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(71) Applicant: **Stanley Fastening Systems L.P.**
**East Greenwich, Rhode Island 02818 (US)**

(72) Inventors:
- **Burke, Brian C.**
  **Warwick, Rhode Island 02816 (US)**
- **Canlas Jr., Prudencio S.**
  **North Kingstown, Rhode Island 02852 (US)**
- **Simonelli, David J.**
  **Conventry, Rhode Island 02816 (US)**

(74) Representative: **Laight, Martin Harvey**
**W.H. Beck, Greener & Co.**
**7 Stone Buildings**
**Lincoln's Inn**
**London WC2A 3SZ (GB)**

## (54) Fastener driving device

(57) A fastener driving device (10) includes a housing containing a chamber (20) for storing compressed air a cylinder structure (34) disposed within the housing, a piston (26) movably disposed within the cylinder, a driver (33) connected to the piston, a main valve (38) cooperable with the cylinder structure and movable between an open position and a closed position. The main valve (38) in its open position allows air to move the piston through a drive stroke. The fastener driving device also includes a trigger valve (36) operable between first and second positions. The trigger valve in its first position communicates air pressure from the chamber (20) to the main valve (38) through a signal passageway (43) so as to retain the main valve in a closed position. The trigger valve in its second position allows the air to be exhausted to atmosphere through the signal passageway (43) to permit the main valve to open. The cylinder (34) and the signal passageway (43) comprise an integrally molded structure.

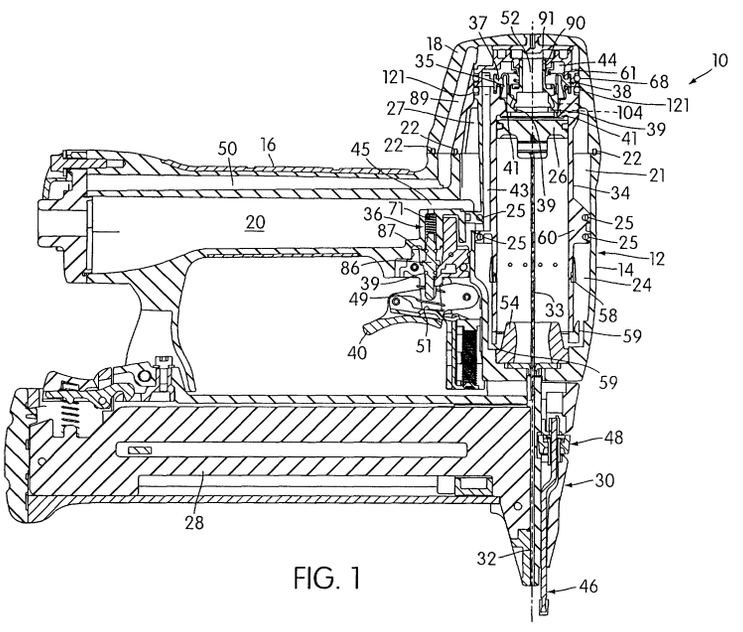


FIG. 1

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## Description

**[0001]** This invention relates to fastener driving devices and, more particularly but not exclusively, to fastener driving devices of the portable type.

**[0002]** Fastener driving tools for driving fasteners such as nails, staples or the like are commonly used in industry and commerce. The fasteners are generally supplied from a collated strip or stick of fasteners disposed in a magazine coupled to a nose-piece portion of the fastener driving tool. The fastener driving tool also comprises a housing to store compressed air provided from an external source, and a cylinder is disposed within the housing. A piston is slidably disposed in the cylinder and a driver is connected to the piston. A main valve can be opened above the cylinder to provide pressurized air to the piston operating the driver. A trigger valve is also provided and sends a pneumatic signal to operate the main valve.

**[0003]** The pneumatic signal is routed from the trigger valve to the main valve via an air passage. Conventional tools typically utilize an air signal passage that is machined into the tool housing or frame.

**[0004]** The machining of the air signal passage in the prior art devices is expensive and time consuming. In addition, the machining step introduces surface irregularities thus potentially creating leaks in the housing.

**[0005]** Therefore, it is desirable to overcome these and other limitations thus allowing overall improved performance and reduced cost of the fastener tool.

**[0006]** According to the present invention in a first aspect there is provided a fastener driving device comprising a housing containing a chamber for containing compressed air; a cylinder structure disposed within said housing; a piston movably disposed within said cylinder; a driver connected to said piston; a main valve cooperable with said cylinder structure and movable between an open position and a closed position, wherein said open position allows air to move said piston through a drive stroke; and a trigger valve operable between a first position wherein said trigger valve establishes a first pressure signal at said main valve through a signal passageway so as to retain said main valve in a closed position, and a second position wherein said trigger valve establishes a second pressure signal at said main valve through said passageway to permit said main valve to open, and wherein said cylinder structure and said signal passageway comprise a molded structure.

**[0007]** Preferably said trigger valve is operable between said first position wherein said trigger valve communicates air pressure from said chamber to said main valve through a signal passageway so as to retain said main valve in a closed position, and said second position wherein said passageway is exhausted to atmosphere to permit said main valve to open.

**[0008]** Preferably said cylindrical structure and said signal passageway form a single structure molded from a plastic.

**[0009]** It is generally preferred that said main valve is disposed towards the top of said cylinder structure.

**[0010]** In some preferred forms of the invention it is arranged that when said trigger valve is in said first position said main valve is closed and when said trigger valve is in said second position said main valve is open, and there is provided a peripheral seal structure surrounding an upper portion of said cylinder structure and an upper portion of said signal passage facilitate air pressure communication of said upper portions.

**[0011]** In accordance with another aspect of the invention there is provided a molded structure for use in a fastener driving device comprising a cylindrical portion having an inner cylindrical surface adapted to cooperate with a piston, said cylindrical portion having a longitudinal axis, a passage portion disposed radially outwardly from said cylindrical surface and having an upper portion adapted to communicate with an upper portion of said cylindrical portion and a lower portion adapted to communicate with a trigger valve.

**[0012]** It is to be appreciated that where features of the invention are set out herein with regard to an apparatus according to the invention, such features may also be provided with regard to a method according to the invention, and vice versa.

**[0013]** In particular there is provided in accordance with the invention in another aspect a method of forming a cylindrical structure and a signal passageway for a fastener driving device comprising providing a mold structure that defines both said cylindrical structure and said signal passageway; introducing molten material to said mold structure; and forming both said cylindrical structure and said signal passageway in a molding operation.

**[0014]** Preferably said material comprises a polymeric material. Alternatively said material comprises a metal.

**[0015]** In accordance with yet another aspect of the invention there may be provided a fastener driving device comprising a housing having a chamber constructed and arranged to contain compressed air; a cylinder disposed within said housing; a piston movably disposed within said cylinder; a fastener striker connected with said piston; a main valve formed at least in part from a flexible material, said main valve having a first portion thereof sealingly engaged with a first portion of said cylinder and a second portion thereof movable between a sealing position with a second portion of said cylinder and an unsealed position as a result of flexing of said flexible material, said unsealed position permitting said compressed air to force said piston to move within said cylinder to enable said fastener striker to move through a fastener driving stroke; and a trigger valve carried by the housing and actuable to enable said second portion of said main valve to move from said sealing position to said unsealed position.

**[0016]** Other aspects of the present invention provide a device of the type described above which is combined with other features hereafter described in detail.

**[0017]** In accordance with yet another aspect of the present invention, a fastener driving device includes a housing containing a chamber for storing compressed air a cylinder structure disposed within the housing, a piston movably disposed within the cylinder, a driver connected to the piston, a main valve cooperable with the cylinder structure and movable between an open position and a closed position. The main valve in its open position allows air to move the piston through a drive stroke. The fastener driving device also includes a trigger valve operable between first and second positions. The trigger valve in its first position communicates air pressure from the chamber to the main valve through a signal passageway so as to retain the main valve in a closed position. The trigger valve in its second position allows the air to be exhausted to atmosphere through the passageway to permit the main valve to open. The cylinder and the signal passageway comprise an integrally molded structure.

**[0018]** In another aspect of the invention, the trigger valve is operable between a first position wherein the trigger valve establishes a first pressure signal at the main valve through a signal passageway so as to retain the main valve in a closed position. The trigger valve in its second position establishes a second pressure signal at the main valve through the passageway to permit the main valve to open. The cylinder and the signal passageway comprise an integrally molded structure.

**[0019]** In one embodiment, the structure comprising the cylinder and the signal passageway are molded from plastic.

**[0020]** Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

FIG. 1 is a cross-sectional view of the fastener tool embodying the present invention;
FIG. 2 is a frontal view of the cylinder of the fastener tool;
FIG. 3 is a longitudinal sectional view of the cylinder;
FIG. 4 is a top of the cylinder;
FIG. 5 shows the map of the air path for the pneumatic signal for actuating main valve 38;
FIG. 6 is an enlarged view of a cap showing the position of a main valve according to one embodiment of the present invention;
FIG. 7 is a sectional view of the inside of the cap at cross-section AA; and
FIG. 8 is an elevational view of the main valve according to one embodiment of the present invention.

**[0021]** Referring now to the drawings, more particularly referring to FIG. 1, there is shown therein a fastener driving device, generally indicated at 10, which embodies the present invention. The tool comprises housing 12 having, among other things, a cylinder containing body portion 14, a handle portion 16 and a cap portion 18. The size and shape of these components can vary considerably depending on the type of fastener and application, but all have in common an internal air chamber 20 for containing compressed air, for example, from an external source.

**[0022]** The compressed air chamber 20 is pressurized from an air supply line through an inlet connection attached to the handle (not shown). In this particular embodiment, the cap 18 may be attached to the body portion 14 with screws (not shown). Part of the volume in cap 18 is used to enlarge the volume of the compressed air chamber 20. The body portion 14 and cap 18 are joined by seals 22 to prevent compressed air from escaping into the atmosphere.

**[0023]** The body portion 14 also includes a return air chamber 24. The return air chamber 24 is pressurized when a piston 26 is near the end (bottom) of its downward drive stroke. The sequence of pressurizing the return chamber 24 will be described in detail below. The chambers 20 and 24 are separated by seals 25.

**[0024]** The lower portion of the housing 12 is connected to a fastener carrying rail or magazine 28. The front of the rail 28 commonly is defined by a nosepiece 30, which is provided with a guide cavity 32. A fastener pusher within magazine 28 (not shown) delivers the fastener into the nose cavity 32 underneath the end of a driver 33. The driver 33 is fixed to the piston 26 and functions together as a unit. A cylinder 34 is mounted in the housing 12. The piston 26 reciprocates in the cylinder 34 during operation. To control the movement of the piston 26, a trigger valve 36 positioned near the handle 16 and a main valve 38 are employed. A passageway 27 permanently allows the pressure in chamber 20 to communicate with a region 35 of main valve 38. While the main valve 38 and trigger valve 36 can be any such valves as known in the art, it is preferred for the main valve 38 to be made and operated in accordance with a co-pending European patent application corresponding to a US. Patent Application entitled "Pneumatic Tool With Self-Sealing Diaphragm Valve System" Serial Number 60/369,884, filed on April 5, 2002, the content of which is incorporated herein by reference.

**[0025]** In Figure 1, the trigger valve 36 is positioned so as to permit pressurized air from chamber 20 to communicate through the valve 36, through a signal passageway 43 and to a chamber 44 above the main valve 38. The trigger valve 36 is controlled by a manual lever 40 as shown in FIG. 1. The signal passageway 43 allows air pressure signal to communicate between trigger valve 36 and main valve 38 through a passage 104, shown on Figure 1 in dotted lines, so as to enable continuous communication with region 35 between a first sealed portion 37 of main valve 38 and second sealed portion 39 of main valve 38. In this condition, main valve 38 is retained in a closed position due to the fact that the surface area on the valve 38 that is exposed to chamber 44 is greater than the surface area of the valve 38 exposed to region 35, so that although there is equal

pressure in regions 44 and 35, there is a net downward force on the main valve 38 to retain portion 39 of the main valve 38 in sealed relation to an upper end 41 of cylinder 34. Actuation of the lever 40 causes trigger valve 36 to seal the chamber 20 from the signal passageway 43 and the same time opens the passageway 43 to atmosphere to permit pressure in the passageways 43 and chamber 44 to exhaust through the valve 36. The passageway 43 is pressurized again when lever 40 is released and the valve 36 is closed. The embodiment of the tool shown in FIG. 1 is that of a manually operated tool, but should a tool be part of a stationary application the trigger valve means could be a remotely located valve and operated by something other than lever 40. The signal passageway 43 is formed at least in major part as an integral structure with the cylinder 34. It can be appreciated, however, that a portion of the signal passage may be considered to reside also in the housing for trigger valve 36 or other portion of the housing 12. A peripheral seal structure 121 surrounds an upper portion of cylinder structure 34 and an upper portion of said signal passageway 43 to facilitate air pressure communication of the upper portions.

**[0026]** A movable contact trip assembly 46 is mounted so as to have a forward end extend outwardly of the nosepiece 30 to be actuated when the device 10 is moved into operative engagement with a workpiece. The contact trip 46 includes fastener depth adjusting mechanism indicated as 48 capable of being conveniently manually adjusted in a manner to determine the countersink depth of the driven fasteners.

**[0027]** The sequential operation of the above-described fastener driving apparatus will now be described. For greater detail of operation, reference may also be had to the aforesaid co-pending European patent application corresponding to US. Patent Application entitled "Pneumatic Tool With Self-Sealing Diaphragm Valve System" Serial Number 60/369,884, filed on April 5, 2002, the content of which is incorporated herein by reference.

**[0028]** At rest, chamber 20 communicates through trigger valve 36, through passageway 43 into the chamber 44 above the main valve 38. The surface area of main valve 35 exposed to region 44 above the main valve is greater than the surface area of main valve 38 exposed to region 38 below the main valve. Thus, although both regions 35 and 44 are exposed to the pressure in chamber 20, the greater surface area exposed to volume 44 causes the main valve to seal. When the trigger 40 is pulled against the bias of a coil spring 49, a valve stem 86 is raised when contacted by a surface 51 of the trigger assembly so that an upper O-ring 87 seals the air pressure chamber 20 from the signal passageway 43 and a lower O-ring 39A is unsealed to enable the chamber 44 above the main valve 38 to exhaust through passageway 43 to the atmosphere through valve 36. Because a chamber 21 is always exposed to air pressure chamber 20, and because such chamber 21 communicates with the region 35, the air pressure in region 35 will cause the main valve 38 to move to its unsealed position when the region 44 is exhausted to atmosphere. It can be appreciated that the region 35 is disposed between the first sealed portion 37 of the main valve and the movable second sealed portion 39 of the main valve. The pressure in region 35 causes a rolling flexure of a portion 61 of the main valve to enable portion 39 to lift and unseal from the portion 41 of cylinder 34.

**[0029]** The opening of the main valve 38 allows the air to enter the top or first portion of the cylinder 34 above the piston 26. At the same time, the air communication of the upper portion of the cylinder 34 above the piston 26 to the atmosphere through an exhaust passage 50 is blocked by sealingly closing a passageway 52 in the center of main valve 38 from the exhaust passageway 50. Specifically, when the main valve is raised in the open position, the upper surface of a portion 90 of the main valve seals to a stop member 91 of cap 18. Specifically, the upward movement of main valve 38 allows cylindrical plastic portion 90 of main valve 38 to sealingly contact stop member 91 to seal passageway 52 from exhaust path 50. The piston 26 along with driver 33 is forced downward rapidly. The driver 33 or fastener striker pushes the fastener out of the drive track 32 in nosepiece 30 with enough force to drive the fastener into the workpiece.

**[0030]** Near the end of the drive stroke, the piston 26 passes a one way check valves 58 in the cylinder 34 that allows air to enter and pressurize return air chamber 24 during the downward stroke. At the end of the drive stroke, the underside of the piston 26 contacts a shock absorber 54. After lever 40 is released, valve stem 36 is lowered under the force of a coil spring 71 so that the lower O-ring 39A seals and the upper O-ring 87 unseals to permit the air pressure in chamber 20 to enter again the passageway 43 to enable the chamber 44 above the main valve 38 to be pressurized again through a passageway 43. Therefore, the air pressure in the chamber 44 above main valve 38 is equalized with the air pressure in chamber 21 which is always exposed to air pressure chamber 20 (through passageway 45). The surface area of main valve 38 exposed to region 44 above the main valve is greater than the surface area of main valve 38 exposed to region 35 below the main valve. Thus, although both regions 35 and 44 are exposed to the pressure in chamber 20, the greater surface area exposed to volume 44 causes the main valve to go back to its initial sealed position. The main valve 38 is pneumatically balanced towards the closed position whenever both the upper and lower sides are subjected to equal air pressure. The main valve 38 thus closes when cavity 44 is pressurized.

**[0031]** It should be appreciated that the principles of the present invention apply to what are known in the art as half-cycle valving systems, full cycle valving systems, and automatic cycle valving systems.

**[0032]** The shifting of the main valve 38 to the closed

position unseals the sealing engagement between the plastic portion 90 of main valve 38 and the stop member 91 so as to allow the space above the piston 26 during upward travel of the piston 26 to exhaust through passageway 52 and exhaust passage 50 to atmosphere. The air above the piston 26 exhausts sequentially through a canal 89, passageway 50 and an exhaust port (not shown). When the air pressure above the piston 26 drops below that under the piston 26, the air in the return air chamber 24 enters the cylinder 34 under the piston 26 through canal 59 and forces the piston 26 and driver 33 upward. Return air chamber 24 has a fixed volume, thus as piston 26 moves upward the pressure in return air chamber 24 is reduced.

**[0033]** The return air chamber 24 is designed with sufficient volume to provide enough air to fully return the piston 26 at the lowest operating pressure with the pressure being reduced to nearly that of the atmosphere prior to the next tool cycle. As the end of the driver 33 raises above the fastener rail 28, the next fastener is positioned into the guide cavity 32 ready to be driven by the next tool cycle.

**[0034]** Turning now to Figure 2, a frontal view of an integrally cast structure 62, comprising the cylinder 34 and air passage 43, is shown. In one embodiment, structure 62 is molded from a molten polymeric material such as plastic in a mold structure. In another embodiment, structure 62 is molded from a molten metal material in a mold structure. The mold structure (not shown) is used to form the shape of structure 62. The mold structure defines both the cylinder 34 and the air passage 43. The structure 62 comprises integrally cast exhaust passage or air canal 43 communicating a volume of air above valve 38 with the trigger valve 36. Structure 62 is held inside body portion 14 of housing 12 (shown in Figure 1) with a sealing mount 60.

**[0035]** Figure 3 is a longitudinal cross-section of structure 62 in the line 3-3 in Fig. 2. Again in this Figure is shown air canal 43. In addition, air canal 43 continues through an angular path leading to trigger valve 36. Figure 4 is a transversal view of top of cylinder 34 showing clearly the air canal 43 in relation with the piston 26 in cylinder 34. Referring back to Figure 3, structure 62 comprises cylindrical portion or cylinder 34. Specifically, the cylindrical portion or cylinder 34 has an inner cylindrical surface 110 adapted to cooperate with piston 26 (shown in Figure 1). The cylindrical portion 34 has a longitudinal axis AA. The passage portion or air canal 43 is disposed radially outwardly from the inner cylindrical surface 110. The passage portion 43 has an upper portion 111 adapted to communicate with an upper portion 112 of the cylindrical portion 34. The passage portion 43 further has a lower portion 113 adapted to communicate with the trigger valve 36 (shown in Figure 1). The peripheral seal structure 121 is also shown surrounding the upper portion 112 of cylinder structure 34 and the upper portion 111 of the signal passage 43.

**[0036]** Figure 5 shows a map of an air path 80 for actuating valve 38. The valve 38 remains against the cylinder 34 as long as both sides of valve 38 are subjected to equal air pressure. To fire the tool, the upper side of the valve 38, positioned opposite to cylinder 34, must be subjected to reduced pressure. This is done by exhausting cavity 44 through exhaust passageway 43 by actuating the trigger valve 36 as illustrated in Figure 5. Now that the opposite sides of the valve 38 are subjected to unequal pressure, the valve 38 is forced to deflect upward thus the lower portion of valve 38 retracts from cylinder 34. Movement of the flexible valve 38 away from the top of cylinder 34 allows pressurized air to enter and force the piston 26 downward.

**[0037]** As previously described, during the tool cycle in which the piston 26 returns to the uppermost portion of the cylinder 34, the air above the piston 26 must be exhausted to the atmosphere. The compressed air used to drive the piston 26 downward can exhaust to the atmosphere by going through exhaust passageway 50 and out of exhaust port.

**[0038]** There will now be described in more detail one form of the main valve 38 which may be used in embodiments of the invention described with reference to Figures 6 to 8. In the example shown, the main valve 38 is formed from a resilient, flexible elastomeric material portion 100 and a more rigid plastic material portion 90. The resilient portion 100 of main valve 38 has said first portion sealingly engaged with said first portion 74a and 74b of cylinder 34. In addition, the resilient portion 100 of main valve 38 has said second portion movable between a lower sealing position with second portion 41 of cylinder 34, and an upper, unsealed position wherein portion 39 is spaced upwardly from portion 41 of the cylinder 34. The main valve 38 unseals as a result of rolling flexing movement of the resilient material at an inverted U-shaped portion 64 thereof. The unsealed position permits the compressed air present in chamber 21 to force the piston 26 to move from the upper position to the lower position to enable the fastener striker 33 to move through a fastener driving stroke. It can be appreciated that the region 35 is disposed between the first sealed portion 42 of the main valve and the movable sealed portion 39 of the main valve. The pressure in region 35 causes upward movement and a rolling flexure of portion 64 of the main valve 38 to enable portion 39 to lift and unseal from portion 41 of cylinder 34.

**[0039]** Referring to FIG. 6, there is illustrated an enlarged partial side cross-sectional view of the tool showing the details of the main valve 38. The cap 18 and seal 22 are separate parts attached to the body 14 for convenience of machining and assembly, but when assembled act as a unit to form housing 12. Located in the center of the cap 18, is formed a the stop member 91, which when assembled also becomes a fixed portion of the housing 12. The stop member 91 includes a valve seating surface 63 with ridges 62a and 62b. The valve seating surface 63 is sealingly attached to the inside of cap 18 with O-ring 63A and seats on stop member91.

The valve seating surface 63 cooperates with the moveable flexible portion 64 of the main valve to be described below to open and close the valve passageway to the piston 26. The stop 91 is constructed and made of material so as to be rather rigid in nature, such as a rigid plastic. Similarly, valve seating surface 63 is also constructed from a rigid material such as a rigid plastic. The valve seating surface 63 is also sealably mounted to the cap 18 using an O-ring 68a. O-ring 68b is used to seal between valve seating surface 63 and the upper portion of cylinder 34.

**[0040]** In one embodiment, the main valve 38 is constructed of an integrally formed resilient member 70 having a seal area 72 shown in Figure 6 in the form of an "H" configuration. The seal area 72 sealingly fits into ridges 62a and 62b on valve seating surface 63 and also sealingly fits the ridges 74a and 74b on the upper portion of cylinder 34. In the embodiment shown, the moveable portion 64 of valve 38 is made of a flexible plastic to allow opening and closing of the valve 38. Further, the moveable portion 64 is annular in shape to accommodate the valve passageway 66 in the cylinder 34.

**[0041]** Turning now to Figure 7, a cross sectional view of the inside of the cap 18 at cross-section AA (in figure 2) is shown. In one embodiment, seating surface is molded from a relatively rigid plastic. Seating surface 63 is shown having ridges 62a and 62b as previously described. Seating surface 63 is sealed to the cap with seal 68a (shown in figure 2) such as O-rings shaped to fit contours of inside of cap 18. The seating surface 63 comprises a portion 76 for holding a spring 80 (the spring is not shown in this figure) used to bias the valve 38 toward the closed position. The seating surface 63 also comprises a canal 78 permitting the air in the backside of valve 38 to be routed to passageway 43 when actuating trigger valve 36 is actuated thus allowing valve 38 to open.

**[0042]** Referring back to Figure 6, it there is shown the placement of the spring 80 in relation to valve 38. Spring 80 fits into portion 76 of seating surface 63 and also fits into a portion 82 of valve 38. In this way, spring 80 holds valve 38 tightly fit to cylinder 34, i.e., biased in closed position, until the air pressure builds within the tool to pneumatically hold valve 38.

**[0043]** The valve 38 is made of a polymer material (e.g., plastic) molded in a form of a semi-flexible diaphragm. The valve is molded in a saucer-like annular shape with a canal forming the said passageway 52 in the center of valve 38 as shown in Figure 8. The thickness of the flexible diaphragm is not uniform in order to provide more strength in the sections that undergo little or no movement.

**[0044]** When installed in the tool, the inner cylindrical shape 90 of valve 38 fits into portion 76 of seating surface 63 (shown in Figure 7) while creating a guide for spring 80 and allowing the spring 80 to compress and decompress around cylindrical shape 90 of valve 38 when valve 38 is opened and closed. The peripheral surface portions 92a and 92b of the valve 38 engage the annular ridges 62a and 62b of seating surface 63 in cap 18. In addition, the peripheral surface portions 92a and 92b also engage the annular ridges 74a and 74b in the upper portion of cylinder 34 (cf., Figure 6). The lower portion 39 of the valve 38 rests against the top portion 41 of cylinder 34. In this installation, the valve 38 seals compressed air cavity 44 from cylinder 34. The elastic characteristics of the material from which the valve 38 is constructed keeps the annular peripheral surface 92a and 92b in contact with the annular ridges 74a and 74b of the cylinder 34 and the movable lower portion 39 of valve 38 against cylinder 34 whenever both regions 35 and 44 below and above the valve 38 are exposed to the atmosphere or both surfaces are subjected to air having equal pressure. This has a great advantage over valves using O-rings as seals since the present configuration requires fewer components than conventional constructions.

**[0045]** The portion 39 of valve 38 remains against the cylinder 34 as long as both sides are subjected to equal air pressure. To fire the tool, the region44 above the valve 38, must be subjected to reduced pressure. This is accomplished by exhausting cavity 44 through passageway 43 by opening the trigger valve 36. Now that the two regions 35 and 44 above and below the valve 38 are subjected to unequal pressure, the valve 38 is forced to deflect upwardly thus the lower portion 39 of valve 38 retracts from cylinder 34. Movement of the flexible valve 38 away from the top of cylinder 34 allows pressurized air present in cavity 21 to enter through the top of cylinder 34 and force the piston 26 downward. A seal 27 (shown in Figure 1 and Figure 2) is used to prevent air from escaping around the piston 26.

**[0046]** As previously described, during the tool cycle in which the piston 26 returns to the uppermost portion of the cylinder 34, the air above the piston 26 is exhausted to atmosphere. This is accomplished through canal 52 in the center of main valve 38 to the top of cap 18. The compressed air used to drive the piston 26 downward can exhaust to atmosphere sequentially through exhaust passageway 89 and exhaust passageway 50.

**[0047]** After the tool has made the drive stroke, the main valve 38 is reset to the closed position, by repressurizing cavity 44. The An O-ring type seal 68b, positioned between seating surface 63 and top of cylinder 34 in cap 18, is used to prevent air from escaping out of the cavity 44.

**[0048]** Should the air supply be disconnected from the tool while the main valve 38 was in the open position, the valve 38 would return to the closed position on top of the cylinder 34. The semi-flexible valve 38 can be easily removed for service since it is not attached by any means to neither the cap 18 nor the cylinder 34.

**[0049]** It must be understood the terms such as upper, lower, above, downward and the like are used in reference to the figures shown in the drawings solely for the purpose of clarity. While the a preferred embodiment of

the present invention has been shown, it is anticipated that those skilled in the art may make numerous changes and modifications without departing from the scope of this invention.

## Claims

**1.** A fastener driving device comprising:

a housing (12) containing a chamber for containing compressed air;

a cylinder structure (34) disposed within said housing;

a piston (26) movably disposed within said cylinder;

a driver (33) connected to said piston;

a main valve (38) cooperable with said cylinder structure and movable between an open position and a closed position, wherein said open position allows air to move said piston through a drive stroke; and

a trigger valve (36) operable between a first position wherein said trigger valve establishes a first pressure signal at said main valve (38) through a signal passageway (43) so as to retain said main valve in a closed position, and a second position wherein said trigger valve establishes a second pressure signal at said main valve (38) through said passageway (43) to permit said main valve to open, and wherein said cylinder structure (34) and said signal passageway (43) comprise an integrally molded structure.

**2.** A fastener driving device according to Claim 1, wherein said trigger valve (36) is operable between said first position wherein said trigger valve communicates air pressure from said chamber to said main valve through a signal passageway (43) so as to retain said main valve (38) in a closed position, and said second position wherein said passageway (43) is exhausted to atmosphere to permit said main valve (38) to open.

**3.** A fastener driving device as recited in Claim 1 or 2, wherein said cylindrical structure (34) and said signal passageway (43) form a single structure molded from a plastic.

**4.** A fastener driving device as recited in any preceding claim, wherein main valve (38) is disposed towards the top of said cylinder structure.

**5.** A fastener driving device according to any of Claims 1 to 4, wherein when said trigger valve (36) is in said first position said main valve (38) is closed and when said trigger valve (36) is in said second position said main valve (38) is open, and there is provided a peripheral seal structure (121) surrounding an upper portion of said cylinder structure (34) and an upper portion of said signal passage (43) facilitate air pressure communication of said upper portions.

**6.** An integrally molded structure for use in a fastener driving device comprising:

a cylindrical portion (34) having an inner cylindrical surface (110) adapted to cooperate with a piston (26), said cylindrical portion having a longitudinal axis,

a passage portion (45) disposed radially outwardly from said cylindrical surface (110) and having an upper portion (111) adapted to communicate with an upper portion of said cylindrical portion (34) and a lower portion (113) adapted to communicate with a trigger valve (36);

said passage portion (43) being integrally molded with said cylindrical portion.

**7.** A method of forming a cylindrical structure (34) and a signal passageway (43) for a fastener driving device comprising:

providing a mold structure that defines both said cylindrical structure (34) and said signal passageway (43);

introducing molten material to said mold structure; and

forming both said cylindrical structure (34) and said signal passageway (43) in a molding operation.

**8.** A method of forming a cylindrical structure and a signal passageway as recited in Claim 7, wherein said material comprises a polymeric material.

**9.** A method of forming a cylindrical structure and a signal passageway as recited in claim 7, wherein said material comprises a metal.

**10.** A fastener driving device comprising:

a housing containing a chamber for storing compressed air
a cylinder structure disposed within said housing;

a piston movably disposed within said cylinder;
a driver connected to said piston;
a main valve cooperable with said cylinder structure and movable between an open position and a closed position, wherein said open position allows air to move said piston through a drive stroke through said cylinder; and
a trigger valve operable between a first position wherein said trigger valve communicates air pressure from said chamber to said main valve through a signal passageway so as to retain said main valve in a closed position, and a second position wherein said passageway is exhausted to atmosphere to permit said main valve to open, and wherein said cylinder and said signal passageway comprise an integrally molded structure.

**11.** A fastener driving device comprising:

a housing containing a chamber for storing compressed air;
a cylinder structure disposed within said housing;
a piston movably disposed within said cylinder;
a driver connected to said piston;
a main valve disposed towards the top of said cylinder structure and movable between an open position and a closed position, wherein said open position allows air to move said piston through a drive stroke; and
a trigger valve operable between a first position wherein said trigger valve establishes a first pressure signal at said main valve through a signal passageway so as to retain said main valve in a closed position, and a second position wherein said trigger valve establishes a second pressure signal at said main valve through said passageway to permit said main valve to open, and

wherein said cylinder and said signal passageway comprise an integrally molded structure.

**12.** A fastener driving device comprising:

a housing containing a chamber for storing compressed air;
a cylinder structure disposed within said housing;
a piston movably disposed within said cylinder;
a driver connected to said piston;
a main valve cooperable with said cylinder structure and movable between an open position and a closed position, wherein said open position allows air pressure to communicate with and drive said piston;
a trigger valve operable between a first position and a second position,

wherein an air pressure signal passage communicates air pressure between said trigger valve and said main valve, wherein when said trigger valve is in said first position said main valve is closed and when said trigger valve is in said second position said main valve is open, wherein said cylinder structure and said signal passage are integrally formed, and a peripheral seal structure surrounding an upper portion of said cylinder structure and an upper portion of said signal passage facilitate air pressure communication of said upper portions.

**13.** A fastener driving device comprising:

a housing having a chamber constructed and arranged to contain compressed air;

a cylinder (34) disposed within said housing;

a piston (26) movably disposed within said cylinder;

a fastener striker (33) connected with said piston;

a main valve (38) formed at least in part from a flexible material, said main valve having a first portion (42) thereof sealingly engaged with a first portion (74a, 74b) of said cylinder (34) and a second portion (39) thereof movable between a sealing position with a second portion (41) of said cylinder and an unsealed position as a result of flexing of said flexible material, said unsealed position permitting said compressed air to force said piston (26) to move within said cylinder to enable said fastener striker (33) to move through a fastener driving stroke; and

a trigger valve (36) carried by the housing and actuable to enable said second portion (38) of said main valve to move from said sealing position to said unsealed position.

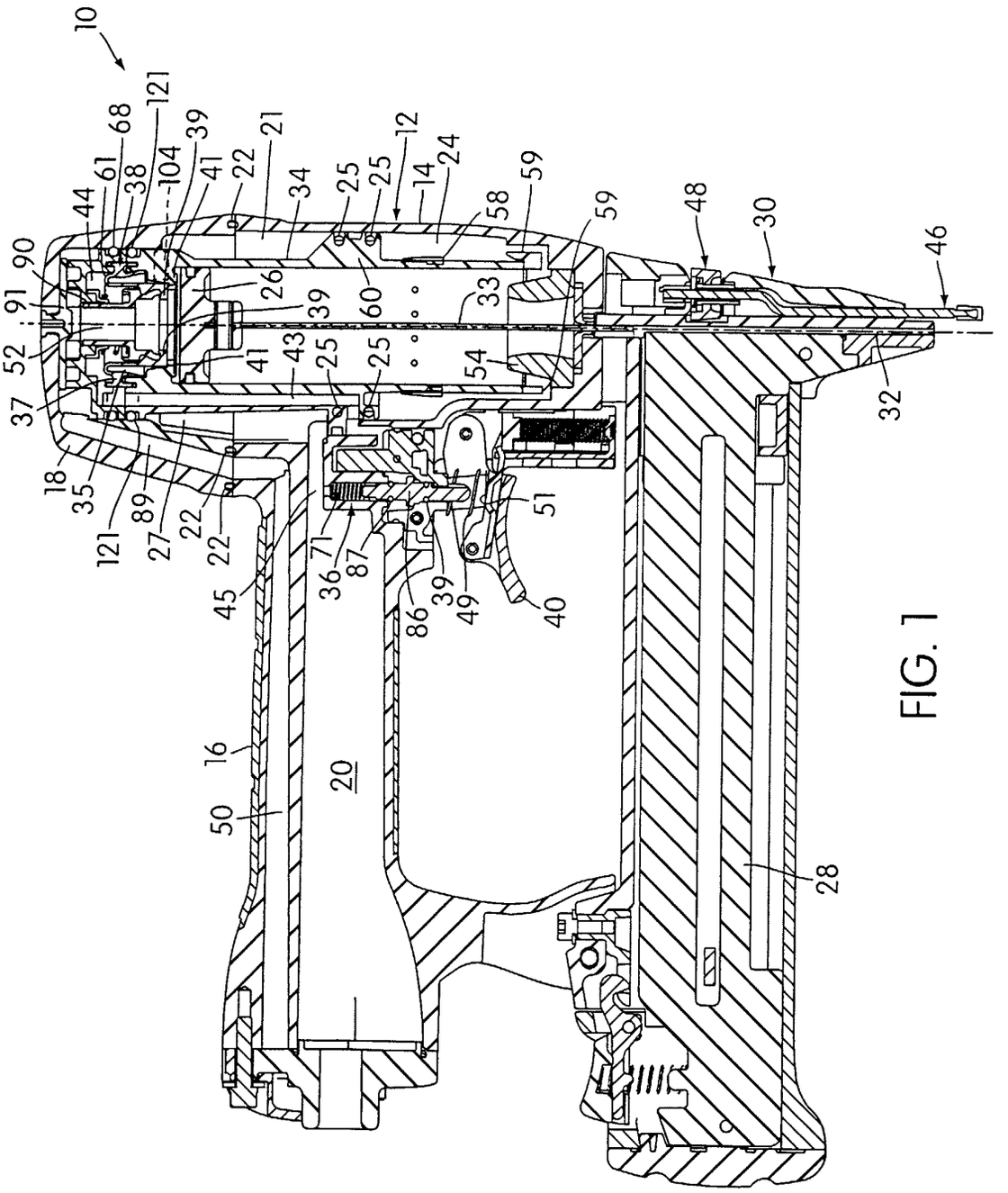
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FIG. 1

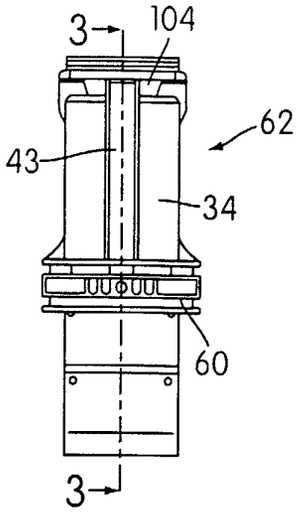


FIG. 2

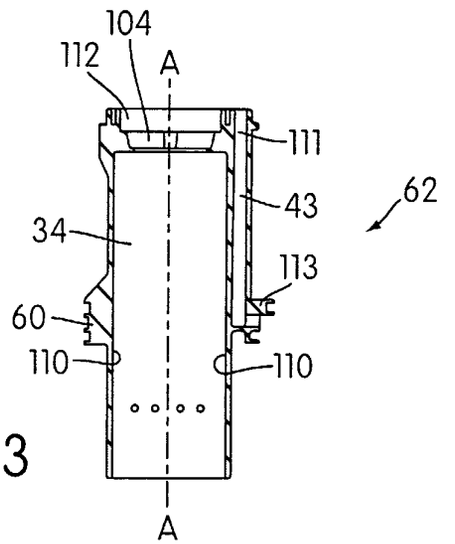


FIG. 3

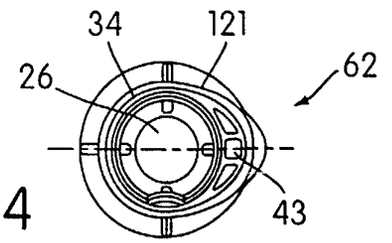


FIG. 4

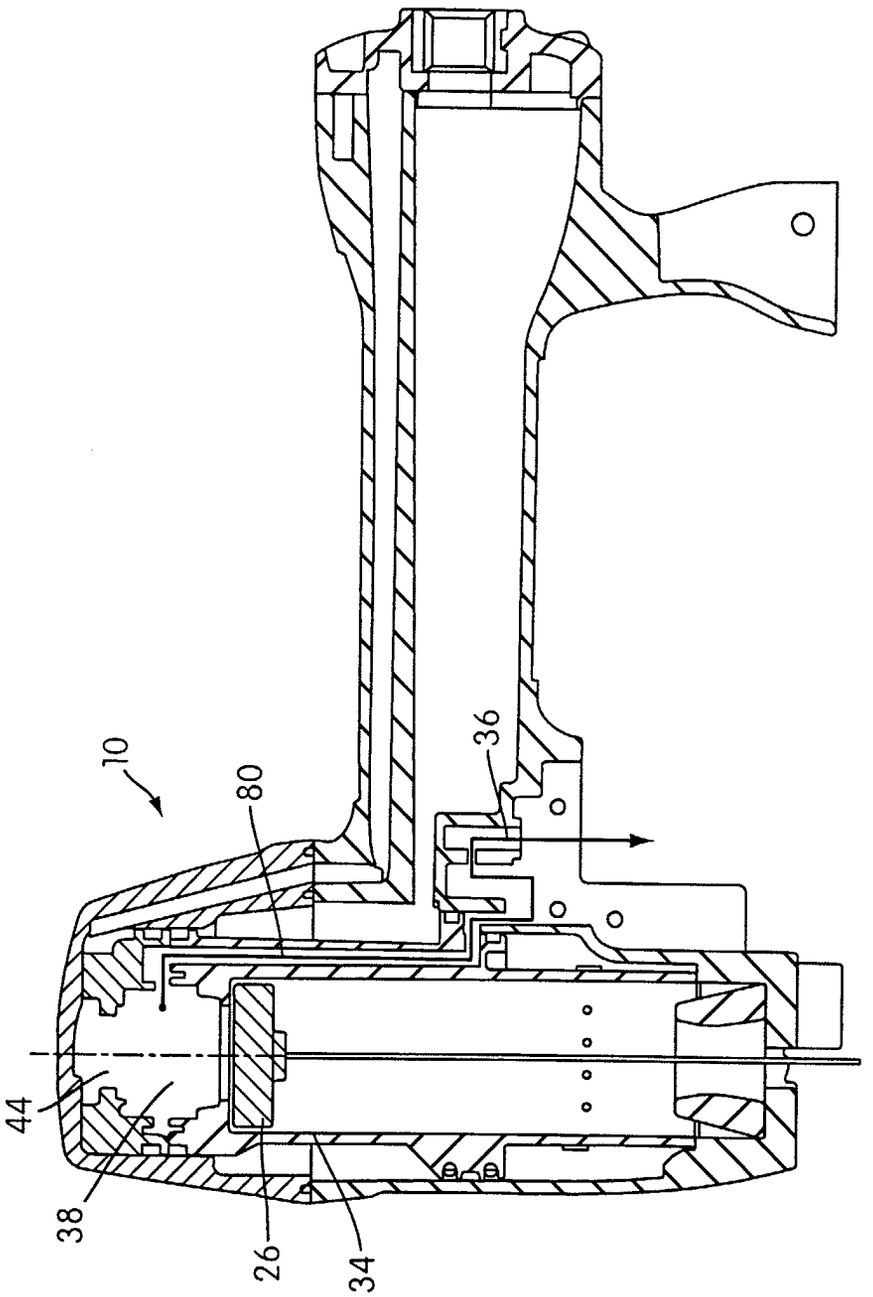


FIG. 5

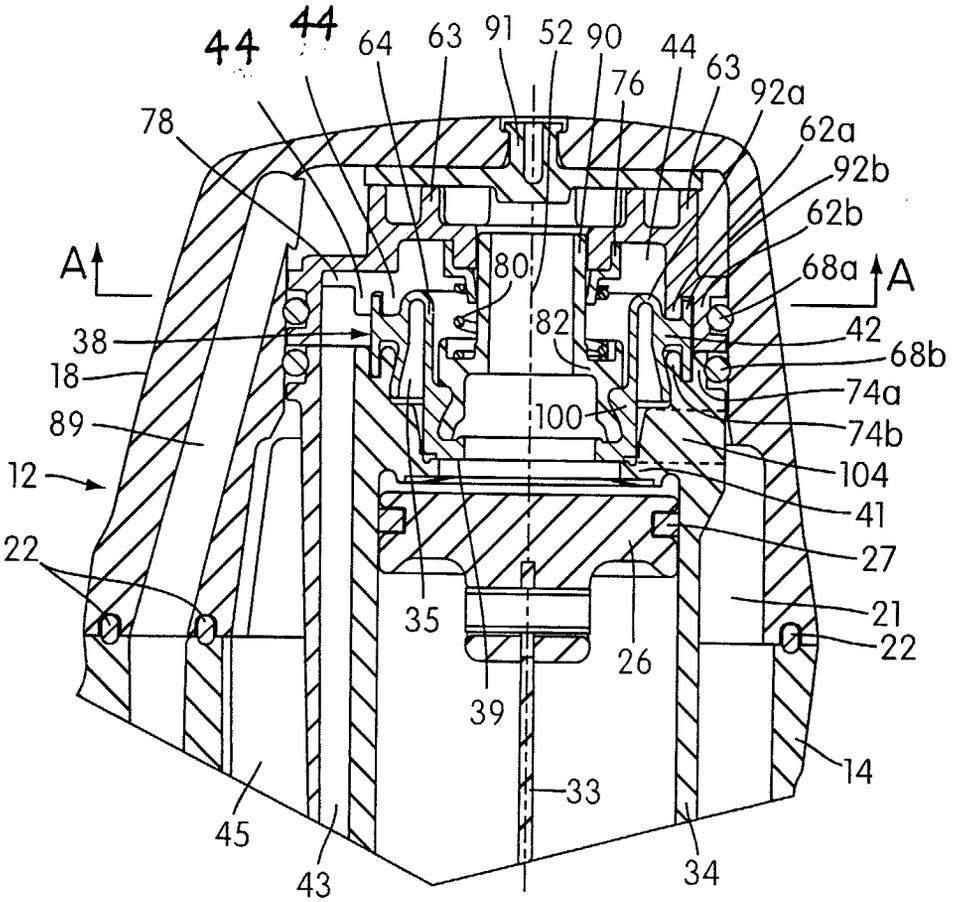
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FIG. 6

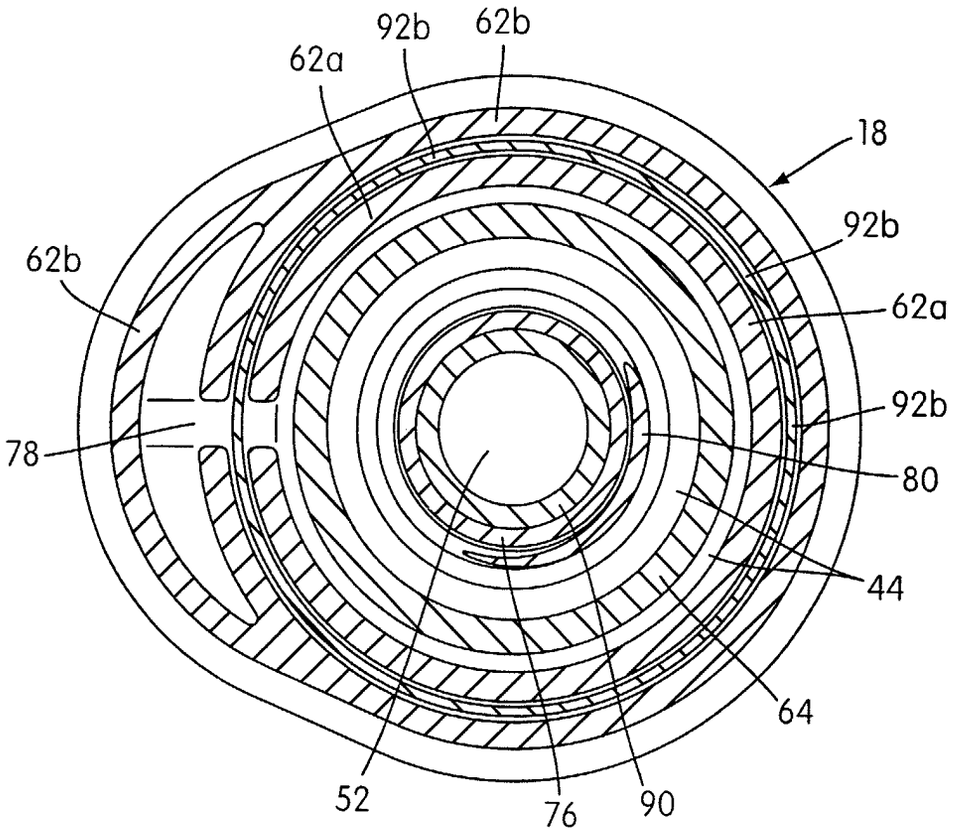


FIG. 7

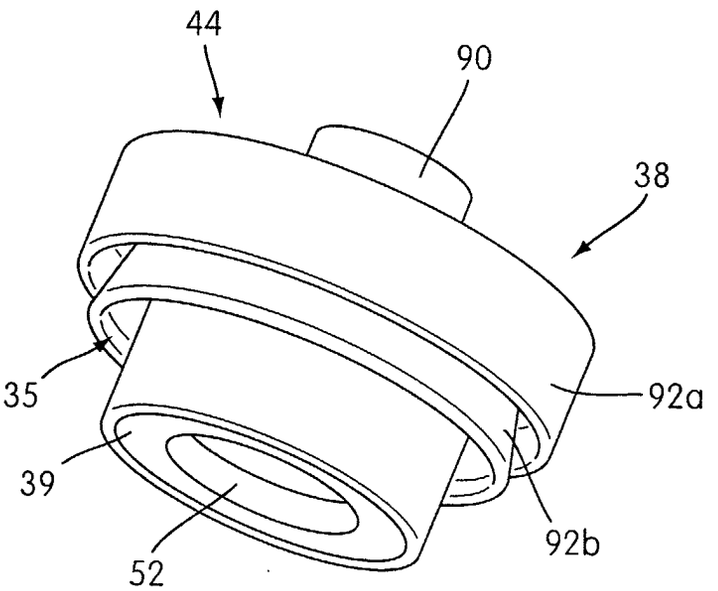


FIG. 8