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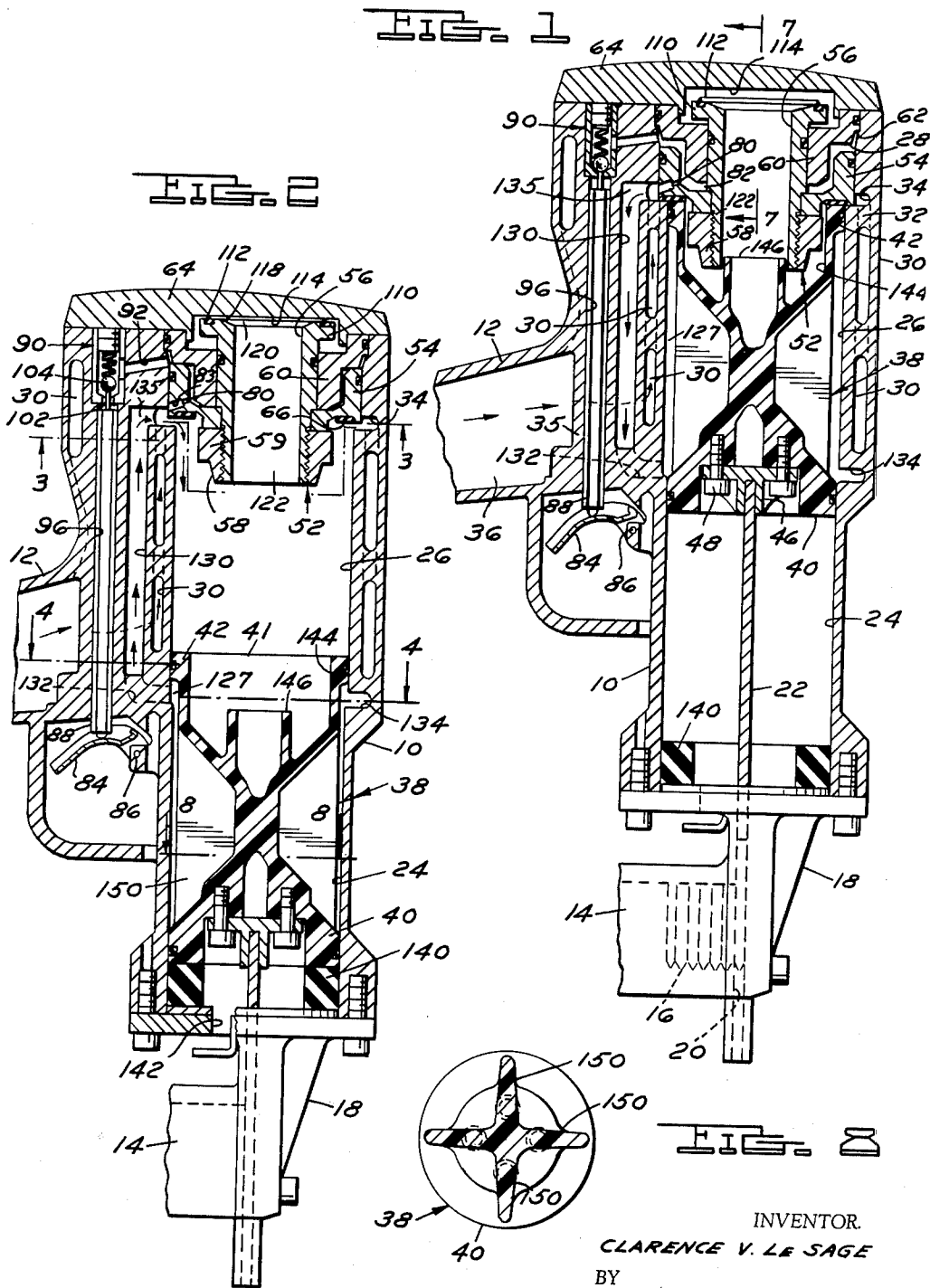
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3,200,716

PNEUMATIC FASTENER DRIVING MACHINE

Filed July 23, 1963

4 Sheets-Sheet 1



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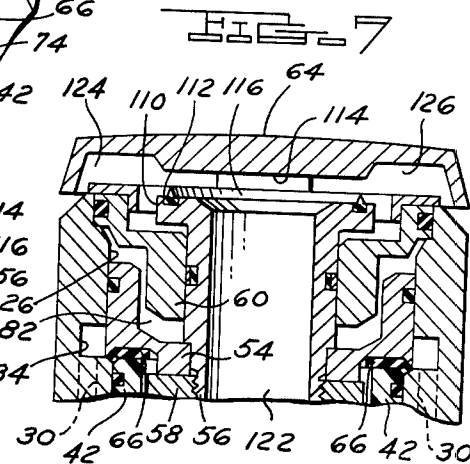
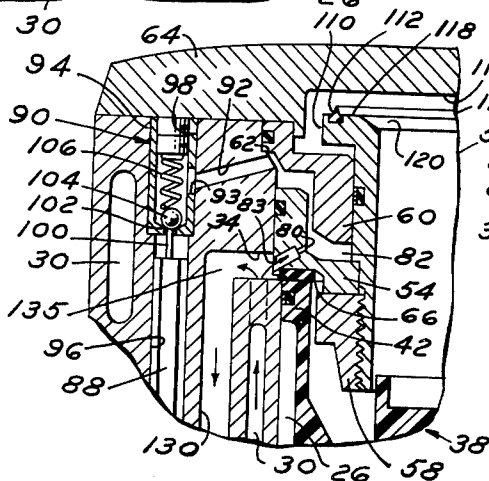
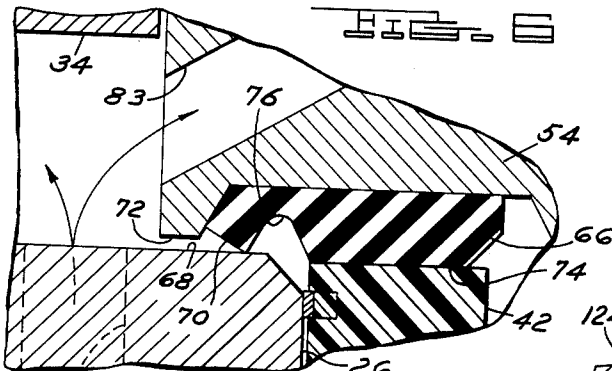
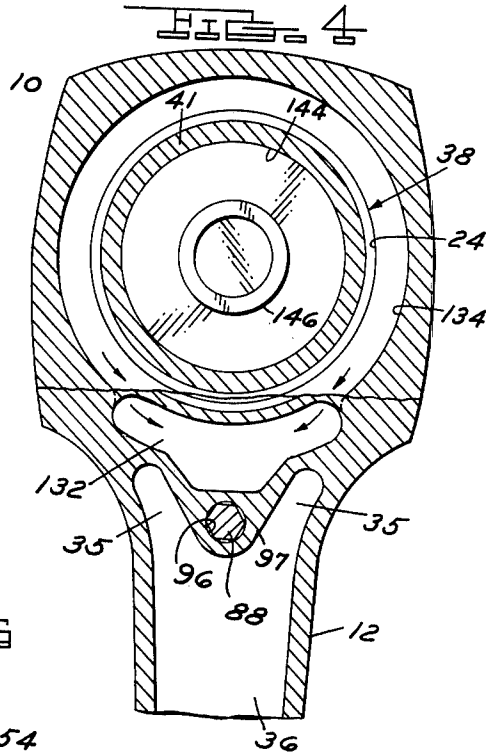
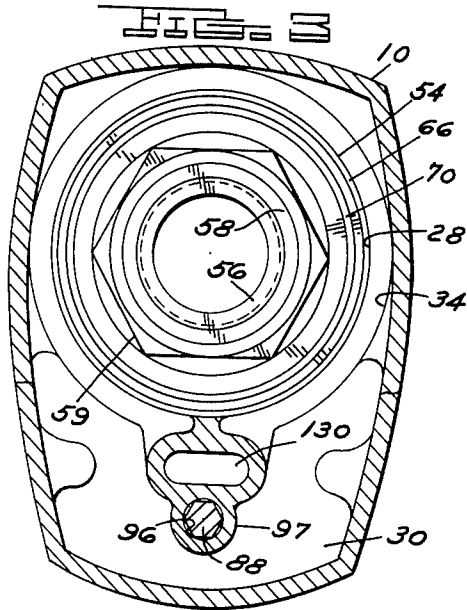
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PNEUMATIC FASTENER DRIVING MACHINE

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4 Sheets-Sheet 2



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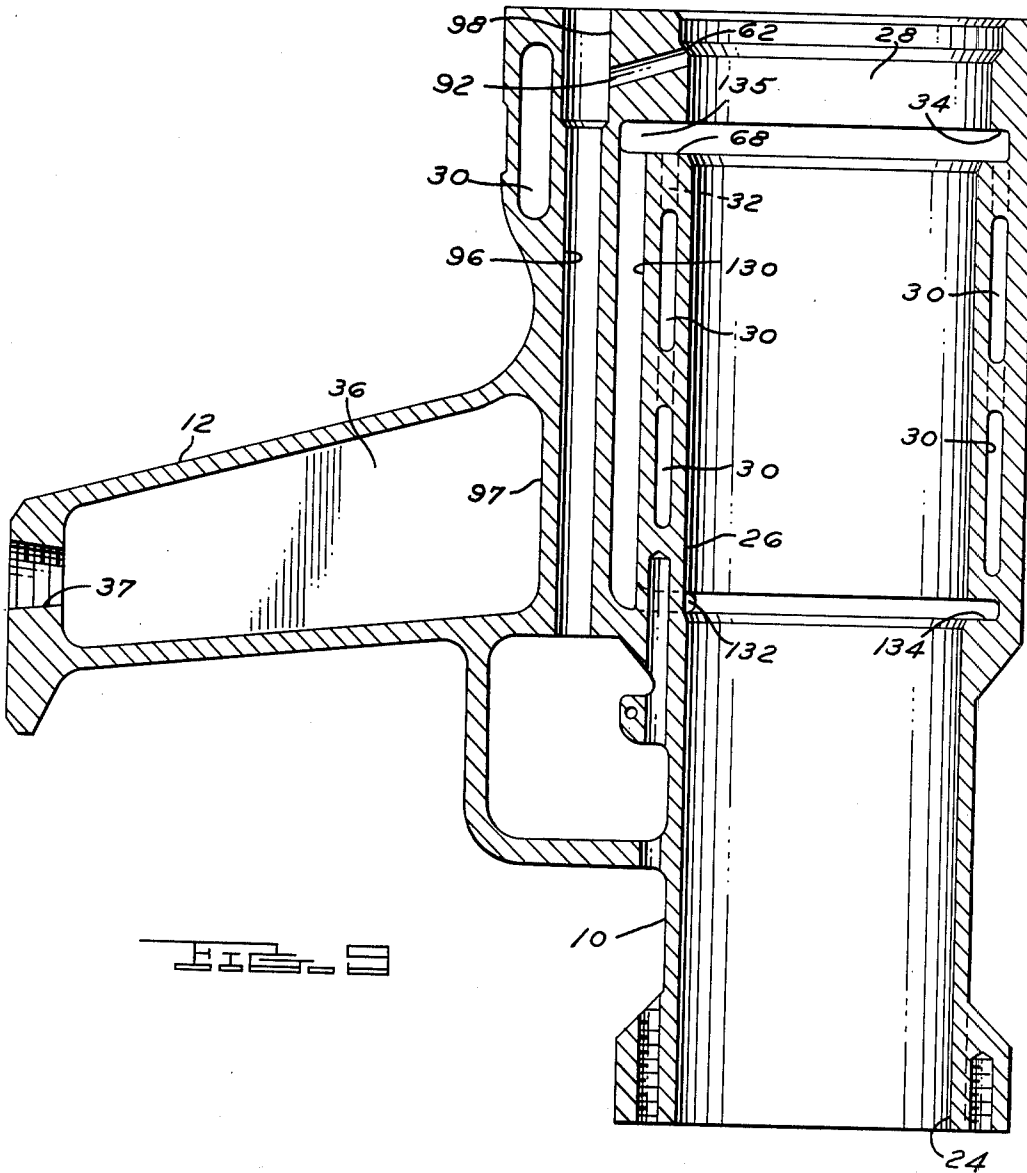
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PNEUMATIC FASTENER DRIVING MACHINE

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4 Sheets-Sheet 3



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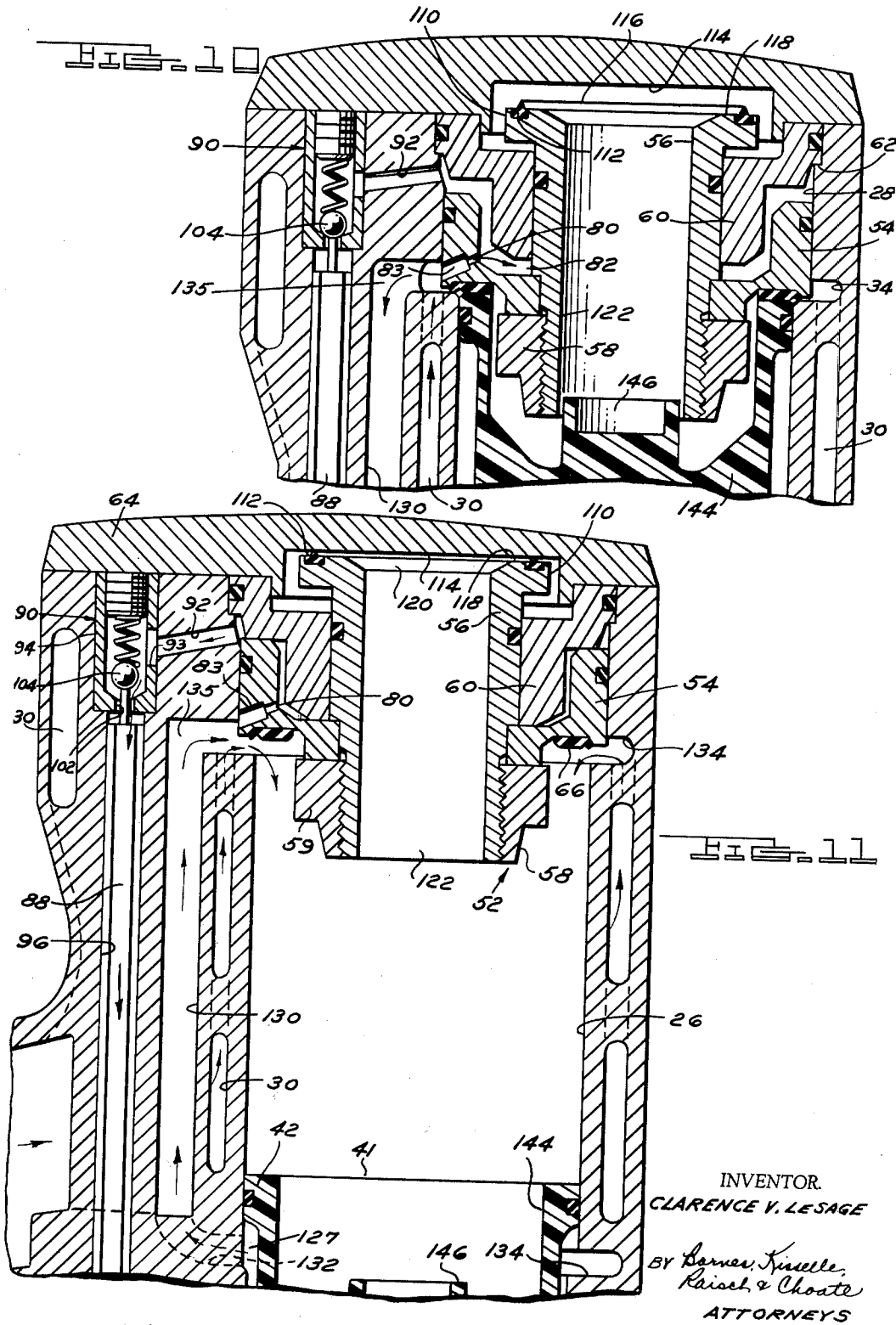
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PNEUMATIC FASTENER DRIVING MACHINE

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3,200,716

PNEUMATIC FASTENER DRIVING MACHINE
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Filed July 23, 1963, Ser. No. 296,960

12 Claims. (Cl. 91-461)

This invention relates to improvements in fastener driving machines and appliances and more particularly to an improved piston driven implement actuated by pressure fluid, for example by air pressure.

While the present invention is herein illustrated and described in the form of a portable fastener driving implement, specifically a gun-type pneumatically operated stapler, it is to be understood that it may be embodied in other structures such as a stationary machine mounted on a suitable base. The implement disclosed herein may be employed in many different industries for fastening together various articles with staples, nails or corrugated fasteners.

An object of the present invention is to provide a machine of the type indicated of simplified construction and improved efficiency which has a relatively high power-to-weight ratio to facilitate use as a portable implement.

A more particular object of the invention is to provide in a machine of the above character an improved valve for controlling the admittance and/or exhaust of pressure fluid to the main cylinder which is entirely pressure fluid actuated so as to eliminate the need for a spring in the valve mechanism.

Other objects, features and advantages of the present invention will become apparent from the following description taken with the accompanying drawings which by way of example illustrate a preferred embodiment of the invention wherein:

FIG. 1 is a fragmentary vertical center section of a portable gun-type pneumatic fastener driving implement embodying the invention, the nose and magazine portions thereof being shown in elevation and the working parts being shown in position ready for actuation of the piston on a driving stroke.

FIG. 2 is a similar fragmentary vertical center section of the implement but showing the piston at the end of its driving stroke, the main cylinder valve open, and the associated exhaust valve closed.

FIGS. 3 and 4 are sectional views taken respectively on the lines 3-3 and 4-4 of FIG. 2.

FIG. 5 is an enlarged view of a portion of FIG. 1 illustrating in part the trigger valve and cylinder valve mechanisms.

FIG. 6 is still a further enlarged view of a portion of FIG. 5 illustrating the valve seating structure of the cylinder valve.

FIG. 7 is a sectional view taken on the line 7-7 of FIG. 1.

FIG. 8 is a sectional view taken on the line 8-8 of FIG. 1.

FIG. 9 is a vertical center section of the body casing of the implement with the working parts omitted.

FIGS. 10 and 11 are enlarged views of the upper portions of FIGS. 1 and 2 respectively.

As illustrated in FIGS. 1 and 9, the pneumatic stapler of the invention has a generally pistol-shaped die cast

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body comprising a barrel casing 10 and a hollow handle 12. Casing 10 contains the fastener driving mechanism and surmounts the forward end of a magazine 14 which may be of known construction for containing wire staples 16 or other types of fasteners. The forward end of magazine 14 is fastened to the lower end of casing 10 by a nose assembly 18 having a guideway 20 in which a staple driving blade 22 reciprocates. Handle 12 (FIG. 9) is shaped so that it may be grasped in the hand for transporting the stapler and holding nose 18 against the work.

As best seen in FIG. 9, casing 10 is formed with three progressively larger diameter co-axial cylinders comprising a forward cylinder 24, a main cylinder 26 and a valve cylinder 28. The upper portion of casing 10 encircling cylinder 26 is cored out to provide an annular pressure air storage chamber 30 which is open around the upper end thereof, except for four connecting webs 32, to an annular groove 34 encircling the upper end of cylinder 26. Chamber 30 on the handle side of casing 10 communicates via a relatively large forked passage 35 (FIG. 4) with another air chamber 36 formed within handle 12. Compressed air or other pressure fluid is supplied to chamber 36 by connecting a suitable hose (not shown) to an inlet 37 (FIG. 9) at the outer end of handle 12, the other end of the hose being connected to a suitable source of compressed air. Due to the relatively unrestricted communication between chambers 36 and 30, constant pressure is maintained in both chambers and together they provide a pressure air storage reservoir having a volumetric capacity approximately three times the displacement of a differential-type driving piston 38 (FIGS. 1 and 2) which reciprocates in cylinders 24 and 26.

Piston 38 has a cylindrical lower end 40 (FIG. 8) which has a sliding seal fit in cylinder 24, and a cylindrical upper end comprising a cup-shaped crown 41 (FIGS. 2 and 4) having a flange 42 of larger diameter than lower end 40 which has a sliding seal fit in cylinder 26.

Lower end 40 of piston 38 carries an adaptor 46 (FIG. 1) which is attached thereto by screws 48 threaded into piston 38, blade 22 being suitably secured to adaptor 46.

A valve assembly 52 (FIGS. 2, 10 and 11) for controlling admittance to and exhaust of air from main cylinder 26 comprises a piston 54, a tube 56 and a hex nut 58. Valve piston 54 is secured to tube 56 by nut 58 threaded on the lower end of tube 56. Valve piston 54 reciprocates in cylinder 28. A sleeve 60 is fixed in casing 10 between a shoulder 62 (FIGS. 1 and 10) at the upper end of cylinder 28 and an end cap 64 removably attached to the upper end of the casing. Tube 56 slides in sleeve 60.

Valve assembly 52 is pneumatically actuated to reciprocate between the position thereof shown in FIGS. 1 and 10 and the position shown in FIGS. 2 and 11 for controlling admission of pressure air from chamber 30 to cylinder 26 and for controlling exhaust of spent pressure air from cylinder 26 to atmosphere. Valve piston 54 has a hard rubber seal ring 66 (FIG. 3) bonded to the underside thereof which has a tapered rim portion 70 (V-shaped in cross section, FIG. 6). Rim 70 seats on the upper end face 68 of cylinder 26 in the cylinder-closing position of valve assembly 52 and provides high contact pressure engagement and also spaces a radial face 72 of valve piston 54 from face 68. Hence, a relatively small

working surface (face 72 and rim 70) of valve piston 54 is constantly exposed to pressure fluid in chamber 30 to provide a force acting upwardly on valve piston 54 tending to unseat rim 70 of ring 66.

Seal ring 66 also has a flat annular face 74 (FIG. 6) against which the end face of crown flange 42 abuts in the raised position of piston 38. Ring face 74 is separated by an annular groove 76 from rim 70.

Valve assembly 52 is normally maintained in cylinder closing position by pressure air admitted from chamber 30 via a constantly open restricted passage 80 in valve piston 54 (FIGS. 5 and 10) to a chamber 82 formed between valve piston 54 and sleeve 60. The working area on the upper side of valve 54 exposed to air pressure in chamber 82 is much larger than the area of face 72 and rim 70 and therefore when the pressure in chamber 82 equals that in chamber 30, the force holding ring 66 seated greatly exceeds the force tending to unseat it. As seen by comparing FIGS. 10 and 11, a counterbore 83 communicates with restricted passage 80 and with groove 34 in all positions of valve piston 54.

The trigger mechanism of the pneumatic stapler controls communication between chamber 82 and the outside atmosphere and comprises a trigger 84 (FIGS. 1 and 2) pivoted at 86 to casing 10, a hexagonal trigger rod 88 contacting trigger 84 at the lower end thereof, an outlet valve assembly 90 at the upper end of rod 88 and an outlet passage 92 leading from chamber 82 to a port 93 in the side of a valve casing 94 of valve assembly 90. Rod 88 slides in a circular bore 96 in an internal portion 97 of the die casing 10 (FIG. 3, 4 and 9) which extends through chamber 30. Valve casing 94 (FIG. 5) is press fitted in a counterbore 98 (FIG. 9) for retention by cap 64. The upper end of rod 88 has a stem 100 which extends axially therefrom through a port 102 in casing 94 and carries a ball check valve 104 for closing port 102. A coil spring 106 biases valve 104 to its normally closed position. When valve 104 is unseated, pressure air escapes from chamber 82 via passage 92 into casing 94, past valve 104 and through port 102 and the clearance space between hex rod 88 and its bore 96, as illustrated by the arrows in FIG. 11.

Exhaust of spent pressure air from main cylinder 26 is controlled by the exhaust valve structure at the upper end of tube 56 of valve assembly 52. A radial end flange 110 of tube 56 carries a hard rubber seal ring 112 which, in the cylinder-opening position of valve assembly 52 (FIGS. 2 and 11), seats against a flat recessed surface 114 of cap 64. As best seen in the enlarged views of FIGS. 5 and 10, ring 112 has a tapered rim 116 (V-shaped in cross section) which insures high unit contact pressure by ring 112 against surface 114. Rim 116 also spaces the annular surface 118 of flange 110 (FIG. 5) from cap surface 114 in the seated position of seat ring 112 (FIG. 2). The upper inner end of tube 56 has a beveled surface 120 radially inwardly of ring 112 which is also spaced from cap surface 114 when ring 112 is seated thereagainst (FIG. 11). Due to this spacing, the portion of surface 118 within ring 112 and beveled surface 120 are not cut off from exposure to main cylinder air pressure via bore 122 of tube 56 when ring 112 is seated against surface 114. However, the working area consisting of surfaces 118 (within ring 112) and 120 tending to unseat ring 112 is less than the effective working area of the underside of valve assembly 52 which is also exposed to main cylinder air pressure when it is in the position of FIG. 2. Hence, the net force acting on valve assembly 52 is in an upward direction (FIG. 2) and is sufficient to hold ring rim 116 tightly seated against cap surface 114. In its seated position, ring 112 closes communication between bore 122 leading to main cylinder 26 and a pair of exhaust passages 124 and 126 (FIG. 7) provided in cap 64 which lead to atmosphere.

Driving piston 38 is normally maintained in the re-

tracted position of FIG. 1 by air at line pressure acting on the relatively small effective working area of the underside of flange 42 of piston crown 41. This working area is equal to the cross-sectional area of cylinder 26 minus that of cylinder 24, and is approximately 11 percent of the effective working area of the upper side of piston 38. However, when valve piston 54 is closed and exhaust valve portion 110 is open, the upper side of piston 38 is exposed only to atmospheric pressure in cylinder 26. The annular space 127 between cylinder 26 and piston 38 intermediate the opposite ends of the piston comprises an air return chamber which is in constant communication with pressure air chamber 30 via an air return passage 130 which communicates at its lower end with cylinder 26 via a flaring outlet 132 (FIGS. 4 and 9) which merges into an annular groove 134 encircling the lower end of cylinder 26. The upper end of passage 130 communicates with chamber 30 via a port 135. It is to be noted that port 135 extends radially inwardly so as to direct the air which is forced from air return chamber 127 upwardly via passage 130 (as a result of downward movement of piston 38 on its driving stroke) radially inwardly across end face 68 of cylinder 26 into the cylinder to thereby supplement incoming pressure air from reservoir 30 for driving piston 38 on its working stroke.

Piston 38 may be made of lightweight metal but is preferably injection molded from a suitable moldable plastic, such as that known by the trademark Lexan and sold by General Electric Company. As shown in FIGS. 2 and 8, crown 41 and lower end 40 of piston 30 form the opposite imperforate cylindrical ends of piston 38, and these ends are interconnected by four axially extending ribs 150 integrally joined to one another along the central axis of piston 38 and extending radially outward therefrom. Due to the relatively low mass of piston 38 compared to that of the remaining structure of the implement, the recoil effect produced by the impact of the piston against bumper 140 at the end of its working stroke is reduced to a minimum.

Operation

Assuming that magazine 14 is loaded with staples 16 and that handle reservoir 36 is connected by a length of hose to a suitable source of compressed air, handle 12 may be grasped in one hand for transporting the stapler to the work. Normally, piston 38 will be in its uppermost position (FIG. 1) with blade 22 raised above the top of the foremost staple 16 disposed in guideway 20. Piston 38 is normally sustained in its raised position by pressure air admitted beneath crown 42 via passage 130 communicating with the interconnected storage reservoirs 30 and 36. Valve assembly 52 will normally be in its lowermost position (FIG. 1) wherein rim 70 (FIG. 6) seats on face 68 of cylinder 26 to thereby close the upper end of cylinder 26 and isolate the upper side of piston 38 from pressure air in reservoir 30, 36, and wherein valve portion 110 is open so that only atmospheric pressure is acting downwardly on the piston. Valve 52 is sustained in its cylinder-closing position by air at line pressure admitted from reservoir 30 to chamber 82 via passages 80, 83, valve 104 being closed at this time.

It is to be understood that when piston 38 and valve assembly 52 are in their above-described positions, valve assembly 52 serves as an upper stop for piston 38 (FIG. 6). Since the downwardly effective working area on the upper side of valve piston 54 exposed to line pressure in chamber 82 (FIGS. 5, 7) is many times the upwardly effective working area of piston 38 between crown flange 42 and lower end 40 thereof likewise exposed to line pressure in air return chamber 127, the force urging piston 38 upwardly against valve piston 54 is not sufficient to unseat it. Under the aforementioned conditions, the stapler may be positioned above the work and

applied thereto by holding its nose 18 thereagainst; or in other cases the stapler may be tilted and placed in position with the nose against a vertical, inclined or overhead work surface.

After the stapler has been applied to the work, the staple-driving phase of operation is initiated by squeezing trigger 84 upwardly to the position of FIG. 2, thereby lifting valve 104 from its seat and opening communication between chamber 82 and atmosphere via passage 92, port 102 and passage 96. The lower end of passage 96 communicates directly with atmosphere. Although chamber 82 is constantly being supplied with air at line pressure via restricted orifice 80, the passages 92, 102 and 96 have a much larger flow capacity than orifice 80 and hence air is bled from chamber 82 much faster than it is replenished. When the air pressure in chamber 82 has dropped sufficiently to lower the force acting downwardly on valve piston 54 (as viewed in FIG. 1) to less than the forces acting upwardly on surface 72 and rim 70 thereof (FIG. 6), valve piston 54 becomes unbalanced and begins to move upwardly, thereby breaking the seal between rim 70 and the cylinder end face 68. This exposes the entire working area of the underside of valve assembly 52 to compressed air as it rushes into cylinder 26 from storage chamber 30, thereby rapidly increasing the total force acting upwardly on valve assembly 52 so that it snaps upwardly and forces ring 112 against surface 114 to close off cylinder 26 from exhaust passages 124, 126.

The quick cylinder-opening action of valve 52 provides a "dumping effect," e.g., it quickly exposes or opens the entire upper end of cylinder 26 so that a large volume of compressed air from reservoir 30 is rapidly admitted to cylinder 26 to drive piston 38 rapidly downward on its driving stroke until it strikes a bumper 140 retained by nosepiece 18 at the lower end of cylinder 24 (FIG. 2). Blade 22 is thus driven by piston 38 with high impact force for separating the foremost staple from the stick of staples 16 and driving it via guideway 20 into the work. The air in cylinder 24 below the lower end 40 of the piston is expelled to atmosphere via a port 142 in nosepiece 18 (FIG. 2). Piston 38 remains in its lowermost position (FIG. 2) as long as trigger valve 104 is held open by the operator, usually only a matter of a second or so, during which time there is a constant though small loss of compressed air from reservoir 30, 36 to atmosphere via the orifice 80, chamber 82 and passages 92 and 96.

In the second or blade-return phase of operation of the pneumatic stapler, piston 38 and valve assembly 52 are returned from their respective positions shown in FIG. 2 to their normal or retracted positions shown in FIG. 1. When trigger 84 is released, spring 106 closes valve 104 so that compressed air entering chamber 82 via orifice 80 no longer can escape to atmosphere and consequently pressure builds up in chamber 82 until it equals the pressure existing in chamber 30, e.g., the nominal supply line pressure. As the air pressure in chamber 82 approaches line pressure, the force acting downwardly on valve assembly 52 increases until it balances and then exceeds the force acting upwardly thereon. This downward unbalancing occurs prior to pressure being equalized in chambers 30 and 82 since the effective working area (acting downwardly) of exhaust valve surfaces 118, 120 exposed to line pressure in cylinder 26 via bore 122 plus the working area of valve piston 54 exposed to pressure in chamber 82 exceeds the oppositely or upwardly acting working area on the underside of valve assembly 52 exposed to line pressure in cylinder 26 as viewed in FIG. 1 or 2. As soon as the net force acting on valve assembly 52 is in the downward direction, valve 52 begins to move downwardly, thereby unseating ring 112 and thus opening communication between cylinder 26 and atmosphere via exhaust passages 122, 124, 126. This causes an immediate and severe

reduction of air pressure in cylinder 26 so that valve piston 54 is urged downwardly as viewed in FIG. 2 towards its cylinder-closing position of FIG. 1 with greater force by the pressure air in chamber 82. Also, when the pressure in cylinder 26 above piston 38 drops as a result of the exhaust valve portion 110 being opened, the pressure air in space 127 beneath piston crown 41 provides sufficient force to drive piston 38 upwardly on its return stroke until it strikes ring 66 of valve piston 54, the latter having seated in cylinder-closing position by this time.

From the foregoing, it will now be apparent that one important feature of the invention is the provision of the poppet valve assembly 52 which functions in the dual role of both an air pressure inlet control valve and an exhaust control valve solely in response to fluid pressures acting thereon under the remote control of trigger valve 104. Valve piston 54 controls the inlet or supply of pressure air to cylinder 26, and exhaust valve portion 110 of tube 56 controls communication between the cylinder 26 above piston 38 with atmosphere. As valve assembly 52 rises to admit pressure air to cylinder 26 above piston 38, it simultaneously closes the exhaust ports 124, 126 through which the cylinder 26 above piston 38 communicates with atmosphere, and vice versa. This arrangement thus eliminates the need for a return spring to initiate unseating movement of exhaust valve portion 110. This not only reduces cost and increases reliability, but also eliminates the undesirable effect of the biasing force of such a spring which tends to retard upward movement of the valve assembly and thereby negate to some extent the aforementioned desired dumping effect.

It is also to be noted that valve assembly 52 operates in the manner of a poppet valve in performing its dual function as a pressure inlet valve and as an exhaust valve for spent pressure air. This type of valve is advantageous over a slide-type valve since a poppet valve does not require tolerances as close as those required by slide valves and does not suffer from wear to the same extent. Valve assembly 52 also simplifies the exhaust passageway structure by uniting tube 56 with valve piston 54 so that tube 56 serves as both an exhaust conduit and valve for closing the conduit. The relatively large bore 122 of tube 56 permits rapid exhaust of spent pressure air from the space above piston 38 in cylinder 26 so that the return stroke of the piston is relatively rapid. This in turn reduces the total cycle time of the gun and thus increases the maximum number of fasteners which can be driven by the implement during a given unit of time.

Several other features of the present invention also contribute to the result of developing maximum power in the working stroke of the piston while economizing motive pressure air during this phase of operation. The theoretically ideal mechanism would provide exposure of the full working area of the upper side of piston 38 to line pressure at the beginning of its working stroke and maintenance of this pressure thereon throughout the working stroke in order to produce the maximum power for driving a staple into the work. Although this ideal condition can only be approximated in a practical pneumatic stapler, another feature of the present invention which contributes to better approximation of the ideal situation is the valve seat structure best seen in FIG. 6. The pointed rim 70 (as viewed in section) of ring 66 which has a circular edge contact with face 68 reduces flow resistance through the initial orifice provided when it is unseated from the end face 68 of cylinder 26 so that pressure air quickly enters annular groove 76 to increase the force acting upwardly on valve assembly 52.

Another feature which contributes to rapid unseating of valve piston 54 and operating efficiency is the provision of co-operative contours on the upper end of piston 38 and on the portion of valve assembly 52 received therein. The cup-shaped crown 41 at the upper end of piston 38 provides a well 144 in which nut 58 and the lower portion of tube 56 of valve assembly 52 nest when piston

38 and valve assembly 52 are in their respective positions shown in FIG. 1. An integral tubular portion 146 of piston 38 extends axially upwardly therefrom and has a close clearance fit in tube 56 for restricting flow of pressure air from well 144 into bore 122 during the initial opening movement of valve piston 54 in the first phase of operation. This causes air pressure to build up rapidly in the annular space between crown 41 and valve assembly 52 and reduces loss of pressure to atmosphere via bore 122 and cap exhaust passages 124, 126. Since pressure air is at this time being bled from chamber 32 whereas the pressure air beneath piston 38 is substantially at line pressure, valve 54 accelerates at a faster rate than piston 38 immediately after valve piston 54 is unseated. Therefore, tubular extension 146 will remain relatively stationary during movement of valve assembly 52 upwardly and hence will continue to restrict communication between well 144 and bore 122 substantially until exhaust valve 110 is seated. Loss of motive pressure air via the exhaust passages to atmosphere is thus substantially reduced during the critical period at the beginning of the working stroke of the piston.

A further feature contributing to economical utilization of pressure fluid is the provision of air return passage 130 and the radially inwardly directed outlet 135 thereof which, as shown in FIG. 2, directs the pressure air trapped in space 127 beneath piston crown 41 directly into cylinder 26. Since piston 38 is a high ratio differential piston (e.g., the downwardly effective area on the upper side of piston 38 is about nine times the oppositely upwardly effective working area of piston 38 exposed to pressure in air return chamber 127), a pressure multiplication effect is obtained which causes pressure air to issue from outlet 135 in a high velocity, radially inwardly directed stream which impinges on valve assembly 52 and is then deflected into cylinder 26 to augment incoming pressure air from reservoir 30.

In addition to the aforementioned features of the fastener driving implement of the invention, it will now be seen that the improved structural organization of the above-described parts of the implement represents a compact arrangement and an efficient design from a manufacturing as well as an operational standpoint since the parts are adapted to be readily made and assembled by mass production techniques. Also, the number of parts is reduced to a minimum.

I claim:

1. In a fastener-applying machine the combination comprising a reservoir for pressure fluid, a cylinder having an inlet port communicating with said reservoir, a piston reciprocable in said cylinder, a valve movable to open and close said inlet port, an exhaust tube movable with said inlet valve and adapted to communicate at opposite ends thereof respectively with said cylinder and with atmosphere, means for slidably guiding said tube and for opening and closing the atmosphere end of said tube in response respectively to closing and opening movement of said inlet valve, said last-mentioned means comprising a sleeve and a closure cap defining an exhaust chamber therebetween communicating with atmosphere, said cap defining an end wall of said exhaust chamber disposed perpendicular to the axis of said tube against which said atmosphere end of the tube axially abuts to close the same, said tube being slidably supported in said sleeve with said atmosphere end of said tube projecting axially therefrom into said exhaust chamber in radially spaced relation from the radially surrounding wall of said exhaust chamber, said tube having a pressure surface exposed via the interior of said tube to pressure fluid in the cylinder when said tube is closed and disposed to develop an opening force on said tube, said inlet valve having a pressure surface exposed to reservoir pressure fluid for holding said inlet valve in open position with a force greater than that developed by said tube pressure surface,

and means for developing a force on said inlet valve additive to the force of cylinder pressure fluid acting on said tube pressure surface to thereby initiate opening movement of said tube and closing movement of said inlet valve.

2. The combination set forth in claim 1 wherein said inlet valve and said piston are disposed co-axially and move oppositely relative to one another between positions adjacent and remote from one another, said piston and said inlet valve having means movable therewith adapted to telescopically overlap in the direction of movement thereof in a region spaced inwardly of said cylinder inlet port to thereby restrict flow of pressure fluid from said reservoir into said exhaust tube when said piston and inlet valve are adjacent one another.

3. In a pneumatic driving machine, a casing having a pressure air reservoir, a cylinder in said casing exposed at one end to said reservoir, an inlet valve for opening and closing communication between said cylinder and said reservoir, a differential piston reciprocable in said cylinder and forming therewith a pressure air return chamber for moving said piston on a return stroke towards said one end of said cylinder, said casing having a passageway for supplying pressure air from said reservoir to said return chamber for normally maintaining the piston near said one end of said cylinder ready to be driven on a power stroke when said inlet valve is opened, said passageway including a port in said cylinder in constant communication with said pressure air return chamber, said passageway having an inlet in constant communication with said reservoir and an outlet located adjacent said one end of said cylinder and oriented relative to said inlet for directing a jet of the pressure fluid from said return chamber via said passageway past said inlet and into said cylinder when the volume of the return chamber is reduced by movement of said piston on its driving stroke, said passageway extending along and exteriorly of said cylinder between said port and said outlet thereof and being adapted for conducting said pressure fluid from said return chamber to said outlet in isolated relation to the pressure air in said pressure air reservoir.

4. A pneumatically actuated fastener driving mechanism comprising a casing having a pressure air reservoir therein, a main cylinder having an inlet end communicating with said reservoir, a power piston reciprocable in said main cylinder, a second cylinder adjacent said inlet end of said main cylinder, a valve piston reciprocable in said second cylinder for opening and closing said inlet to control admittance of pressure air from said reservoir to said main cylinder for driving said power piston on a driving stroke, said valve piston having a first pressure surface partially exposed to pressure air in said reservoir when said valve piston is closed and fully exposed to said pressure air when said valve piston initially opens, said first pressure surface being disposed to develop opening force on said valve piston, means forming a restricted orifice for supplying pressure air from said reservoir to said second cylinder on the side of said valve piston remote from said main cylinder for developing a closing force on said valve piston, normally closed trigger means operable for bleeding pressure air from said cylinder at a faster rate than it is supplied thereto via said restricted orifice, an exhaust conduit communicating with said inlet end of said main cylinder and operably connected for movement with said valve piston, a closure on said casing having an exhaust passage normally communicating with atmosphere and with said conduit, said closure being adapted to close communication between said exhaust passage and said conduit when said valve piston is open, said conduit having a pressure surface exposed to pressure air in said main cylinder when said conduit is closed by said closure and adapted to co-operate with said remote side of said valve piston when said trigger means is closed to provide an effective working area greater than and acting oppositely to said first pressure surface of said

valve piston for developing sufficient force to initiate cylinder-closing movement of said valve piston.

5. The combination set forth in claim 4 wherein said means forming said restricted orifice comprises a portion of said valve piston having a passage therethrough with a restricted portion therein defining said restricted orifice, said valve piston communicating with said second cylinder and with said fluid pressure chamber in all positions of said valve piston.

6. In a pneumatic power unit of the type having a housing including an accumulator chamber, a power cylinder having an opening at one end thereof communicating with said chamber and a piston movable in a power stroke in said cylinder from a point of beginning adjacent said one end, a cylinder valve seating on an annular stop adjacent said one end of the cylinder and controlling communication between said chamber and said cylinder, a valve-controlling piston operatively connected to said cylinder valve, a valve cylinder in which said valve-controlling piston is slidable to open and close said cylinder valve, means for supplying pressure air to said chamber and to said valve cylinder on both sides of said valve-controlling piston, a trigger valve for venting air from the side of said valve-controlling piston remote from said power unit piston whereby the pressure air on the other side thereof moves said valve-controlling piston to open said cylinder valve so as to admit accumulated pressure air within said chamber through said inner end of said power unit cylinder to drive said power unit piston in a power stroke from said point of beginning; the combination therewith of means forming an exhaust chamber communicating with atmosphere and defining a pair of spaced walls disposed transverse to the axis of said valve cylinder and a cylindrical bore opening at one end thereof in one of said walls coaxial with said valve cylinder and communicating therewith at the opposite end of said bore, an exhaust valve movable with said cylinder valve and having an exhaust passage therein communicating with said power unit cylinder, said exhaust valve comprising a tubular member fixed to said cylinder valve and having a cylindrical stem slidable in said bore and a flanged end disposed in said exhaust chamber and radially spaced therefrom, said flanged end being adapted to axially abut the other of said walls of said exhaust chamber means when said cylinder valve opens to thereby close communication between said exhaust passage and said exhaust chamber, said flanged end moving out of abutment with said other wall for opening said exhaust passage to atmosphere when said cylinder valve closes for exhausting spent pressure air from said power unit cylinder upon return of the power unit piston to said point of beginning, said flanged end having a pressure surface constantly exposed via said exhaust passage to pressure fluid in said power unit cylinder and disposed such that said pressure fluid acts thereon to initiate opening movement of said exhaust valve and closing movement of said cylinder valve when said trigger valve is closed.

7. In a pneumatic fastener driving implement the combination comprising a casing having a main cylinder open at one end, a valve cylinder adjacent said end of said main cylinder and a pressure air reservoir communicating with said end of said main cylinder, a driving piston reciprocable in said main cylinder, a valve piston reciprocable in said valve cylinder for opening and closing communication between said reservoir and said main cylinder, an exhaust tube extending through said valve piston and movable therewith, means forming a fixed wall at an end of said valve cylinder remote from said main cylinder and slidably receiving said exhaust tube therethrough, said tube, valve cylinder, valve piston and wall defining a chamber therebetween, a restricted passageway adapted to admit pressure air from said reservoir to said chamber in all positions of said valve piston for urging it towards cylinder-closing position, trigger means for releasing pressure air from said chamber at

a faster rate than it is supplied thereto via said restricted passageway, said valve piston having a surface constantly exposed to pressure air in said reservoir for opening said valve piston when said trigger means is actuated to release pressure air from said chamber, means including said tube forming an exhaust valve for closing exhaust of spent pressure air from said main cylinder via said tube in the open position of said valve piston, said tube having a pressure surface constantly exposed via said tube to pressure air in said main cylinder and adapted to develop a force on said tube for closing said valve piston when said trigger valve is actuated to prevent release of pressure air from said chamber.

8. The combination set forth in claim 7 wherein said driving piston reciprocates between positions adjacent to and remote from the closed position of said valve piston, said driving piston having a generally cup-shaped recess therein facing said valve piston, said valve piston and said exhaust tube being adapted to project at least partially into said recess when said driving piston and said valve piston are adjacent one another to thereby restrict flow of pressure air from said reservoir into said exhaust tube during initial opening movement of said valve piston.

9. The combination set forth in claim 7 wherein said exhaust valve means includes a cap affixed to said casing and adapted to form with said wall an exhaust chamber communicating with said tube and atmosphere, said tube having annular flange means adapted to seat against said cap in the open position of said valve piston for closing communication between said tube and said exhaust chamber.

10. The combination set forth in claim 9 wherein said flange means comprises a flange having an end surface facing said cap and a seal ring thereon adapted for pressure air sealing engagement with said cap and wherein said tube pressure surface comprises a portion of said end surface of said flange disposed radially inwardly of said ring, said ring being adapted to space said flange surface from said cap during engagement of the ring with the cap.

11. The combination set forth in claim 7 wherein said valve piston has a ring of hard rubber or the like bonded thereto, said ring having a tapered rim adapted for high contact pressure engagement with said end of said main cylinder in the closed position of said valve piston and further having a flat annular seating surface disposed radially inwardly of said rim adapted for contacting engagement with said piston.

12. In a fastener-applying machine the combination comprising a reservoir for pressure fluid, a cylinder having an inlet port communicating with said reservoir, a piston reciprocable in said cylinder, a valve movable to open and close said inlet port, an exhaust tube movable with said inlet valve and adapted to communicate at opposite ends thereof respectively with said cylinder and with atmosphere, means for opening and closing the atmosphere end of said tube in response respectively to closing and opening movement of said inlet valve, said tube having a pressure surface exposed via the interior of said tube to pressure fluid in the cylinder when said tube is closed and disposed to develop an opening force on said tube, said inlet valve having a pressure surface exposed to reservoir pressure fluid for holding said inlet valve in open position with a force greater than that developed by said tube pressure surface and means for developing a force on said inlet valve additive to the force of cylinder pressure fluid acting on said tube pressure surface to thereby initiate opening movement of said tube and closing movement of said inlet valve, said inlet valve and piston being disposed co-axially and moving oppositely relative to one another between positions adjacent and remote from one another, said piston and said inlet valve having means movable therewith adapted to restrict flow of pressure

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fluid from said reservoir into said exhaust tube when said piston and inlet valve are adjacent one another, said last-mentioned means comprising a projection extending axially from said piston into said tube with a pressure fluid flow restricting fit when said inlet valve and said piston are adjacent one another, said projection being adapted to be withdrawn from said tube when said inlet valve and said piston move oppositely relative to one another towards the remote positions thereof.

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