

[54] **PNEUMATICALLY ACTUATED FASTENER DRIVING DEVICE WITH IMPROVED PISTON RETURN AIR SYSTEM**

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[58] Field of Search **227/130**

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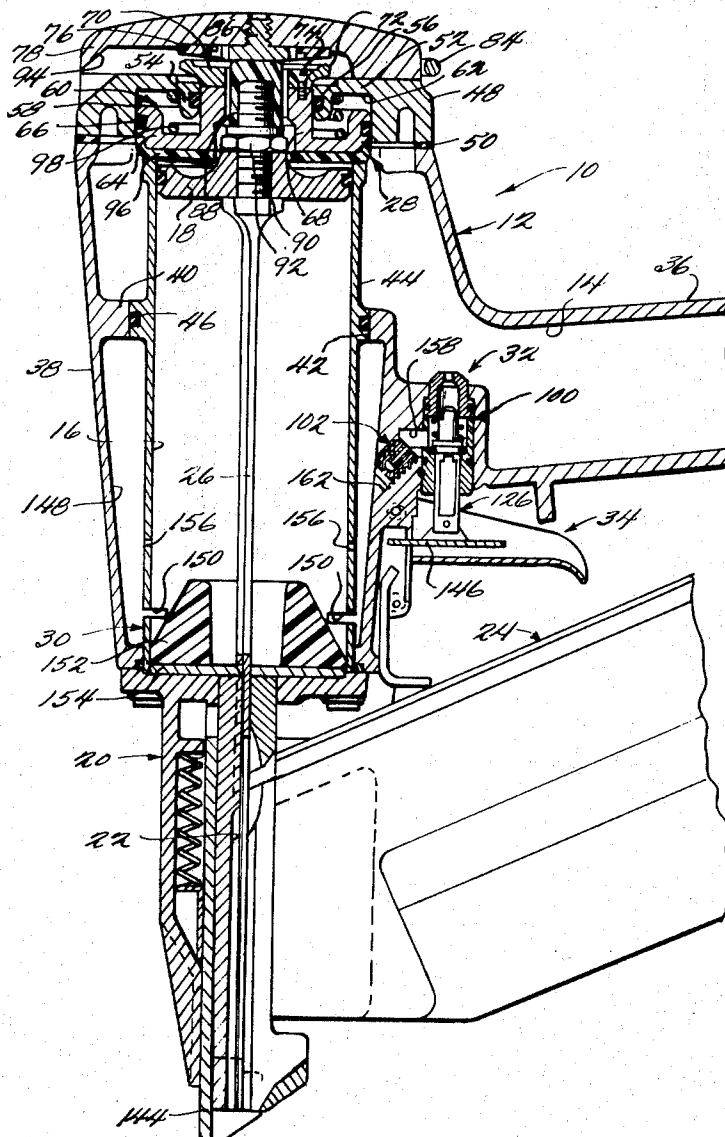
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[57] **ABSTRACT**

A single fire, pneumatically actuated fastener driving device having a pilot pressure actuated main valve and a plenum chamber return system, the movement of the mail valve into a position to effect the return stroke being dependent upon and effected by the establishment of a pressure within the plenum chamber sufficient to insure a full return stroke.

9 Claims, 6 Drawing Figures



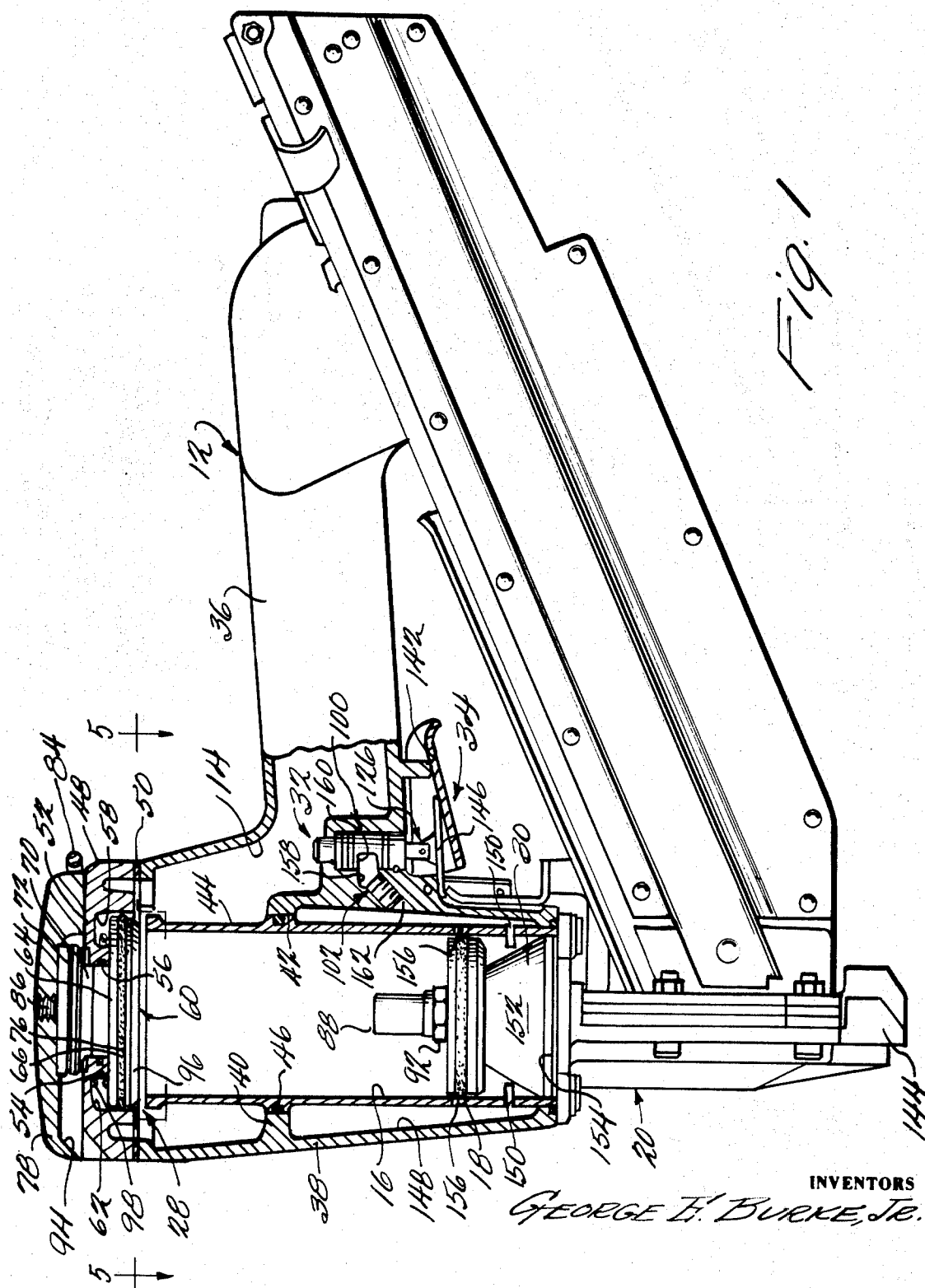


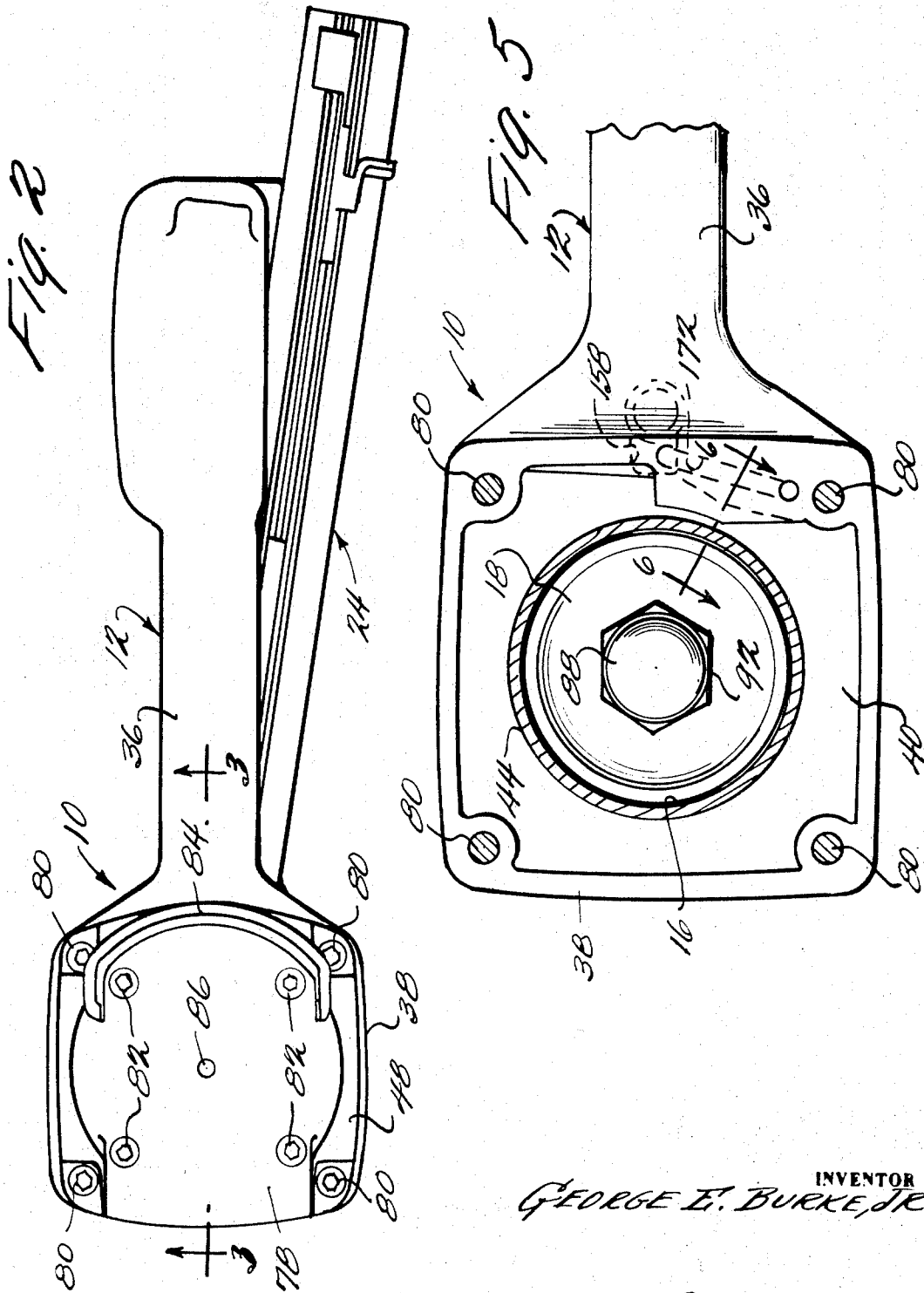
Fig. 1

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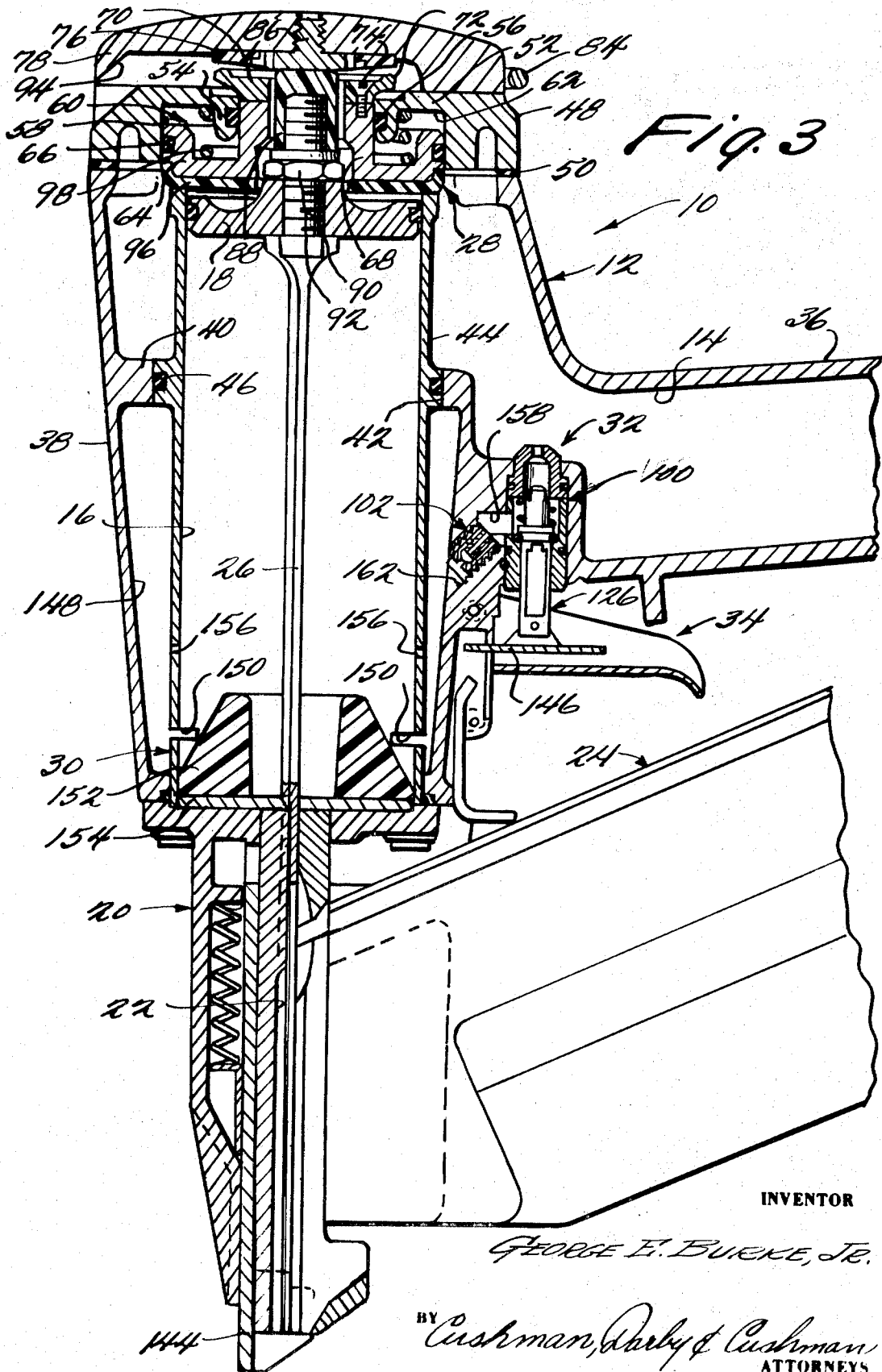
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PNEUMATICALLY ACTUATED FASTENER DRIVING DEVICE WITH IMPROVED PISTON RETURN AIR SYSTEM

This invention relates to pneumatic fastener driving devices and more particularly to improvements in the air system for effecting a single operating cycle of the piston and fastener driving element of the device.

Pneumatic fastener driving devices are well known in the art and generally embody a housing defining a reservoir for receiving air under pressure from a suitable source, a drive cylinder, a drive piston slidably mounted within the drive cylinder, a fastener driving element connected with the piston for movement therewith through a drive track communicating laterally with a fastener magazine assembly. The device is provided with an air system including a manually actuated valve mechanism pneumatically controlling a main valve mechanism operable to communicate the reservoir with the drive chamber to effect the drive stroke of the piston and fastener driving element during which the leading fastener in the drive track is moved outwardly thereof into a workpiece.

Various arrangements have been utilized in devices of this type for effecting the return stroke of the piston and fastener driving element, as for example, a return spring, a differential piston return or a plenum chamber return. The plenum chamber type return is particularly advantageous in that it permits the device to have a lower profile than is the case with the differential piston return and to utilize the air pressure more efficiently than a spring return.

The conventional plenum chamber return system usually includes an opening in the wall of the cylinder at a position spaced slightly above the seal of the piston when the latter has substantially completed its drive stroke. The pressure acting on the piston to effect its drive stroke is communicated through these openings, toward the end of the drive stroke, to a plenum chamber which usually is disposed in surrounding relation to the lower portion of the cylinder. When the piston reaches the end of its drive stroke, an annular seal is formed in the bottom of the cylinder in surrounding relation to the fastener driving element and the drive track at a position spaced radially inwardly from the lower end of the cylinder. The latter includes openings therein communicating with the plenum chamber permitting the charge of air within the plenum chamber to enter the lower end of the drive cylinder in a position to act upon the downwardly facing outer peripheral surface of the piston when the pressure acting on the upper surface of the piston is exhausted to atmosphere by the closing of the main valve. The return air serves to effect a rapid return stroke at the beginning of which the annular seal surrounding the fastener element and drive track is broken. When this seal is broken, a restricted passage provided by the clearance of the fastener driving element within a bottom plate in the drive cylinder functions to dissipate the return air pressure to atmosphere, desirably at a time just prior to or simultaneously with the completion of the return stroke.

One of the problems encountered in plenum chamber return systems is that the manual actuating mechanism can sometimes be released so rapidly after its movement into the actuating position that the return

cycle is initiated at a time prior to the plenum chamber receiving a sufficient charge of air to fully effect completion of the return stroke. Where only a partial return stroke is accomplished and the extent of the partial return stroke is insufficient to permit the lower end of the fastener driving element to clear the next fastener within the fastener magazine, no fastener will be driven during the next operating cycle. The failure of the device to drive a fastener during each operating cycle can present serious problems under some conditions of use. For example, where relatively large nails are being driven into wooden structural elements, the operator, relying upon the fact that he hears the device go through two operating cycles, may have in fact driven only one fastener, due to the circumstances mentioned above. The result is that a construction requiring two nails in only provided with one, so that failure may occur during use of the structure.

In accordance with the principles of the present invention the problem of dry firing due to excessively rapid movement of the manual actuating mechanism is eliminated by making the initiation of the return stroke responsive to the establishment of a full charge in the plenum chamber at the end of the drive stroke. With this arrangement the problems outlined above are eliminated while at the same time permitting manual recycling in a minimum of time.

Accordingly, it is an object of the present invention to provide a fastener driving device having an improved air system for effecting a single operating cycle of the piston and fastener driving element of the device in response to a single manual actuation which operates in accordance with the principles set forth above.

Another problem encountered in the operation of conventional fastener driving devices is the accidental operation of the device through two successive operating cycles in response to a single manual actuation. This malfunction sometimes occurs, particularly in the larger capacity devices, where the main valve is utilized to stop the piston at the end of its return stroke. In the event that a line surge in pressure or some other unusual high pressure condition is created within the device, an excessive charge of return air may be established within the plenum chamber at the end of the drive stroke. During the return stroke this excessive charge of air has the effect of returning the piston at a rate greater than normal so that its inertia at the end of the return stroke is sufficient to move the main valve out of its closed position into a position initiating another cycle.

There have been numerous proposals in the patented prior art for providing a piston stop which is fixed with respect to the housing and independent of the main valve. In accordance with the principles of the present invention a piston stop arrangement of this type is provided in conjunction with a main valve of known construction. Heretofore, the utilization of a fixed piston stop has necessitated the provision of a special main valve construction. In accordance with the principles of the present invention, a fixed piston stop is utilized in combination with the main valve construction of conventional design.

Accordingly, it is an object of the present invention to provide a combination main valve construction and fixed piston stop which operates on the principles set forth above.

Another object of the present invention is the provision of a fastener driving device of the type described having an improved air system for effecting a single operating cycle of the piston and fastener driving element in response to a single manual actuation which is simple in construction, effective in operation and economical to manufacture and maintain.

These and other objects of the present invention will become more apparent during the course of the following detailed description and appended claims.

The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

In the drawings:

FIG. 1 is a side elevational view of a fastener driving device, with parts broken away for purposes of clearer illustration, embodying the principles of the present invention;

FIG. 2 is a top plan view of the device shown in FIG. 1;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary vertical sectional view of the trigger valve mechanism and check valve mechanism of the air system showing the former in its actuated position;

FIG. 5 is an enlarged fragmentary sectional view taken along the line 5—5 of FIG. 1; and

FIG. 6 is a fragmentary sectional view taken along the line 6—6 of FIG. 5.

Referring now more particularly to the drawings, there is shown in FIGS. 1-3 thereof a fastener driving device, generally indicated at 10, embodying the principles of the present invention. In the drawings, the device is shown oriented so as to drive a fastener vertically downwardly into a horizontal workpiece. It will be understood, however, that the device is capable of driving a fastener into workpieces oriented in any position other than the horizontal. For convenience, the device will be described in relation to the orientation illustrated, and consequently terms such as "horizontal," "vertical," "above," "below," "forward," "rearward," etc. as used herein are to be construed in their relative sense.

The device 10 includes a housing structure 12 having internal surfaces defining a reservoir 14 for receiving air under pressure from a suitable source (not shown) communicated with the reservoir by means of a conventional fitting (likewise not shown). Means is provided within the housing structure 12 defining a cylindrical chamber 16 within which a driving piston 18 is slidably mounted. The housing structure 12 includes a nosepiece assembly 20 defining an elongated drive track 22 which is axially aligned with the cylindrical chamber 16 and communicates laterally with a magazine assembly, generally indicated at 24. The magazine assembly is operable to receive a supply of fasteners and to feed successive leading fasteners from the supply contained therein into the drive track. Successive fasteners moved into the drive track 22 from the fastener magazine assembly 24 are driven outwardly of the drive track and into a workpiece by a fastener driving element 26 connected with the piston 18 to move therewith from a first position wherein the piston is disposed in the upper end of the cylindrical chamber 16 and the lower end of the fastener driving

element is disposed above the fastener within the drive track 22 through a drive stroke into a second position wherein the piston is disposed adjacent the lower end of the cylindrical chamber 16 and from said second position through a return stroke back into the first position.

The drive stroke of the piston 18 and fastener driving element 26 is accomplished by communicating the air under pressure within the reservoir 14 with the upper end of the cylindrical chamber 16 under the control of a main valve mechanism, generally indicated at 28.

The main valve mechanism 28 is mounted for movement between a first position preventing communication between the reservoir and the upper end of the cylindrical chamber 16 and establishing communication of the upper end of the cylindrical chamber 16 with the atmosphere and a second position wherein the communication between the upper end of the cylindrical chamber 16 and the atmosphere is discontinued and communication of the reservoir 14 with the upper end of the cylindrical chamber 16 is established. Air under pressure serves to effect the return stroke of the piston 18 and fastener driving element 26 in response to the movement of the main valve mechanism 28 into its first position, the return air being controlled and communicated by a plenum chamber assembly, generally indicated at 30. The main control valve mechanism 28 is moved between its first and second positions by a pilot pressure air system, generally indicated at 32, controlled manually by a manual actuating mechanism, generally indicated at 34.

The housing structure 12, as shown, includes a main casting shaped to provide a hollow handle portion 36 which extends generally horizontally and is integrally connected at its forward end with a generally vertically extending hollow driving portion 38. The interior of the driving portion is formed with a radially inwardly extending annular flange 40 disposed intermediate the ends thereof defining an interior bore 42. The upper and lower ends of the driving portion 38 of the main casting are formed with openings which are in axial alignment with the bore 42. A cylinder member 44 is mounted within the driving portion 38 within the bore 42 and the associated end openings thereof, the cylinder member including a radially outwardly extending annular flange provided with an annular groove for receiving an O-ring seal 46, which sealingly engages the bore 42. The interior of the cylinder member 44 defines the cylindrical drive chamber 16, the hollow interior of the handle portion 36 and the intercommunicating hollow interior of the driving portion 38 above the flange 40 surrounding the adjacent exterior periphery of the cylindrical member defining the reservoir 14.

The upper end of the cylinder member 44 is open so as to communicate alternately to the atmosphere and to the reservoir 14 under the control of the main valve mechanism 28, which is mounted in the housing structure 12 above the upper end of the cylinder member 44. To this end, the housing structure 12 includes a separate annular member 48 which is sealingly engaged, as by a gasket 50 or the like, on the upper surface of the main casting in surrounding relation to the upper opening therein. As best shown in FIG. 3, the annular member 48 is formed with a radially inwardly ex-

tending upper wall portion 52 having a cylindrical portion 54 extending downwardly from the inner periphery thereof. The inner periphery of the cylindrical portion has an annular groove formed therein for receiving an O-ring seal 56. The annular member 48 also includes an interior cylindrical surface 58 extending downwardly from the exterior periphery of the upper wall portion 52, the cylindrical surface 58 and O-ring seal 56 cooperating with a main valve member 60 to define an annular pilot pressure chamber 62.

As best shown in FIG. 3, the valve member 60 preferably includes an outer upwardly extending annular portion 64 having an annular groove formed in the periphery thereof which receives an O-ring 66 adapted to slidably sealingly engage the cylindrical surface 58 and a cylindrical portion 68 extending upwardly from the inner periphery thereof. The cylindrical portion 68 is formed with a cylindrical exterior periphery which slidably sealingly engages the O-ring seal 56. Mounted on the upper end of the cylindrical portion 68 is an annular exhaust valve element 70 having an upwardly facing radially outwardly extending annular valve seat 72 formed thereon. The valve element 70 is fixed to the valve member 60 by any suitable means as, for example, a plurality of bolts 74 or the like extending through the annular sealing element and into threaded engagement with the adjacent cylindrical portion of the valve member.

The valve seat 72 is adapted to cooperatively engage an annular valve element 76 of plastic material positioned with a recess formed in a downwardly facing exhaust cavity provided by a cap member 78. As best shown in FIG. 2 the annular member 48 is preferably secured to the main casting by a series of bolts 80 whereas the cap member 78 is secured to the annular member by a series of bolts 82. Preferably, the cap member is apertured to receive a pivoted bail 84 which is normally disposed in the horizontal position shown, but which can be pivoted upwardly into a vertical position providing a means by which the device may be suspended.

The valve element 76 is fixedly positioned with the recess of the cap member by a bolt 86 or the like having a flanged periphery engageable with a cooperating interior flange on the valve element 76 and a threaded shank engageable within a central threaded opening formed in the cap member. The central lower surface of the bolt provides a rigid piston stop surface which cooperates with a stop surface fixed with respect to the piston 18 to limit the upper movement of the piston within the cylindrical chamber 16. As shown, the piston stop surface is provided by the upper end of an inverted cup-shaped bumper element 88 threadedly engaged on the upper end of a shank 90 having its lower end rigidly mounted to the upper end of the fastener driving element 26 and extending through a suitable central opening in the piston 18. It will be noted that a nut 92 is threadedly engaged on the shank between the piston and the cap to effect rigid securement of the fastener driving element 26 to the piston 18.

The valve seat 72 and valve element 76 serve to control the communication of the upper end of the cylindrical chamber 16 with the atmosphere through a suitable exhaust outlet 94 formed between the cap member 78 and the annular member 48. Communication of the

upper end of the chamber 16 with the reservoir 14 is controlled by a centrally apertured generally cup-shaped valve element 96 made of suitable plastic material and engaged on the outer and lower peripheral surfaces of the valve member 60. The lower surface of the valve element 96 adjacent its outer marginal edge is adapted to engage the upwardly facing end surface of the cylindrical member 44 to close off communication between the reservoir 14 and the cylindrical chamber.

The main valve member 60 is resiliently biased downwardly into its first position by a coil spring 98 disposed within the pilot pressure chamber 62 with its upper end in engagement with the horizontal wall portion 52 and its lower end in engagement with the intermediate portion of the main valve member 60. The main valve member 60 is normally maintained in this first position by fluid under pressure within the pilot pressure chamber 62 as a result of the functioning of the pilot pressure air system 32 embodying the principles of the present invention.

As best shown in FIGS. 3 and 4, the pilot pressure system 32 includes a trigger valve assembly, generally indicated at 100, which, when actuated, serves to exhaust the pilot pressure within the chamber 62 to atmosphere and a check valve assembly, generally indicated at 102, operatively connected between the plenum chamber assembly 30 and the trigger valve assembly 100 for communicating air under pressure from the plenum chamber assembly to the pilot pressure chamber when the trigger valve assembly is deactuated.

As best shown in FIG. 4, the trigger valve assembly 100 is mounted within a cylindrical recess 104 formed in the main casting of the housing structure 12 at a position adjacent the juncture of the lower forward part of the handle portion 36 with the driving portion 38. The recess 104 opens downwardly and has an upper apertured wall communicating with the reservoir 14. Mounted within the inner end of the recess is a first valve insert 106 of generally inverted cup-shaped configuration. As shown, the valve insert 106 extends through the apertured inner wall defining the recess and is sealed within the recess as by an O-ring 108 disposed within an exterior annular groove formed in the exterior periphery of the insert. The insert includes an interior cylindrical surface 110 defining a space which is open at its lower end and communicates at its upper end with the reservoir 14 through a restricted orifice 112 formed in the upper end wall of the valve insert.

Disposed within the recess 104 below the insert 106 in abutting engagement therewith is a second valve insert 114. This valve insert is also sealed within the recess as by an O-ring seal 116 disposed within an annular groove formed within the periphery of the insert. The lower insert 114 is retained within the recess by any suitable means as, for example, a retaining pin 118 extending transversely through the main casting.

Extending through the lower valve insert 114 is an axial bore 120 having a counterbore 122 formed in its upper end portion so as to define therewith an upwardly facing shoulder providing an annular valve seat 124. Mounted within the bore 120 is a valve member, generally indicated at 126, which includes a lower cylindrical stem portion 128. The stem portion which extends through the bore 120 is provided with a pair of

flatted sides, indicated at 130, between the ends thereof. The valve member 126 includes a flange portion 132 spaced above the stem portion 128 and an annular valve element 134 of suitable sealing material, as for example, plastic or the like, is mounted on the valve member between the flange portion 132 and the stem portion 128 so as to engage the annular valve seat 124. The valve member also includes an upper cylindrical portion 136 of a diameter to closely engage within the cylindrical surface 110 of the first valve insert 106. The cylindrical portion is formed with flatted sides, as indicated at 138, adjacent its upper end.

The engagement of the stem portion 128 of the valve member within the bore 120 serves to mount the valve member for vertical reciprocation between an inoperative position (shown in FIG. 3) wherein the valve element 134 is disposed in engagement with the valve seat 124 and the cylindrical portion 136 is disposed below the cylindrical surface 110 and an operative position (shown in FIG. 4) wherein the cylindrical portion 136 is disposed within the cylindrical surface 110 and the valve element 134 is spaced upwardly from the valve seat 124. Preferably, the valve member is mechanically biased into its inoperative position, as by a coil spring 140 disposed in surrounding relation to the cylindrical portion 136 and having its upper end in engagement with the lower surface of the valve insert 106 and its lower end in engagement with the upper surface of the flange portion 132 of the valve member.

The valve member 126 is moved from its inoperative position to its operative position by manual actuation of the manual actuating mechanism 34 which, as best shown in FIG. 1, preferably includes a pivoted trigger member 142, a contact trip member 144 and an interlock mechanism 146 operatively connected between the trigger member, the contact trip member and the lower end of the stem portion of the valve member 126. The construction and operation of the interlock mechanism 146 is generally as disclosed in the commonly-assigned patent to Readyhough No. 3,572,572, issued Mar. 30, 1971, which is hereby incorporated by reference into the present specification.

Referring now more particularly to FIG. 4, the check valve mechanism 102 may be of any desired construction and, as previously mentioned, is mounted between the plenum chamber assembly 30 and the trigger valve assembly 100. To this end, it will be noted that the plenum chamber assembly 30 is of generally conventional design and includes a return air plenum chamber 148 defined by the interior periphery of the driving portion 38 of the main casting below the flange 40 and the adjacent exterior periphery of the cylinder member 44. The plenum chamber 148 communicates with the lower end of the drive chamber 16 as by a plurality of circumferentially spaced openings 150 formed in the cylinder member 44 at a position adjacent the lower end thereof. Disposed within the lower end of the cylinder member is a resilient bumper element 152 of frustoconical exterior periphery having its lower end seated on a plate 154 mounted in a recess within the upper portion of the nose piece assembly 20. The plate 154 is apertured to receive the fastener driving element 26 therethrough, the aperture providing a restricted discharge passage for the return air. The upper end of the bumper element 152 extends above the openings

150 and is adapted to be engaged by the lower surface of the piston 18 when the latter reaches the end of its drive stroke.

The plenum chamber 148 is charged with air under pressure from the drive chamber 16 when the piston 18 reaches the end of its drive stroke at a time just prior to or substantially simultaneously with the engagement of the piston with the bumper element. To accomplish this function, a plurality of circumferentially spaced openings 156 are formed in the cylinder member 44 at a position slightly above the seal of the piston when the latter is in engagement with the bumper element 152.

The counterbore 122 of the trigger valve mechanism 15 is communicated with the plenum chamber 148 through a passageway within which the check valve assembly 102 is mounted. The passageway includes a lateral opening 158 formed in the main casting in communication with the central forward portion of the recess 104, a registering opening 160 extending radially through the valve insert 114 into communication with the counterbore 122 and an inclined bore 162 formed in the main casting extending upwardly and rearwardly through the wall defining the rearward portion of the plenum chamber 148 and into communication with the lateral passage 158.

As best shown in FIG. 4, the check valve assembly 102 includes a valve insert sleeve 164 suitably mounted within the inclined bore 162 as, for example, by a threaded engagement therein, the valve insert sleeve 164 including an upwardly and rearwardly facing frustoconical valve seat 166 formed between a main bore and a counterbore provided axially within the valve insert sleeve 164. Disposed within the counterbore of the valve insert sleeve 164 is a valve member 168 including a segmental spherical valve element portion and a valve stem portion extending therefrom. The valve stem portion is slidably received within a sleeve 170 having a plurality of circumferentially spaced ribs extending radially outwardly therefrom and engaged within the counterbore of insert sleeve 164.

Referring now more particularly to FIG. 5, it will be noted that the lateral passage 158 between the check valve assembly 102 and the trigger valve assembly 100 is also communicated with the pilot pressure chamber 62 of the main valve mechanism 28. This communication is provided by an upwardly inclined passage 172 formed in the main casting with its lower end communicating with the lateral passage 158 and its upper end communicating with the upper surface of the main casting adjacent the upper opening thereof. As best shown in FIG. 6, the upper end of the passage 172 is communicated with the pilot pressure chamber 62 through passageways formed in the annular member 48 including a passage 174 extending upwardly from the lower surface thereof in alignment with the upper end of the passage 172 (through a registering opening in the gasket 50), and a downwardly extending bore 176 formed in the adjacent upper surface of the annular member 48 in communication with the pilot pressure chamber 62 and passage 174. The upper end of the bore 176 is sealed with respect to the cap member 78 by an O-ring seal 178 or the like.

OPERATION

To commence the operation of the device it is first necessary to connect the inlet fitting of the reservoir to the outlet fitting of a hose leading from a source of air under pressure. Prior to making this connection, the entire air system within the device 10 is at atmospheric pressure. Nevertheless, the trigger valve member 126 is resiliently biased into its inoperative position by the spring 140 and the main valve member 60 is resiliently biased into its first position by the spring 98. When the source of air under pressure is connected with the reservoir 14, the pressure within the reservoir increases and this increase in pressure is immediately communicated with the pilot pressure chamber 62 through the restricted orifice 112, past the flatted sides 138 of the cylindrical portion 136 of the valve member 126, through counterbore 122, opening 160, passages 158, 172 and 174 and bore 176 (FIGS. 4, 5 and 6).

It will be noted that when this increase in pressure communicates with the lateral passage 158, check valve member 168 will be urged into its closed position, thus preventing escape of air under pressure to the plenum chamber 148. The size of the restricted orifice 112 is such as to permit a build-up in pressure within the pilot pressure chamber 62 within a time period sufficient to prevent the pressure build-up in the reservoir 14 acting on the peripheral surface area of the valve member 60 communicating therewith from overcoming the pressure build-up in the pilot pressure chamber 62 plus the pressure applied by the spring 98. With this arrangement, an inadvertent drive stroke of the piston 18 in response to the connection of the source pressure with the device 10 is prevented.

The device is now in condition to be actuated by the manual actuating mechanism 34, which when actuated has the effect of moving the trigger valve member 126 from its inoperative position shown in FIG. 3 into its operative position shown in FIG. 4. During this movement, the cylindrical portion 136 of the valve member 126 engages within the cylindrical surface 110 of the valve insert 106, thus severely restricting the flow of air from the reservoir 14 through the restricted orifice 112 into the counterbore 122. Upon actuation, the valve element 134 is also moved upwardly away from the valve seat 124 communicating the counterbore 122 with the atmosphere through the bore 120 and the flatted sides 130 of the valve stem portion 12. As soon as this passage to atmosphere is provided, the air under pressure within the pilot pressure chamber 62 is allowed to be exhausted.

As the air within the pilot pressure chamber is exhausted to atmosphere, the air under pressure within the reservoir 14 acting upwardly on the valve member 60 through an annular pressure surface equal to the diameter of the cylindrical surface 58 and the exterior diameter of the upper end of the cylindrical member 44 will overcome the bias of the spring 98 and pilot pressure chamber air, thus effecting movement of the main valve member 60 from its first position upwardly toward its second position. When the valve member 60 reaches its second position, valve seat 72 engages the valve member 76, thus closing off communication with the atmosphere through the exhaust passage 94. The air under pressure within the reservoir 14 now is communicated past the open main valve mechanism 28 to

the upper end of the drive chamber 16 and acts upon the upper surface of the piston 18 to effect a downward movement of the latter rapidly through its drive stroke. During the drive stroke, the fastener driving element 26 functions to drive a fastener within the drive track 22 outwardly thereof into a workpiece.

As the piston 18 approaches the end of its drive stroke, the seal of the piston will pass the openings 156 and then the piston will engage the bumper element 152 as the drive stroke is completed. The air under pressure acting on the upper surface of the piston passes through the openings 156, into the plenum chamber 148. As long as the manual actuating mechanism 34 is manually maintained in its actuated position, the air under pressure within the plenum chamber 148 will flow past the check valve mechanism 102 into the counterbore 122 of the trigger valve mechanism 100 and outwardly to atmosphere past the flatted sides 130 of the valve stem portion 128. As soon as the operator manually releases the manual actuating mechanism 34 into its inoperative position, this flow path of the air under pressure within the plenum chamber 148 to atmosphere is closed thus trapping the plenum chamber air and permitting the same to flow into the pilot pressure chamber 62 through the passages 172 and 184 and bore 176.

The communication of high pressure air to the pilot pressure chamber 62 moves the main valve mechanism 28 into its first position closing off the communication between the upper end of the drive chamber and the reservoir 14, and effecting communication of the upper end of the drive chamber with atmosphere through the open valve member 76. As the air within the drive chamber 16 above the piston 18 is exhausted, the high pressure air within the plenum chamber 148 acting on the lower surface of the piston through the openings 150 effects a relatively rapid return stroke of the piston. In this regard, it will be noted that the engagement of the piston with the upper surface of the bumper element 152 serves to trap the return air so as to effect the aforesaid return stroke. The fastener drive element 26 is mounted within the plate 154 with sufficient clearance to permit the air under pressure effecting the return stroke of the piston to dissipate to atmosphere so that when the piston reaches the upper end of its return stroke the air pressure in both the drive chamber 16 as well as the plenum chamber 148 will be reduced to atmospheric pressure. It will be understood, however, that the return air dissipation function may be provided by other arrangements as well. The check valve assembly 102 functions to prevent the high pressure air within the pilot pressure chamber 62 from dissipating to atmospheric pressure along with the return air in the lower end of the drive cylinder and plenum chamber.

A preferred construction of the fastener driving element 25, the nose piece assembly 20 and the fastener magazine assembly 24 is disclosed in commonly-assigned application Ser. No. 138,148 filed concurrently herewith in the name of Peleg B. Briggs, Jr., the disclosure of which is hereby incorporated by reference into the present specification.

It can be seen that the operation of the air system is such that the closing of the main valve mechanism 28 is effected in response to the build-up of pressure in the

plenum chamber 148 following the completion of the drive stroke of the piston 18. This functional relationship is of significance since it insures not only that a full drive stroke will be effected under full reservoir pressure but that a full charge of return air pressure will enter the plenum chamber to insure a full return stroke. The arrangement is of particular importance in that this full cycle is insured whether the operator releases the manual actuating mechanism 34 rather slowly or as rapidly as possible.

The conventional arrangement is to utilize reservoir pressure to charge the pilot pressure chamber of the main valve under the control of the trigger valve. An arrangement of this type can sometimes result in a premature closing of the main valve where rapid or instantaneous actuation of the trigger valve is made. Under these circumstances the pressure actuating the piston is allowed to exhaust through the main valve before a full charge of return air builds up in the plenum chamber to effect the return stroke. Under these circumstances encountered in conventional return systems it becomes necessary to effect a manual return stroke of the piston or to again actuate the trigger valve before the next nail can be driven. With the present arrangement, this type of malfunction is effectively prevented since the actuation of the main valve into its closed position is made responsive to a pressure build-up in the plenum chamber sufficient to complete the return stroke.

The size of the orifice 112 is such as to prevent flow of reservoir pressure therethrough when the trigger valve mechanism is released sufficient to build up pressure within the pilot pressure chamber before the completion of the drive stroke and the charging of the plenum chamber. Thus, the build-up of pressure within the pilot pressure chamber sufficient to close the main valve will come from the pressure communicating from the plenum chamber rather than from the pressure of the reservoir through the orifice no matter how instantaneously the operator is able to release the trigger valve. The present system thus not only insures the completion of a full cycle of operation in response to whatever the speed of actuation of the manual actuating mechanism is but in those instances where instantaneous release occurs, the operating cycle time is reduced to an absolute minimum, thus permitting the device to be actuated as rapidly as possible commensurate with insured full cycle operation.

The provision of the orifice 112 is solely for the purpose of preventing inadvertent actuation of the device when initially connected with a source of pressure and is not operable thereafter. Other arrangements for accomplishing the purpose of preventing an inadvertent initial actuation may be provided. For example, a restricted passage could be provided between the reservoir 14 and the pilot pressure chamber which communicates with the pilot pressure chamber through member 48 at a position adjacent the O-ring seal 66 when the main valve member 60 is in its first or closed position. Such a restricted passage would provide communication only when the main valve is in its closed position since movement of the main valve into its open position would cause the O-ring seal 66 to move above the position of communication of the restricted passage with the pilot pressure chamber.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing preferred specific embodiment has been shown and described for the purpose of illustrating the functional and structural principles of this invention and is subject to change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

I claim:

1. A fastener driving device comprising a housing, means within said housing defining a reservoir for receiving and containing fluid under pressure supplied thereto from a source of fluid under pressure, means within said housing defining a cylindrical drive chamber having one end arranged for communication with said reservoir,
 - a piston mounted within said drive chamber for movement from a first position adjacent said one drive chamber end through a drive stroke into a second position adjacent the opposite end of said drive chamber and from said second position through a return stroke into said first position,
 - means carried by said housing defining a drive track,
 - means carried by said housing for receiving a supply of fasteners and for feeding successive fasteners from said supply laterally into said drive track,
 - a fastener driving element slidably mounted within said drive track and operatively connected with said piston for movement thereby through a drive stroke in response to the drive stroke of said piston to drive a fastener in said drive track outwardly into a workpiece and through a return stroke in response to the return stroke of said piston,
 - main valve means movable between a first position communicating said one drive chamber end with the atmosphere and preventing communication between said one drive chamber end and said reservoir and a second position communicating said one drive chamber end with said reservoir and preventing communication of said one drive chamber end with the atmosphere so that said piston and fastener driving element will be moved through the drive stroke thereof in response to the movement of said main valve means into said second position and through the return stroke thereof in response to the movement of said main valve means into said first position,
 - means within said housing defining a pilot pressure chamber pneumatically operatively connected with said main valve means for effecting movement of said main valve means into said first position and in response to the communication of pilot pressure therein and for effecting movement of said main valve means into said second position in response to the exhaust of pilot pressure therefrom,
 - means defining an exhaust outlet for said pilot pressure chamber,
 - manually operable valve means mounted for movement between a normally closed position preventing communication of said pilot pressure chamber with said exhaust outlet and a manually actuated opened position communicating said pilot pressure chamber with said exhaust outlet to thereby ex-

haust said pilot pressure chamber to atmosphere so as to effect movement of said main valve means into said second position and hence said piston through said drive stroke in response to the movement of said manually operable valve means into said opened position,

means within said housing defining a return air plenum chamber,

means establishing communication between the pressure air within said one drive chamber end acting on said piston to effect the drive stroke of the latter and said plenum chamber when said piston reaches the end of said drive stroke and for communicating the plenum chamber with the opposite end of said drive chamber so that the air under pressure in said plenum chamber can effect the return stroke of said piston when said main valve means is moved into said first position,

means defining a flow path for air under pressure from said plenum chamber to said pilot chamber operable when said manually controlled valve means is moved into said closed position to establish a pilot pressure in said pilot chamber sufficient to effect movement of said main valve means into said first position and hence said piston through said return stroke only after said plenum chamber has received sufficient air under pressure to insure completion of said piston return stroke and said manually controlled valve means has been moved into said closed position,

means for dissipating the air under pressure within the opposite end of said drive chamber and said plenum chamber to atmospheric pressure in conjunction with the completion of said piston return stroke, and

means in said flow path for preventing flow of air under pressure from said pilot chamber into said plenum chamber so as to prevent exhaust of the air under pressure within said pilot chamber through said plenum chamber and to permit such exhaust solely through said exhaust outlet in response to a subsequent manual movement of said manually controlled valve means into said opened position.

2. A fastener driving device as defined in claim 1 including means operable only when said reservoir is initially communicated with a source of air under pressure for communicating air under pressure with said pilot pressure chamber in response to the communication of said reservoir with a source of air under pressure so as to maintain said main valve means in said first position until said manually operated valve means is manually moved into said opened position.

3. A fastener driving device as defined in claim 2 wherein said means operable only when said reservoir is initially communicated with a source of air under pressure includes a restricted orifice communicating at one end with said reservoir at all times and at its other end with said pilot pressure chamber when said manually operated valve means is in its normally closed position and main valve means is in said first position.

4. A fastener driving device as defined in claim 3 wherein said means operable only when said reservoir is initially communicated with a source of air under pressure further includes means operable in response to the movement of said manually operable valve means

into said opened position for substantially closing communication between the other end of said restricted orifice and said pilot pressure chamber.

5. A fastener driving device as defined in claim 1 wherein said drive chamber defining means comprises a cylindrical member having an annular surface surrounding said one end thereof, said main valve means comprising an annular main valve member of an exterior diameter greater than the diameter of the annular surface of said cylinder member, said main valve member including an annular marginal surface for engagement with the annular surface of said cylinder member when said main valve means is in said first position and a central open-ended tubular portion, said tubular portion having an upwardly facing annular valve seat thereon, said housing including means defining a fixed annular valve element for engagement with the annular valve seat on said tubular portion when said main valve means is disposed in said second position, said piston having a stop element extending upwardly therefrom of a size to be received within the tubular portion of said main valve member, said housing including means defining a fixed stop surface within said fixed annular valve element for engaging the piston stop element when said piston is disposed in said first position.

6. A fastener driving device comprising a main housing including a main tubular portion having an open upper end and a hollow handle portion extending laterally from said tubular portion,

means within said housing including said hollow handle portion defining a reservoir for receiving and containing fluid under pressure supplied thereto from a source of fluid under pressure,

means within the tubular portion of said housing defining a cylindrical drive chamber having an upper end arranged for communication with said reservoir,

a piston mounted within said drive chamber for movement from a first position adjacent said one drive chamber end through a drive stroke into a second position adjacent the opposite end of said drive chamber and from said second position through a return stroke into said first position,

means carried by said housing defining a drive track, means carried by said housing for receiving a supply of fasteners and for feeding successive fasteners from said supply laterally into said drive track,

a fastener driving element slidably mounted within said drive track and operatively connected with said piston for movement thereby through a drive stroke in response to the drive stroke of said piston to drive a fastener in said drive track outwardly into a workpiece and through a return stroke in response to the return stroke of said piston,

main valve means movable between a first position communicating said one drive chamber end with the atmosphere and preventing communication between said one drive chamber end and said reservoir and a second position communicating said one drive chamber end with said reservoir and preventing communication of said one drive chamber end with the atmosphere so that said piston and fastener driving element will be moved through the drive stroke thereof in response to the

movement of said main valve means into said second position and through the return stroke thereof in response to the movement of said main valve means into said first position,

said main valve means including an annular main valve member having an annular piston portion extending upwardly from the outer periphery thereof and a tubular portion extending upwardly from the inner periphery thereof, said tubular portion having a cylindrical exterior surface,

a housing closure structure detachably fixedly connected to said main housing in closing relation to the open upper end of the tubular portion thereof, said closure structure having means defining an outer interior cylindrical surface slidably sealingly engaging said main valve piston portion and inner annular seal means slidably engaging the cylindrical exterior surface of said tubular portion of said main valve member,

said closure structure and said main valve member defining a pilot pressure chamber therebetween, said tubular portion having an upwardly facing annular valve seat thereon,

a fixed annular valve element carried by said closure structure for engagement with the annular valve seat on said tubular portion when said main valve means is disposed in said second position,

said piston having a stop element extending upwardly therefrom of a size to be received within the tubular portion of said main valve member,

means on said closure structure defining a fixed stop surface disposed within said fixed annular valve element for engaging the piston stop element when said piston is disposed in said first position,

manually actuated means for communicating air under pressure with said pilot pressure chamber and for exhausting air therefrom to effect movement of said main valve means between said positions thereof, and

means for effecting the return stroke of said piston.

7. A fastener driving device as defined in claim 6 wherein said closure structure includes an annular housing member detachably fixedly secured to said main housing and a cap member detachably fixedly secured above said annular housing member and defining therewith an annular exhaust chamber disposed above said pilot pressure chamber and within which said fixed annular valve element and said stop surface are disposed, said annular valve seat being formed on an element detachably fixedly secured to the upper end of the tubular portion of said main valve member and having a diameter greater than the diameter of the exterior cylindrical surface of said tubular portion but less than the diameter of said exhaust chamber.

8. A fastener driving device as defined in claim 6 wherein said means for effecting the return stroke of said piston comprises means within said main housing defining a return air plenum chamber and means establishing communication between the pressure air within said one drive chamber end acting on said piston to effect the drive stroke of the latter and said plenum chamber when said piston reaches the end of said drive stroke and for communicating the plenum chamber with the opposite end of said drive chamber so that the air under pressure in said plenum chamber can effect the return stroke of said piston when said main valve means is moved into said first position.

9. A fastener driving device as defined in claim 8 wherein said manually actuated means comprises means defining an exhaust outlet for said pilot pressure chamber,

manually operable valve means mounted for movement between a normally closed position preventing communication of said pilot pressure chamber with said exhaust outlet and a manually actuated opened position communicating said pilot pressure chamber with said exhaust outlet to thereby exhaust said pilot pressure chamber to atmosphere so as to effect movement of said main valve means into said second position and hence said piston through said drive stroke in response to the movement of said manually operable valve means into said opened position,

means defining a flow path for air under pressure from said plenum chamber to said pilot chamber operable when said manually controlled valve means is moved into said closed position to establish a pilot pressure in said pilot chamber sufficient to effect movement of said main valve means into said first position and hence said piston through said return stroke only after said plenum chamber has received sufficient air under pressure to insure completion of said piston return stroke and said manually controlled valve means has been moved into said closed position,

means for dissipating the air under pressure within the opposite end of said drive chamber and said plenum chamber to atmospheric pressure in conjunction with the completion of said piston return stroke, and

means in said flow path for preventing flow of air under pressure from said pilot chamber into said plenum chamber so as to prevent exhaust of the air under pressure within said pilot chamber through said plenum chamber and to permit such exhaust solely through said exhaust outlet in response to a subsequent manual movement of said manually controlled valve means into said opened position.

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