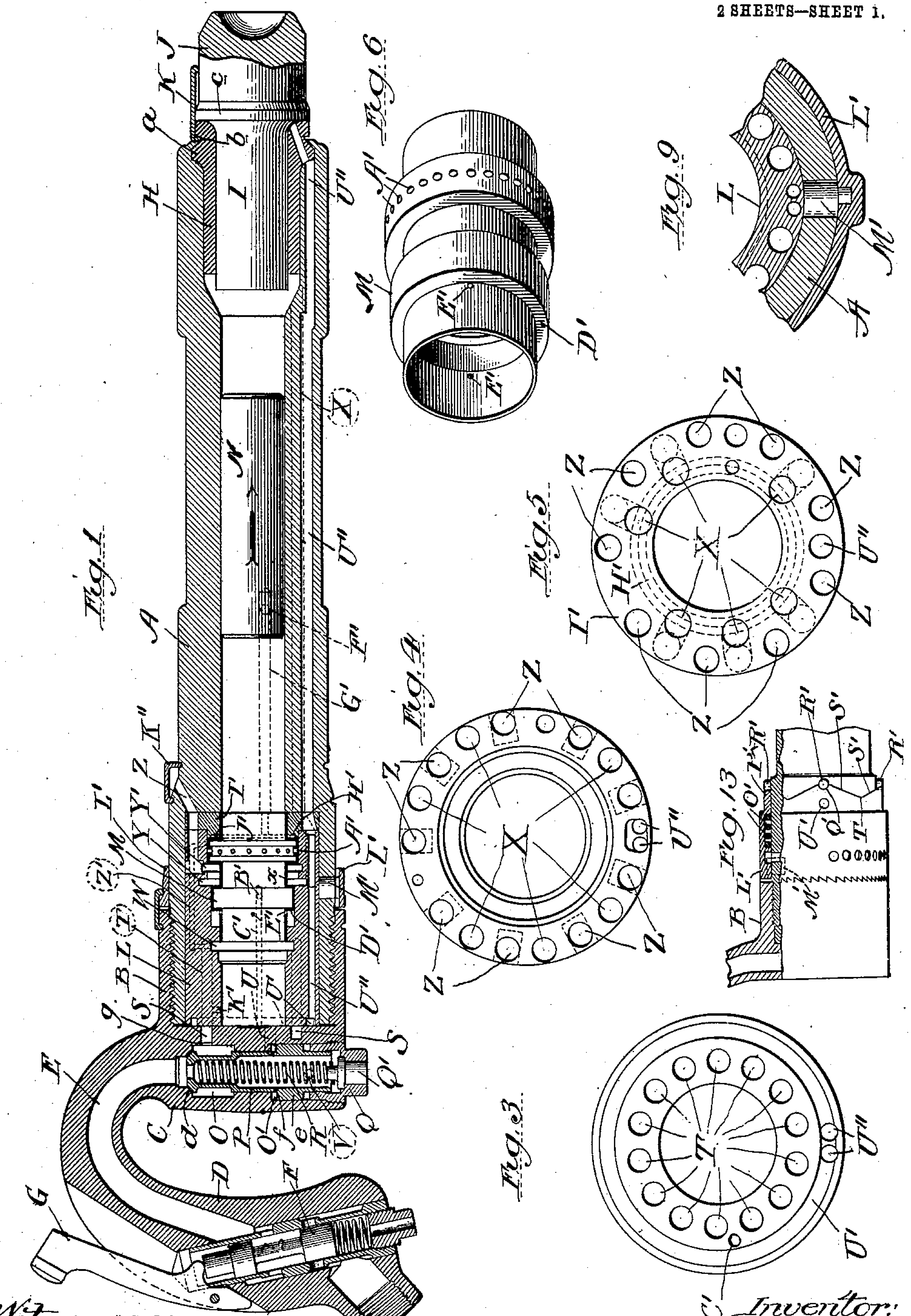

Witnesses:

H. G. Barrett

Louis B. Erwin

Inventor:

Joseph Boyer

By Rector & Hibben

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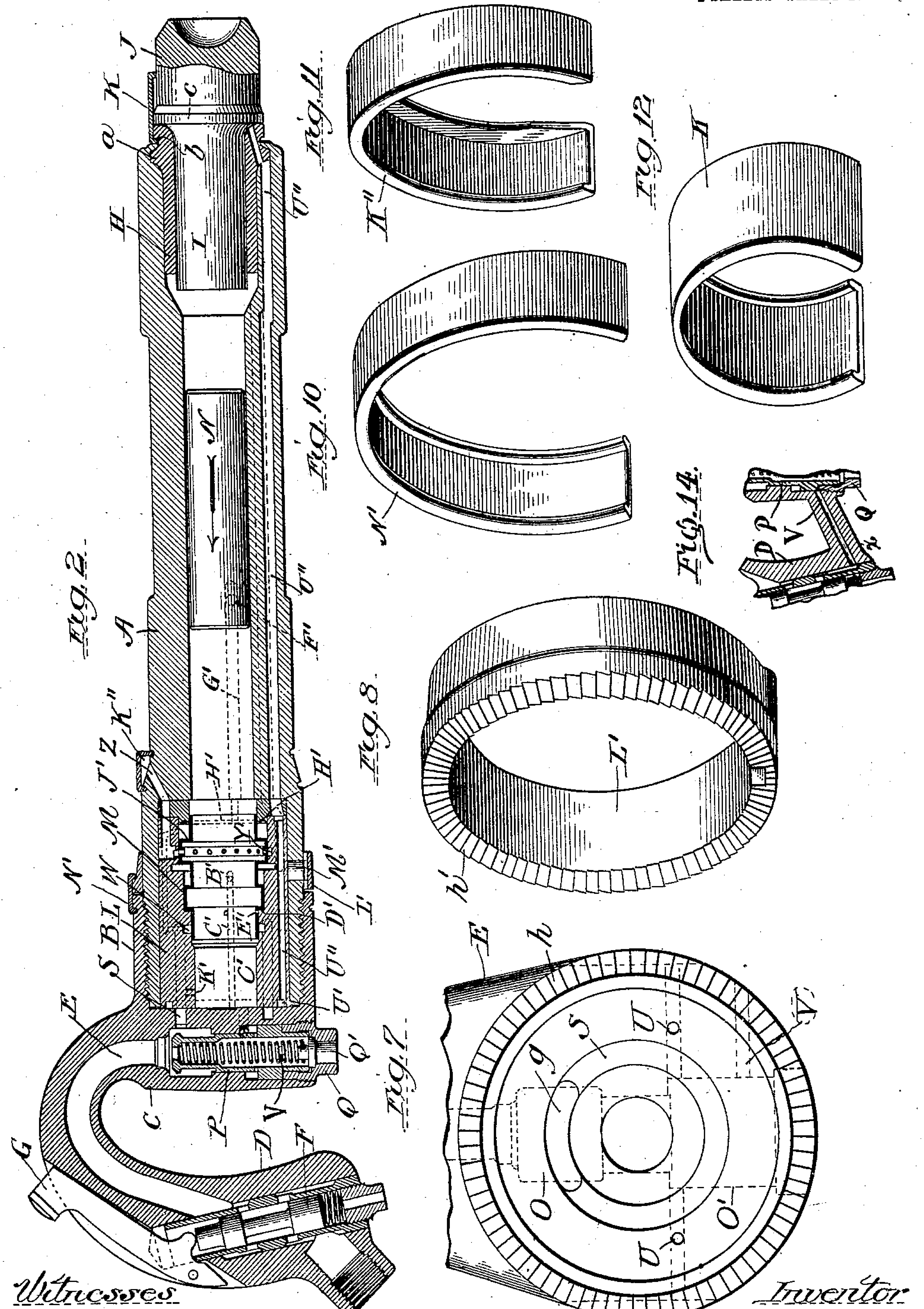

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Harold G. Barrett

Louis B. Erwin

Inventor

Joseph Boyer

By Rector & Hibben his Attys.

UNITED STATES PATENT OFFICE.

JOSEPH BOYER, OF DETROIT, MICHIGAN.

PNEUMATIC HAMMER.

No. 917,242. Specification of Letters Patent. Patented April 6, 1909.

Application filed April 1, 1902. Serial No. 100,902.

To all whom it may concern:

Be it known that I, JOSEPH BOYER, a citizen of the United States, residing in Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Pneumatic Hammers, of which the following is a description, reference being had to the accompanying drawings, forming part of this specification.

My invention has for its object the improvement of tools of the character referred to in respect to efficiency of operation and simplicity and durability of construction, and consists in certain novel constructions, combinations and modes of operation of the several parts of such tools which will be hereinafter set forth and particularly pointed out in my claims.

In the drawings, Figure 1 represents a middle, longitudinal vertical section of the complete tool, with the throttle valve controlling admission of the motive fluid to the tool closed and the several parts thereof at rest; Fig. 2 a corresponding view with the throttle valve opened, to admit motive fluid to the tool, and with the distribution valve of the tool in a different position from that shown in Fig. 1; Fig. 3 an elevation of the rear end of the valve case; Fig. 4 an elevation of the front end thereof, with the end cap or lid removed; Fig. 5 an elevation of the forward side of such cap or lid; Fig. 6 a perspective view of the distribution valve removed from the valve casing; Fig. 7 an elevation of the forward side of the cylinder head or handle-base and the internally threaded sleeve projecting therefrom, with the cylinder and valve casing removed; Fig. 8 a perspective view of the locking ring or sleeve which coöperates with the front end of the sleeve projecting from the handle-base, to lock the latter to the cylinder; Fig. 9 a sectional detail of the locking key for said ring and the parts coöperating with it; Figs. 10, 11 and 12 perspective views of the three spring clips employed upon the tool and hereinafter described, Fig. 13 is a view of a modification of the locking device and Fig. 14 is a modification.

The same letters of reference are used to indicate corresponding parts in the several views.

The cylinder A of the tool has an exteriorly threaded rear end upon which is screwed an internally threaded sleeve B formed integral with and projecting forwardly from the cylinder head or handle-base C, which in turn has formed integral with it the grasping handle D. The inlet passage E for the motive fluid is led through the handle D and controlled by a throttle valve F of familiar construction operated by a thumb-lever G.

At its front end the cylinder A is bored out and has secured in it the bushing H which receives the shank I of the working tool, which is in the present instance a button-set J for heading rivets. The bushing H is provided near its outer end with an annular shoulder *a* whose forward side terminates in a recess or circumferential groove *b*, which latter receives the inturned flange upon the rear end of the spring clip K, which fits around the set J and is provided at its forward end with a second inturned flange whose engagement with an annular shoulder *c* formed upon the set holds the latter in position in the front end of the tool while permitting limited play of it forward and backward. The forward end of the cylinder A is originally bored out in such manner as to permit the insertion of the bushing H, with its annular shoulder *a*, into the position shown, and after the bushing has been inserted the extreme forward end of the cylinder is spun down over the forward side of said shoulder, as shown, to secure the bushing in place.

At its rear end the cylinder A is bored out to receive a cylindrical valve casing or block L whose internal bore constitutes a rearward continuation of the main piston chamber within the cylinder, and contains the distribution valve M, Fig. 6, by the reciprocation of which the motive fluid admitted to the tool is alternately admitted to and exhausted from the opposite ends of the piston chamber to reciprocate the piston N therein.

The throttle valve in the grasping handle D of the tool, before referred to, is a hand operated valve, and remains closed, to entirely cut off the motive fluid from the tool, except when purposely opened by pressing down the thumb lever G as in Fig. 2. In the absence of any other provision the opening of this throttle valve would set the tool in operation, but inasmuch as it is highly desirable to prevent operation of the tool, inadvertently or otherwise, except when the rivet set J is pressed firmly against the work to be operated upon so that the latter will receive and resist the force of the blows of the piston N upon the shank I of the set J, I have provided a second throttle valve, of novel construction and operation, which permits reciprocation of the piston and operation of the tool only when the set J or other working tool is pressed against the work and thereby maintained in normal position in the front end of the cylinder; and this valve may now be described.

Formed in the cylinder head or handle-base C is a valve chamber with whose upper end communicates the lower forward end of the main inlet passage E. This valve chamber has a contracted middle portion, and enlarged upper and lower portions O and O′, separated from each other by the tubular valve P located in said chamber and snugly fitting the contracted middle portion thereof. The upper end of this valve P is shaped to fit a valve seat *d* at the lower end of the inlet passage E, and thereby, when the valve is in its upper position as in Fig. 1, cut off the motive fluid from the upper portion O of the valve chamber. Below its middle the valve P is provided with annular enlargement *e* snugly fitting the portion O′ of the valve chamber and constituting a piston movable therein. The lower end of the valve chamber is closed by a screw plug Q whose upper end is centrally bored to snugly receive the tubular lower end of the valve P beneath the piston *e*. Both the upper and lower ends of the valve P are open so that the motive fluid is constantly admitted to its interior from the inlet passage E, and the valve is provided immediately above its piston *e* with one or more holes *f* through which the motive fluid admitted to the interior of the valve may pass into the portion of the chamber O′ above the piston *e*. A coiled spring R located within the valve and resting at its lower end upon the screw plug Q (or a socket piece Q′ therein) and exerting a constant upward pressure on the valve tends to hold its upper end against the seat *d* and thereby cut off the motive fluid from the chamber O, as in Fig. 1. Whenever the valve is depressed, against the resistance of the spring R, the motive fluid will be admitted to said chamber and will pass thence through a short (but wide) port *g* into an annular groove S formed in the forward face of the cylinder head or handle base C, (Fig. 7). This groove S communicates through a circular series of longitudinal ports T (Fig. 3) with the distribution valve chamber and piston chamber, in the manner hereinafter described, with the result that whenever the valve P is depressed and the motive fluid thereby admitted to the chamber O groove S and ports T, the tool will be set in operation.

The pressure of the motive fluid against the upper end of the valve P is sufficiently counterbalanced by the pressure against its lower end (within the screw plug Q) to enable the spring R to normally hold the valve in its upper or closed position, Fig. 1, and the valve is automatically opened by the act of pressing the tool up to its work, in the following manner and by the following means: Leading from the portion of the valve chamber O′ above valve piston *e* is a passage U communicating with an annular groove U′ formed in the rear face of the valve block L, and with the groove U′ communicates the rear end of a long passage U″ extending forward through the valve casing L, cylinder wall A, and bushing H, and opening through the forward end of the latter immediately behind the shoulder *c* of the rivet set J. When the shoulder of the rivet set is pressed tightly against the forward end of the bushing H, as by the act of pressing the tool up to its work, the front end of the passage U″ will be closed by the shoulder *c* in the rivet set, but at all other times the motive fluid admitted to the valve chamber O′ from the interior of the valve P will be permitted to escape through the long passage U″. It results from this construction and arrangement of the parts that when the hand operated throttle valve F is opened motive fluid will be at once admitted through the inlet passage E to the interior of the valve P, and thence through the minute ports *f* into the valve chamber O′. If the motive fluid is free to escape from said chamber, through the port, groove and passage leading to the front end of the tool, the valve P will remain closed, under the pressure of the spring R, and no motive fluid will be admitted to the upper portion O of the valve chamber and thence to the distribution valve chamber and piston chamber. If, however, the escape of the motive fluid from the chamber O′ is cut off its pressure in said chamber, exerted upon the upper side of the valve piston *e*, will force the valve downward to open position, Fig. 2, and thereby admit the motive fluid to the chamber O, the groove S and ports T, and set the tool in operation. If, therefore, the tool is pressed up to its work at the time the hand operated throttle valve is opened it will be immediately set in operation by the opening of said valve, but if it be not pressed up to its work at such time the motive fluid admitted to the valve chamber O′ will escape therefrom through the passage U″ and not exert a sufficient pressure upon the valve piston *e* to open the valve, and the tool will therefore not be set in operation until it is pressed up to its work and the shoulder of the rivet-set or other working tool caused to close the forward end of the passage U″.

The control of the exhaust from the chamber O′ by means of the rivet-set or other working tool J at the front end of the cylinder is highly advantageous and desirable, in that it renders the operation of the valve P automatic; but it is evident that said exhaust might be controlled in other ways to cause the valve P to be opened when the exhaust was closed, and to be closed by its spring when the exhaust was opened. Again, as will be apparent, motive fluid pressure admitted to the under side of the piston *e* of the valve might be substituted for the spring R for normally holding the valve closed, the pressure area of the under side of the piston being in such case sufficiently reduced to permit the pressure upon its upper side to overcome that below it and depress the valve when the exhaust from the chamber O′ was closed. Motive fluid might be led to the under side of the piston *e* for such purpose through a passage in the bridge-piece *x* frequently employed to connect the lower end of the handle with the handle base C, as shown in Fig. 4, in which case said passage could communicate at one end with the inlet passage E below the hand operated throttle valve F and at its other with the lower end of the chamber O′ by a port such as indicated at V, so that whenever the tool was connected to the motive fluid supply, motive fluid would be admitted to the under side of the piston *e* regardless of the open or closed position of the valve F. In the present instance the port indicated at V is simply a vent hole to connect the lower end of the chamber O′ with the atmosphere.

The circle of longitudinal ports T (Fig. 3) which communicate at their rear ends with the annular groove S in the cylinder head or handle-base connect at their forward ends with a circumferential groove W in the valve block L, so that when the valve M is in the forward position shown in Fig. 1 the motive fluid admitted to the groove S and ports T passes into the piston chamber through the groove W and drives the piston forward to deliver a blow to the shank I of the working tool, the air in front of the piston at such time escaping backward through a passage X which communicates at its rear end with a groove Y in the valve block L, which groove, when the valve is in forward position, is in communication with an exhaust groove Y′ which is in constant communication with exhaust passages Z leading to the exterior of the tool, (Figs. 1, 4 and 5).

When the valve M is shifted to its rearward position, Fig. 2, the admission of motive fluid through the inlet groove W is cut off by the rear end of the valve, and ports A′ formed in the shell of the valve Fig. 6 are brought into register with the exhaust groove Y′, thus placing the rear end of the piston chamber in communication with the exhaust passages Z, to permit backward movement of the piston. In such rearward position of the valve M the groove Y with which the rear end of the passage X leading to the front of the piston chamber is connected is placed in communication with a port B′ at the front end of a live air passage C′ which extends rearwardly through the valve block L and communicates at its rear end with the live air groove S in the handle-base. Motive fluid is thus admitted through the passage C′, port B′, groove Y and passage X to the front end of the piston chamber to drive the piston rearward. There are in the present instance six of the passages X, (Figs. 4 and 5) all communicating at their rear ends with the groove Y and opening at their forward ends into the piston chamber, to permit a freer exhaust of the air in the front end of the piston chamber than if a single passage only were employed.

The reciprocation of the valve M is accomplished as follows: When the valve is in forward position, Fig. 1, there is a constant pressure of motive fluid exerted upon its extreme rear end, and also upon its rearwardly facing shoulder D′ to which the motive fluid is admitted from the interior of the valve through minute holes E′, and this constant pressure tends to maintain the valve in forward position. Opening into the piston chamber by a port F′, about midway of its length, is a rearwardly extending passage G′ whose rear end communicates with a groove H′ formed in the rear face of the cap piece I′ of the valve block L and facing the annular shoulder J′ of the valve M, Fig. 5. The face of this annular shoulder J′ of the valve is of greater area than the combined areas of the shoulder D′ and the extreme rear end of the valve, so that when motive fluid is admitted to it the pressure upon it will overcome the pressure which is holding the valve in forward position, and will force the valve rearward to the position shown in Fig. 2. This occurs when, in the forward movement of the piston, its rear end passes and uncovers the port F′ at the forward end of the passage G′—an event which is about to occur in the position of the parts shown in Fig. 1—whereupon the valve will be shifted rearward, with the result of cutting off the motive fluid from the rear end of the piston chamber and placing the latter in communication with the exhaust, and admitting the motive fluid to the forward end of the piston chamber, to drive the piston backward after it has delivered its blow to the tool. When the valve has been shifted rearward in the manner described the motive fluid is also admitted to the pressure area J′ through an auxiliary passage Z′ communicating at its rear end with the live air groove W, which additional supply of motive fluid assists that admitted through the passage G′ in holding the valve in rearward position.

The shifting of the valve from its rearward position, Fig. 2, back to its forward position, Fig. 1, is accomplished as follows: As the piston, moving rearward, approaches the rear end of its stroke it enters the bore of the valve M, which it snugly fits, and after its rear end has entered the contracted middle portion of the valve at x, the escape of air from the rear end of the piston chamber, which had before occurred through the ports A′ in the valve, is cut off, and thereafter the air thus trapped in front of the rearwardly moving piston is compressed to such a degree that its pressure exerted upon the extreme rear end of the valve and its shoulder D′ forces the valve forward again to the position shown in Fig. 1. The forward end of the piston has, prior to such time, passed rearward of and uncovered the port F′ of the passage G′ leading to the large pressure area J′ of the valve, thus permitting the escape of the motive fluid from such pressure area preparatory to the forward movement of the valve just described. The bore of the valve block L at the rear end of the valve chamber proper, constituting the rear end of the piston chamber, is of such size as to snugly fit the piston, so that when the rear end of the piston enters such bore it is effectively cushioned against the air trapped therein and prevented from striking the cylinder head. A small port K′ connects the extreme rear end of the piston chamber with one of the live air passages T, so as to admit live air into the rear end of the piston chamber for the purpose of starting the piston and valve forward in event they should both be in rearward position at the beginning of any operation of the tool.

A spring clip K″, Fig. 11, partially surrounding the cylinder and provided with inturned flanges engaging circumferential grooves therein, covers the outer ends of the exhaust passages Z and directs the exhaust to the under side of the cylinder.

For the purpose of securely locking the handle and handle base or cylinder head to the cylinder, and preventing the parts from becoming unscrewed under the jar of the tool in operation, the following means are provided: The forward end of the internally threaded sleeve B of the handle-base is serrated or provided with ratchet teeth h, as shown in Fig. 7, which serrations or teeth coöperate with like teeth h' formed upon the rear end of a locking sleeve or ring L′, Fig. 8. This ring is slipped loosely over the cylinder, but when in position thereon, is held from rotation by a key M′ consisting of a circular block fitting in a round hole in the under side of the cylinder and provided upon its under side with a projecting rib or key extending longitudinally of the cylinder and fitting a corresponding groove or key-way formed upon the inner surface of the under side of the ring L′, Figs. 1, 2 and 9.

In assembling the parts the handle is screwed as tightly as possible upon the end of the cylinder, and the ring L′ pressed rearward and its teeth engaged with those on the forward end of the cylinder B, and then a spring clip N′, Fig. 10, is sprung around the parts to hold them in engagement with each other. This spring clip is provided with inturned flanges at its front and rear ends, which engage, respectively, a shoulder upon the ring L′ and a circumferential groove in the sleeve B. The clip thus serves to hold the teeth upon the ring in locked engagement with the teeth upon the ring in locked engagement with the teeth sleeve, and as the ring is held from rotation by the key M′ it follows that the sleeve B is likewise held from rotation, so that the handle cannot become unscrewed from the cylinder.

The rib or key proper projecting from the outer surface of the round block M′ and engaging the key-way in the locking ring L is set at one side of middle position upon the block, or eccentrically thereto, as shown in Fig. 9, so that by turning the block half way around in its seat in the cylinder wall the position of the rib or key will be correspondingly changed. The offset position of the rib upon the block equals one half the width of one of the teeth upon the locking ring and sleeve, with the result that if in screwing the handle upon the cylinder it comes to rest in a position where the teeth upon its front end and the teeth upon the locking ring do not tightly interlock the locking ring may be slipped forward out of engagement with the teeth and the block M′ turned half way around, and the locking ring slid back again into engagement with the teeth upon the handle sleeve, whereupon the teeth upon the ring and sleeve may in most instances be made to accurately register and firmly interlock.

Instead of employing the spring clip N′ to hold the locking ring in engagement with the teeth upon the handle sleeve, the construction illustrated in Fig. 13 may be employed, where a coiled spring O′ serves to hold the locking ring L′ in engagement with the teeth upon the handle sleeve B. In this construction the locking ring is held from rotation upon the cylinder by a key M′ as in Figs. 1, 2 and 9, but the ring is of greater width than in those figures and its forward half is bored out to form within it a circumferential recess or chamber to receive the coiled spring O′, which is a steel spring of considerable strength and rigidity, and in the present instance is approximately square in cross section. In front of this spring, and fitting in the extreme forward end of the circumferential recess within the locking ring, is a second ring P′ whose rear edge is a plain circle and fits against the forward side of the spring O′. The forward edge of the ring P′, however, is provided at intervals with locking notches Q′ adapted to coöperate with round pins R′ projecting from the cylinder A. Between the notches Q′ in the forward edge of the ring the latter recedes rearward to a point midway between the locking notches, thus presenting between each pair of adjacent notches two inclined surfaces S′ whose junction at T′ may be said to form the bottom of a wide and shallow notch or recess connecting the adjacent locking notches Q′.

In assembling the parts the ring P′ is slid forward over the rear end of the cylinder in position for its shallow notches or recesses connecting the locking notches Q′ to register with the pins R′ at the points T′, thus permitting the ring to be slipped further forward over the cylinder than if it were turned to position for its locking notches Q′ to engage the pins R′. The spring Q′ is then slipped over the cylinder and pushed forward against the ring P′, and then the locking ring L′; after which the handle is screwed upon the rear end of the cylinder as tightly as possible, and the teeth upon its front end engaged with the teeth upon the locking ring L′. The ring P′ is then turned by means of a spanner wrench applied to a hole U′ provided in it for such purpose until the locking notches Q′ are engaged with the pins R′ upon the cylinder. As the inclined surfaces S′ of the ring P′ ride over the pins R′ in this turning of the ring the latter will be forced rearward and compress the spring O′ and force the locking ring L′ into firm engagement with the teeth upon the sleeve B, and thereby securely lock the handle to the cylinder. When it is desired to release the handle the sleeve P′ will be turned by means of the spanner wrench and its locking notches O′ be disengaged from the pins R′ and the points T′ of the ring be brought opposite the pins, thereby permitting the locking ring L′ to be slipped forward out of engagement with the handle sleeve B and the latter to be released.

Other applications of a spring to hold the locking ring in engagement with the teeth on the sleeve may obviously be employed for the same purpose and with the same result.

Having thus described my invention, I claim:

1. In a pneumatic hammer, the combination of a throttle valve and means for automatically opening said valve by motive fluid pressure upon pressing the tool to its work.

2. In a pneumatic hammer, a throttle valve having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage communicating with such pressure area and requiring closure to cause the motive fluid admitted to such pressure area to open the valve; substantially as described.

3. In a pneumatic hammer, a throttle valve held normally closed by a spring and having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage communicating with such pressure area and requiring closure to cause the motive fluid admitted to such pressure area to open the valve; substantially as described.

4. In a pneumatic hammer, a throttle valve having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage leading therefrom and controlled by the working tool, whereby said passage will be closed and the throttle valve be opened by the fluid pressure only when the tool is pressed to its work; substantially as described.

5. In a pneumatic hammer a throttle valve held normally closed by a spring and having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage leading therefrom and controlled by the working tool, whereby the motive fluid will be caused to open said valve only when said exhaust passage is closed by the working tool; substantially as described.

6. In a pneumatic hammer, a throttle valve having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage leading therefrom to the front end of the cylinder and adapted to be closed by the working tool when the latter is in working position, whereby the throttle valve will be opened by the pressure of the motive fluid only when said tool is in working position; substantially as described.

7. In a pneumatic hammer, a throttle valve held normally in closed position by a spring and having a piston or pressure area to which motive fluid is admitted to open the valve, and an exhaust passage leading therefrom and adapted to be closed by the insertion of the working tool into working position in the front end of the cylinder, whereby the throttle valve will be opened by the fluid pressure only when said tool is in such position; substantially as described.

8. In a pneumatic hammer, the combination, with a hand-operated throttle valve, controlling the initial admission of motive fluid to the tool, of a supplemental throttle

valve located between the hand-operated valve and the body of the tool and operated by fluid pressure to control the final admission of motive fluid to the tool; substantially as described.

9. In a pneumatic hammer, the combination, with a hand-operated throttle valve controlling the initial admission of motive fluid to the tool, of a supplemental throttle valve located between said hand-operated valve and the body of the tool and automatically opened by fluid pressure when the tool is held up to its work; substantially as described.

10. In a pneumatic hammer, the combination, with a hand-operated throttle valve controlling the initial admission of motive fluid to the tool, of a supplemental throttle valve controlling the final admission of motive fluid to the tool and having a piston or pressure area to which motive fluid is admitted upon the opening of the hand-operated valve, and an exhaust passage leading from such pressure area and requiring closure to cause the motive fluid admitted to such pressure area or piston to open the valve; substantially as described.

11. In a pneumatic hammer, the combination, with a hand-operated throttle valve controlling the initial admission of motive fluid to the tool, of a supplemental throttle valve controlling the final admission of the motive fluid to the tool and having a piston or pressure area to which motive fluid is admitted upon opening the hand-operated valve, and an exhaust passage leading from such pressure area and controlled by the working tool at the front end of the cylinder, whereby the motive fluid is caused to open said supplemental valve only when the tool is pressed up to its work; substantially as described.

12. In a pneumatic hammer, the combination, with a hand-operated throttle valve located in the handle of such tool and controlling the admission of motive fluid to the tool, of a supplemental throttle valve located in the body of the tool and automatically opened by fluid pressure upon pressing the tool up to its work; substantially as described.

13. In a pneumatic hammer, the combination, with a hand-operated throttle valve located in the handle of the tool and controlling the initial admission of motive fluid thereto, of a supplemental throttle valve located in the body of the tool and controlling the final admission of motive fluid thereto, said supplemental valve having a piston or pressure area to which motive fluid is admitted upon opening the hand-operated valve, and an exhaust passage leading from such pressure area and requiring closure to cause the motive fluid admitted to such pressure area to open said supplemental valve; substantially as described.

14. In a pneumatic hammer, the combination with a hand-operated throttle valve located in the handle of the tool and controlling the initial admission of motive fluid thereto, of a supplemental throttle valve located in the body of the tool and controlling the final admission of motive fluid thereto, said supplemental valve having a piston or pressure area to which motive fluid is admitted upon the opening of the hand-operated valve, and an exhaust passage leading from such pressure area and controlled by the working tool at the front end of the cylinder, whereby the motive fluid admitted to said pressure area will operate to open the valve only when the exhaust passage is closed by said working tool; substantially as described.

15. In a pneumatic hammer, a tubular throttle valve controlling the admission of motive fluid to the tool, and to whose interior motive fluid is admitted when the valve is in closed position, ports affording communication between the interior of the valve and an external pressure area or piston thereto, and an exhaust passage communicating with such pressure area and requiring closure to cause the motive fluid admitted to such pressure area from the interior of the valve to open the latter; substantially as described.

16. In a pneumatic hammer, a tubular throttle valve controlling the admission of motive fluid to the tool, and to whose interior motive fluid is admitted when the valve is in closed position, a coiled spring operating to yieldingly hold the valve in closed position, an external pressure area or piston upon the valve to which motive fluid is admitted from the interior of the valve through ports in the walls thereof, and an exhaust passage communicating with such pressure area and requiring closure to cause the motive fluid admitted to such pressure area to open the valve against the resistance of the spring; substantially as described.

17. In a pneumatic hammer, a tubular throttle valve controlling the admission of motive fluid to the tool, and to the interior of which motive fluid is admitted when the valve is in closed position, an external pressure area or piston on said valve to which motive fluid is admitted from the interior of the valve through ports in the walls thereof, and an exhaust passage communicating with such pressure area and controlled by the working tool at the front end of the cylinder; substantially as described.

18. In a pneumatic hammer, a tubular throttle valve controlling the admission of motive fluid to the tool, and to the interior of which motive fluid is admitted when the valve is closed, a coiled spring confined in

the tubular bore of said valve and operating to yieldingly hold the same in closed position, an external pressure area or piston on said valve to which motive fluid is admitted from the interior of the valve through ports in the walls thereof, and an exhaust passage communicating with such pressure area and controlled by the working tool at the front end of the cylinder; substantially as described.

19. In a pneumatic hammer, the part C having the inlet passage E and outlet port *g* and containing the valve chamber having the enlarged upper portion O and lower portion O′, the tubular valve P coöperating with the valve seat *d* at its upper end and provided with the piston *e* reciprocating in the chamber O′, and with the ports *f* furnishing communication between the interior of the valve and said chamber, the coiled spring R operating to yieldingly hold the valve in closed position, and the exhaust passage U communicating with the chamber O′; substantially as described.

20. In a pneumatic hammer, the cylinder head or handle-base C having the lower end of the inlet passage E terminating in its upper portion, and containing the valve chamber having the enlarged upper portion O′, with its outlet port *g*, and the enlarged lower portion O′ with an outlet U, in combination with the screw plug Q closing the lower end of said chamber, the tubular valve P coöperating with the valve seat *d* at its upper end to cut off communication between the inlet passage E and outlet port *g* of the chamber O, and provided with the piston *e* reciprocating in the chamber O′ and with the ports *f* furnishing communication between said chamber and the interior of the valve, and the coiled spring R confined in the tubular bore of the valve and operating to yieldingly hold the latter against its seat *d*; substantially as described.

21. In a pneumatic hammer, a cylindrical distribution valve located at the rear end of the piston chamber and adapted to have the piston pass through it at the end of its rearward stroke, said valve controlling the admission and exhaust of the motive fluid at both ends of the piston chamber, in combination with a piston operating at its rearward stroke to shift the valve in one direction by air compressed by the piston as it approaches the end of such stroke, and operating at its forward stroke to shift the valve in the opposite direction by motive fluid admitted to a pressure area of the valve through a passage controlled by the piston; substantially as described.

22. In a pneumatic hammer, a cylindrical distribution valve having differential pressure areas and located at the rear end of the piston chamber in position to have the piston pass through it at the end of its rearward stroke, a live air groove alternately opened and closed by the rear end of said valve, to admit the motive fluid to the interior of the valve and its smaller pressure area, and the rear end of the piston chamber, and cut it off therefrom, and a passage communicating at its rear end with the larger pressure area of the valve and opening at its forward end into the piston chamber by a port uncovered by the piston at the end of the forward stroke of the latter, in combination with a piston reciprocating in the piston chamber and operating as it approaches the end of its rearward stroke to shift the valve in one direction by air compressed in front of the piston and acting upon the smaller pressure area of the valve, and operating at its forward stroke to shift the valve in the opposite direction by motive fluid admitted to the larger pressure area of the valve through the port and passage uncovered by the piston; substantially as described.

23. In a pneumatic hammer, the valve block L located at the rear end of the cylinder and containing the valve chamber and circumferential grooves W, Y and Y′, the latter communicating with the exhaust passages Z, the cylindrical valve M reciprocating in the valve chamber and provided with the annular pressure area D′ and with the ports E′ furnishing communication between said pressure area and the interior of the valve, the exhaust ports A′, and the annular pressure area J′, in combination with the live air passage C′ opening into the valve chamber by the port B′, the passage X connecting the front end of the piston chamber with the groove Y and placed by the valve in alternate communication with the exhaust groove Y′ and the live air port B′, the passage G′ communicating at its rear end with the groove H′ facing the pressure area J′ of the valve, and opening at its forward end into the piston chamber by the port F′, the auxiliary passage Z′ connecting the groove W with the forward portion of the valve chamber, and the piston N controlling the port F′ and operating at its rearward stroke to shift the valve by air compressed in front of the piston and acting upon the rear end of the valve; substantially as described.

24. The cylinder A having the exhaust passages Z Z′ opening through its exterior, in combination with the spring clip K″ covering the outlets of said passages and serving to deflect the exhaust to the under side of the tool; substantially as described.

25. An externally threaded cylinder or member and an internally threaded sleeve or member screwed thereon and provided with teeth upon its end, in combination with a locking ring movable longitudinally on the cylinder but held from rotation thereon, and provided with teeth adapted to interlock

with the teeth upon the sleeve, and means for holding said locking ring and sleeve together; substantially as described.

26. The externally threaded cylinder A and the sleeve B screwed thereon and provided with the teeth *h*, in combination with the ring L′ movable longitudinally upon the cylinder A but held from rotation thereon, and provided with teeth *h′* engaging the teeth *h* upon the sleeve B, and the spring clip N′ operating to hold the ring L′ in engagement with the sleeve B; substantially as described.

27. The externally threaded cylinder A and the sleeve B screwed thereon and provided with the teeth *h* at its end, in combination with the ring L′ mounted upon the cylinder A and provided with the teeth *h′* and with the longitudinal groove or key way, the key M′ seated in the cylinder A and provided with the projecting rib or key engaging the groove in the ring L′, and the spring clip N′ having the inturned flanges at its front and rear ends engaging shoulders upon the ring L′ and sleeve B, respectively; substantially as described.

28. The cylinder A bored out at its front end to receive the bushing H with its annular shoulder *a*, in combination with said bushing fitting in said cylinder and secured therein by having the front end of the cylinder spun down over its said shoulder *a;* substantially as described.

29. In a pneumatic hammer, the combination of a normally closed throttle valve and means for automatically opening said valve by motive fluid pressure upon pressing the tool to its work; substantially as described.

30. In a pneumatic hammer, the combination of a throttle valve, a spring for normally holding the same closed, and means for automatically opening the valve by motive fluid pressure upon pressing the tool to its work; substantially as described.

31. In a pneumatic hammer, the combination, with the working tool thereof, of an automatic throttle valve spring pressed to normally close the inlet passage to the working parts of the hammer, and fluid pressure means under the control of the working tool and arranged to operate the valve and thereby open the inlet passage by the act of pressing the tool to the work; substantially as described.

32. In a pneumatic hammer, the combination, with the working tool thereof, of an automatic throttle valve spring pressed to normally close the inlet passage to the working parts of the hammer, and having an outer pressure area, such valve being constantly exposed as to its interior to live motive fluid and having a constantly open leak port adjacent the pressure area for the exhaust of air from the hammer, said exhaust being under the control of the working tool which closes said exhaust in the pressing of such tool against the work; substantially as described.

33. In a pneumatic hammer, the combination, with the working tool thereof, of an automatic throttle valve spring pressed to normally close the inlet passage to the working parts of the hammer, and having an outer pressure area movable in a chamber normally at exhaust pressure through an exhaust passage extending adjacent to and governed by the working tool and closed thereby when the tool is pressed to the work, said valve being constantly exposed as to its interior to live motive fluid and provided with a leak port for constantly admitting air to said chamber, which air leaks therefrom through the exhaust passage, but is effective against said pressure area whenever the exhaust passage is closed by the working tool; substantially as described.

JOSEPH BOYER.

Witnesses:
A. J. Doughty,
L. E. Summers.