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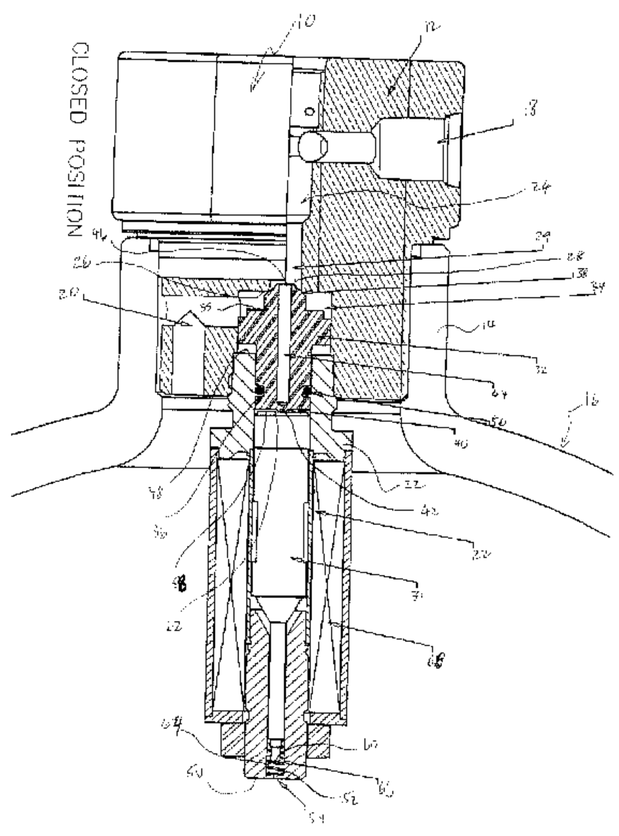
(54) Titre : VANNE DE RESERVOIR RESISTANT INSTANTANEMENT A L'ECRASEMENT
(54) Title: CRASHPROOF INSTANT-ON TANK VALVE



(57) Abrégé/Abstract:
The present invention provides a valve for controlling flow of gas from a pressure vessel comprising a fluid passage, a first valve seat mounted in the fluid passage and including an orifice, a sleeve including a second valve seat and an orifice opening into the pressure vessel, a secondary piston slidably carried within the sleeve and including a first sealing surface for closing the orifice of the first valve seat, a bleed passageway extending through the secondary piston, and a third valve seat including an orifice opening into the bleed passageway, and a primary piston slidably carried within the same sleeve and including a second sealing surface for closing the orifice of the third valve seat of the secondary piston, and a third sealing surface for closing the orifice of the sleeve. The secondary piston can further include a body such that the bleed passageway is formed within the body. The bleed passageway can communicate with the fluid passage. A biasing means can be provided for biasing the primary piston towards the secondary piston. The sleeve can further comprise sidewalls extending from the valve seat and terminating at a distal end to define an opening at the distal end. The body of the secondary piston can include a periphery wherein a sealing member is carried at the periphery of the body between the body and the sleeve, thereby preventing gas from flowing between the periphery of the body and the sleeve. The primary piston can be biased towards the first position by a resilient member, such as a spring means. The valve can further comprise an outlet port and a first throughbore, wherein the first throughbore extends from the outlet port to the orifice of the first valve seat, and a manual override valve is disposed between the orifice of the first valve seat and the outlet port for selectively sealing the flow passage. The secondary piston can comprise a first part and a second part such that the first part comprises a non-magnetic material and the second part comprises magnetic material.

ABSTRACT

The present invention provides a valve for controlling flow of gas from a pressure vessel comprising a fluid passage, a first valve seat mounted in the fluid passage and including an orifice, a sleeve including a second valve seat and an orifice opening into the pressure vessel, a secondary piston slidably carried within the sleeve and including a first sealing surface for closing the orifice of the first valve seat, a bleed passageway extending through the secondary piston, and a third valve seat including an orifice opening into the bleed passageway, and a primary piston slidably carried within the same sleeve and including a second sealing surface for closing the orifice of the third valve seat of the secondary piston, and a third sealing surface for closing the orifice of the sleeve. The secondary piston can further include a body such that the bleed passageway is formed within the body. The bleed passageway can communicate with the fluid passage. A biasing means can be provided for biasing the primary piston towards the secondary piston. The sleeve can further comprise sidewalls extending from the valve seat and terminating at a distal end to define an opening at the distal end. The body of the secondary piston can include a periphery wherein a sealing member is carried at the periphery of the body between the body and the sleeve, thereby preventing gas from flowing between the periphery of the body and the sleeve. The primary piston can be biased towards the first position by a resilient member, such as a spring means. The valve can further comprise an outlet port and a first throughbore, wherein the first throughbore extends from the outlet port to the orifice of the first valve seat, and a manual override valve is disposed between the orifice of the first valve seat and the outlet port for selectively sealing the flow passage. The secondary piston can comprise a first part and a second part such that the first part comprises a non-magnetic material and the second part comprises magnetic material.

CRASHPROOF INSTANT-ON VALVE

FIELD OF INVENTION

This invention relates to gas valves, and particularly instant-on type gas valves.

BACKGROUND OF THE INVENTION

Because of environmental concerns and emissions laws and regulations, manufacturers of motor vehicles are searching for a clean burning and cost efficient fuel to use as an alternative to gasoline. Natural gas is one candidate for such a purpose, and many vehicles have been converted to natural gas as a fuel source. Typically, the natural gas is stored on board the vehicle in compressed form in one or more pressurized cylinders.

Gas flow from such pressurized cylinders are controlled by valves. One major concern is the vulnerability of such gas valves to crash damage. If the vehicle is involved in an accident, the gas valve must not fail in an unsafe or catastrophic manner. To this end, internally-mounted gas valves have been designed to mitigate such unsafe or catastrophic conditions. Examples of such valves are disclosed in Wadensten et al, U.S. Patent No. 4,197,966, Wass et al, U.S. Patent No. 5,197,710, and Borland et al, U.S. Patent No. 5,562,117.

Although both Wass and Borland disclose internally-mounted gas valves, these gas valves suffer from the fact that they are relatively slow in opening when downstream pressure is relatively low. Further, although the gas valve disclosed in Wadensten can be characterized as fast opening relative to the gas valves disclosed in Wass and Borland, Wadensten's valve design is complicated, requiring a relatively large number of components. Further, Wadensten's valve cannot be used for tank filling operations through the same tank nozzle, thereby necessitating a further nozzle in the associated tank for filling operations.

SUMMARY OF THE INVENTION

In one broad aspect, the present invention provides a valve for controlling flow of gas from a pressure vessel comprising a fluid passage, a first valve seat mounted in the fluid passage and

including an orifice, a sleeve including a second valve seat and an orifice opening into the pressure vessel, a secondary piston slidably carried within the sleeve and including a first sealing surface for closing the orifice of the first valve seat, a bleed passageway extending through the secondary piston, and a third valve seat including an orifice opening into the bleed passageway, and a primary piston slidably carried within the same sleeve and including a second sealing surface for closing the orifice of the third valve seat of the secondary piston, and a third sealing surface for closing the orifice of the sleeve. The secondary piston can further include a body such that the bleed passageway is formed within the body. The bleed passageway can communicate with the fluid passage. A biasing means can be provided for biasing the primary piston towards the secondary piston. The sleeve can further comprise sidewalls extending from the valve seat and terminating at a distal end to define an opening at the distal end. The body of the secondary piston can include a periphery wherein a sealing member is carried at the periphery of the body between the body and the sleeve, thereby preventing gas from flowing between the periphery of the body and the sleeve. The primary piston can be biased towards the first position by a resilient member, such as a spring means. The valve can further comprise an outlet port and a first throughbore, wherein the first throughbore extends from the outlet port to the orifice of the first valve seat, and a manual override valve is disposed between the orifice of the first valve seat and the outlet port for selectively sealing the flow passage. The secondary piston can comprise a first part and a second part such that the first part comprises a non-magnetic material and the second part comprises magnetic material.

The primary piston can be characterized by a first position, wherein the second sealing surface is seated against the third valve seat of the secondary piston thereby closing the orifice formed in the secondary piston and the third sealing surface is spaced from the second valve seat of the sleeve to permit communication with the pressure vessel across the orifice of the sleeve. The primary piston can further be characterized by a second position wherein the second sealing surface is spaced from the third valve seat of the secondary piston and the third sealing surface is seated against the second valve seat of the sleeve thereby closing the orifice of the sleeve. The primary piston can assume the second position by actuation by a solenoid coil.

By fitting the primary and secondary pistons within a single sleeve, the number of components and, therefore, the complexity of the structure is appreciably reduced. Further, the provision of a biasing means to bias the secondary pistons to close flow out of the valve permits use of passages provided within the valve for tank filling operations, thereby eliminating the requirement of a separate nozzle being provided in the tank and dedicated for filling operations.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

Figure 1 is a sectional elevation view of an embodiment of an instant-on valve of the present invention showing the instant-on valve in a closed position;

Figure 2 is a sectional elevation view of the instant-on valve of the present invention illustrated in Figure 1 showing the instant-on valve in a transition position;

Figure 3 is a sectional elevation view of the instant-on valve of the present invention illustrated in Figure 1 showing the instant-on valve in an open position;

Figure 4 is a sectional elevation view of another embodiment of an instant-on valve of the present invention;

Figure 5 is a sectional elevation view of the instant-on valve of the present invention illustrated in Figure 1 showing the flow path taken through the instant-on valve during filling of an associated pressure vessel with a gaseous mixture; and

Figure 6 is a sectional elevation view of a further embodiment of an instant-on valve of the present invention.

DETAILED DESCRIPTION

Figure 1 shows an internally-mounted instant-on valve (10) of an embodiment of the present invention. Instant-on valve (10) includes a valve body (12) mounted within a nozzle (14) of a pressure vessel (16). Valve body (12) includes an outlet port (18) and an inlet port (20). A flow passage (24) extends from the outlet port (18) and through the valve body (12) and is in communication with inlet port (20). A valve seat (26) is provided in flow passage (24). Valve seat (26) includes an orifice (28) provided at an inner end (30) of valve seat (26). Throughbore (29) extends between outlet port (18) and orifice (28) and forms part of flow passage (24).

Instant-on valve (10) is also provided with a sleeve (22). A primary piston (31) and a secondary piston (32) are disposed and slidably carried within sleeve (22), and are moveable therein. Sleeve (22) includes a first end (48) and a second end (50). First end (48) is open for communication with flow passage (24). Second end (50) includes a valve seat (52) with an orifice (54) formed therein. Sidewalls (51) extend from valve seat (52) and terminate at a distal end (53) whereby second end (50) is defined. Sleeve (22) communicates with pressure vessel (16) via orifice (54).

Secondary piston (32) includes a body (33) comprising a first end (34) and a second end (36). Secondary piston (32) is comprised of non-magnetic material. The first end (34) includes a sealing surface (38) for closing the orifice (28). The first end (34) is further characterized by a surface (35) exposed to gaseous pressure within pressure vessel (16). The second end (36) includes a valve seat (40) having an orifice (42). A bleed passage (44) is formed within body (33) and extends therethrough between the orifice (42) and an outlet port (46) provided at the first end (34). Outlet port (46) opens into flow passage (24), and particularly throughbore (29). Orifice (42) communicates with flow passage (24) via bleed passage (44). A sealing member (56), such as an o-ring, is carried at the periphery of body (33) between body (33) and sleeve (22) thereby creating a seal to prevent gas from flowing between orifice (54) and first end (48) of sleeve (22).

Primary piston (31) is disposed behind secondary piston (32). Primary piston (31) includes a first end (58) and a second end (60). Primary piston (31) is comprised of magnetic material. First

end (58) includes a first sealing surface (62) for closing orifice (42). Second end (62) includes a second sealing surface (64) for engaging valve seat (52), thereby closing orifice (54). Resilient member or spring (66) is provided behind primary piston (31) to bias primary piston (31) towards secondary piston (32) for pressing first sealing surface (62) against valve seat (40) and closing orifice (42). In one embodiment, spring (66) is housed at second end (50) of sleeve (22) and presses against second end (60) of primary piston (31).

Surrounding sleeve (22) is a solenoid coil (68). Solenoid coil (68) is provided to apply electromagnetic forces on primary piston (31) by external actuation, thereby causing movement of the primary piston (31) against the force of spring (66) and fluid pressure forces within sleeve (22).

Figures 1, 2, and 3 illustrate an embodiment of an instant-on valve (10) of the present invention in various conditions of operation. Figure 1 illustrates instant-on valve (10) in a closed position. In this condition, solenoid coil (68) is not energized. Under these circumstances, spring (66) biases primary piston (31) towards secondary piston (32). In this respect, second sealing surface (64) is spaced from orifice (54) of valve seat (52) in sleeve (22), thereby opening orifice (54) to fluid pressure in the pressure vessel (16). Contemporaneously, first sealing surface (62) on primary piston (31) is pressed against valve seat (40) on secondary piston (32), thereby closing orifice (42). Because orifice (54) in sleeve (22) is open to fluid pressure in pressure vessel (16), the spaces between sleeve (22) and primary piston (31), and sleeve (22) and secondary piston (32) but below sealing member (56), are also exposed to fluid pressure of pressure vessel (16). Turning to secondary piston (32), first end (34) of secondary piston (32) is exposed to fluid pressure within pressure vessel (16) via inlet port (20). These fluid forces, acting downwardly upon secondary piston (32) are overcome by the combined action of spring (66) and fluid pressure within sleeve (22), the latter forces being translated to secondary piston (32) by primary piston (31). As such, sealing surface (38) on secondary piston (32) is pressed against valve seat (26), thereby closing orifice (28).

Figure 2 illustrates instant-on valve (10) in a transition position. Instant-on valve (10) is in a transition position moments after solenoid coil (68) is energized. Moments after solenoid coil (68)

is energized, electromagnetic forces produced thereby act upon primary piston (31) and overcome the forces exerted by spring (66) and gas pressure within sleeve (22), thereby causing second sealing surface (64) in primary piston (31) to seat against valve seat (52) provided on sleeve (22), thereby closing orifice (54). Simultaneously, first sealing surface (62) on primary piston (31) retracts from valve seat (40) of secondary piston (32), thereby opening orifice (42). By opening orifice (42) in secondary piston (32), gas contained within sleeve (22) begins to escape through bleed passage (44) within secondary piston (32) via orifice (42) and flow out of instant-on valve (10) through outlet port (18). As this happens, gas pressure within sleeve (22) begins to drop. However, under these conditions, fluid pressure in this region has not dropped sufficiently to unseat secondary piston (32) from valve seat (26). This is because the fluid forces acting on the surface of first end (34) of secondary piston (32), including fluid forces within throughbore (29), are still insufficient to overcome fluid forces within sleeve (22) acting upon the surface of second end (36) of secondary piston (32).

Figure 3 illustrates instant-on valve (10) in an open position. In this condition, fluid within sleeve (22) (below sealing member (56)) has further escaped through bleed passage (44) in secondary piston (32). At this point, gaseous forces acting behind the surface of second end (36) have sufficiently subsided to have become overcome by the fluid forces acting upon the surface of first end (34) of secondary piston (32). In response, sealing surface (38) of secondary piston (32) has become unseated from valve seat (26), thereby creating an uninterrupted flow path between the interior of pressure vessel (16) and outlet port (18) via fluid passage (24).

Figure 4 illustrates a further embodiment of an instant-on valve (100) of the present invention. Instant-on valve (100) illustrated in Figure 4 is identical with the instant-on valve (10) illustrated in Figures 1, 2, and 3, in all respects except for the fact that secondary piston (32) is comprised of first and second parts (32a) and (32b). First part (32a) is comprised of non-magnetic material. Second part (32b) is comprised of magnetic material. Second part (32b) is disposed closer to the solenoid coil (68) relative to the first part (32a). First part (32a) is integral with second part (32b). In one embodiment, second part (32b) is threaded on to first part (32a). By utilizing this

arrangement, secondary piston (32) is unseated faster from valve seat (26) relative to the instant-on valve (10) illustrated in Figures 1, 2, and 3.

Figure 5 illustrates the flowpath taken through instant-on valve (10) during filling of pressure vessel (16) with a gaseous mixture. Fill valve (70), which is typically a quick-connect fitting, is opened to effect flow of gas from fill station (72) to pressure vessel (16). Gas flows through check valve (74) and enters instant-on valve (10) through outlet port (18) which functions as an inlet port during filling operations. From port (18), gas flows via throughbore (29) and through orifice (28). Gas flowing through orifice (28) presses upon secondary piston (32), causing unseating of secondary piston (32) from valve seat (26) of flow passage (24). As a result, an uninterrupted flowpath is created between port (18), and therefore fill station (72), and pressure vessel (16). When the filling operation is complete, spring (66) exerts sufficient force on primary piston (31), which is thereby transmitted to secondary piston (32), to cause secondary piston (32) to close orifice (28).

Figure 6 illustrates a further embodiment of an instant-on valve (200) of the present invention. Instant-on valve (200) is identical to instant-on valve (10) illustrated in Figures 1, 2, and 3, in all respects except for the fact that a manual shut-off valve (202) is provided in fluid passage (24) between outlet port (18) and orifice (28), thereby permitting manual shut-off of fluid passage (24). In this respect, instant-on valve (200) includes a second throughbore (204) opening into first throughbore (29). First throughbore (29) includes a second valve seat (206) with an orifice (208) interposed between outlet (18) and orifice (28). Manual shut-off valve (202) includes a sealing surface (204) for seating against valve seat (206), thereby closing orifice (208) and blocking flow passage (24) such that communication between outlet port (18) and inlet port (20) is interrupted. Stem (210) extends from sealing surface (204) and through port (212) provided in pressure vessel (16) via throughbore (204). Manual level (214) is provided at a distal end (216) of stem (210) to facilitate closing of fluid passage (24) by manual intervention.

In one embodiment, instant-on valve (100) or (200) is designed for operation with environment characterized by an operating pressure up to 5000 psig.

Although the disclosure describes and illustrates preferred embodiments of the invention, it is to be understood that the invention is not limited to these particular embodiments. Many variations and modifications will now occur to those skilled in the art. For definition of the invention, reference is to be made to the appended claims.

CLAIMS:

1. A valve for controlling flow of gas from a pressure vessel comprising:

a fluid passage;

a first valve seat mounted in the fluid passage and including an orifice;

a sleeve including a second valve seat and an orifice opening into the pressure vessel;

a secondary piston slidably carried within the sleeve and including a first sealing surface for closing the orifice of the first valve seat, a bleed passageway extending through the secondary piston, and a third valve seat including an orifice opening into the bleed passageway; and

a primary piston slidably carried within the same sleeve and including a second sealing surface for closing the orifice of the third valve seat of the secondary piston, and a third sealing surface for closing the orifice of the sleeve.

2. The valve as claimed in claim 1 wherein the secondary piston includes a body and the bleed passageway is formed within the body;

3. The valve as claimed in claim 1 wherein the bleed passageway communicates with the fluid passage.

4. The valve as claimed in claim 1 further comprising a biasing means for biasing the primary piston towards the secondary piston.

5. The valve as claimed in claim 1 wherein the sleeve further comprises sidewalls extending from the valve seat and terminating at a distal end to define an opening at the distal end.

6. The valve as claimed in claim 5 wherein the body of the secondary piston includes a periphery and wherein a sealing member is carried at the periphery of the body between the

body and the sleeve, thereby preventing gas from flowing between the periphery of the body and the sleeve.

7. The valve as claimed in claim 1 wherein the primary piston is characterized by a first position, wherein the second sealing surface is seated against the third valve seat of the secondary piston thereby closing the orifice formed in the secondary piston and the third sealing surface is spaced from the second valve seat of the sleeve to permit communication with the pressure vessel across the orifice of the sleeve, and wherein the primary piston is characterized by a second position wherein the second sealing surface is spaced from the third valve seat of the secondary piston and the third sealing surface is seated against the second valve seat of the sleeve thereby closing the orifice of the sleeve.

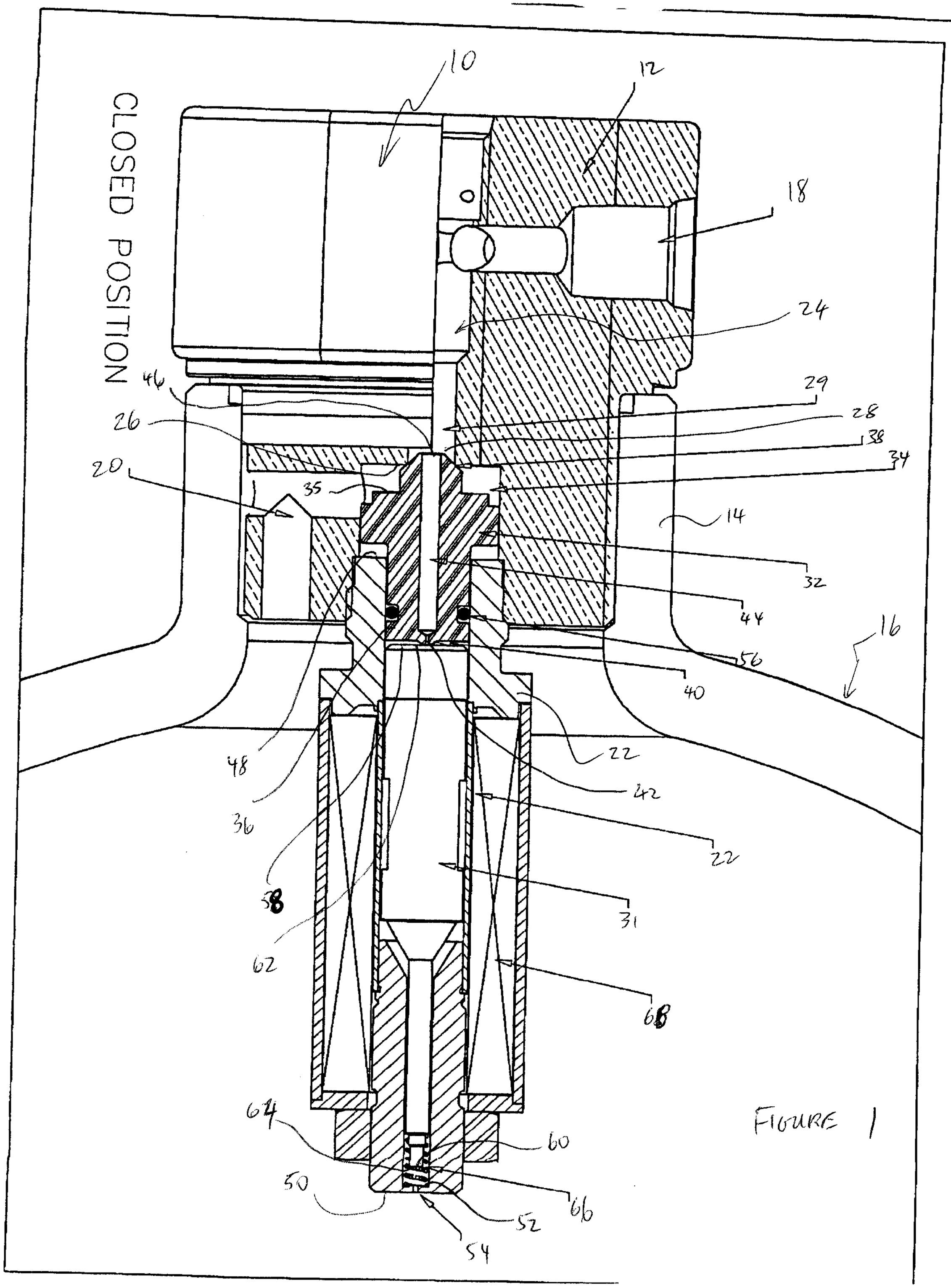
8. The valve as claimed in claim 7 wherein the primary piston is biased towards the first position by a resilient member.

9. The valve as claimed in claim 8 wherein the resilient member is a spring means.

10. The valve as claimed in claim 8 wherein the primary piston assumes the second position by actuation by a solenoid coil.

11. The valve as claimed in claim 1 further comprising an outlet port and a first throughbore, wherein the first throughbore extends from the outlet port to the orifice of the first valve seat, and a manual override valve is disposed between the orifice of the first valve seat and the outlet port for selectively sealing the flow passage.

12. The valve as claimed in claim 1 wherein the secondary piston is comprised of a first part and a second part such that the first part comprises non-magnetic material and the second part comprises magnetic material.


CLOSED POSITION
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54

FIGURE 1

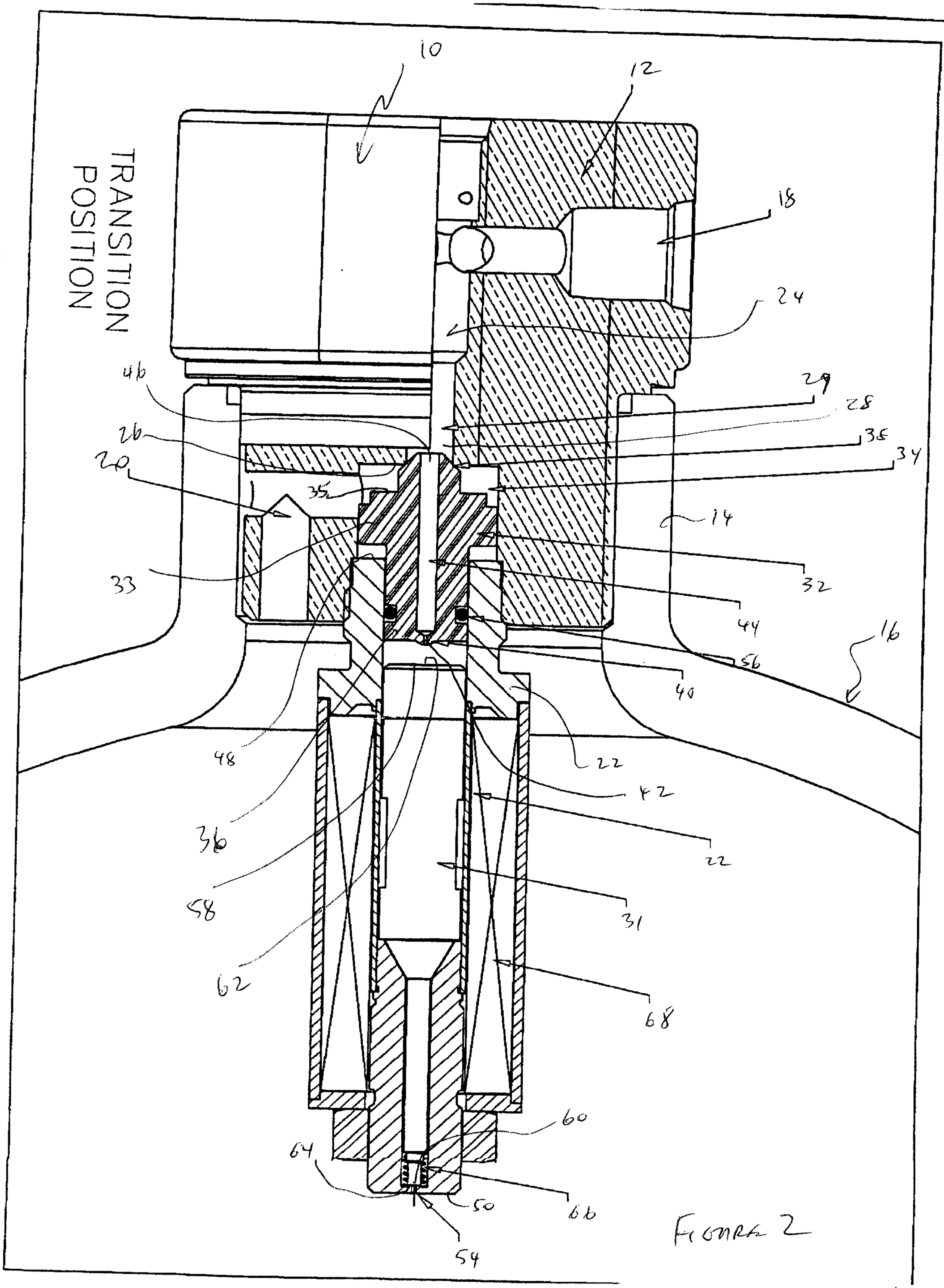
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FIGURA 2

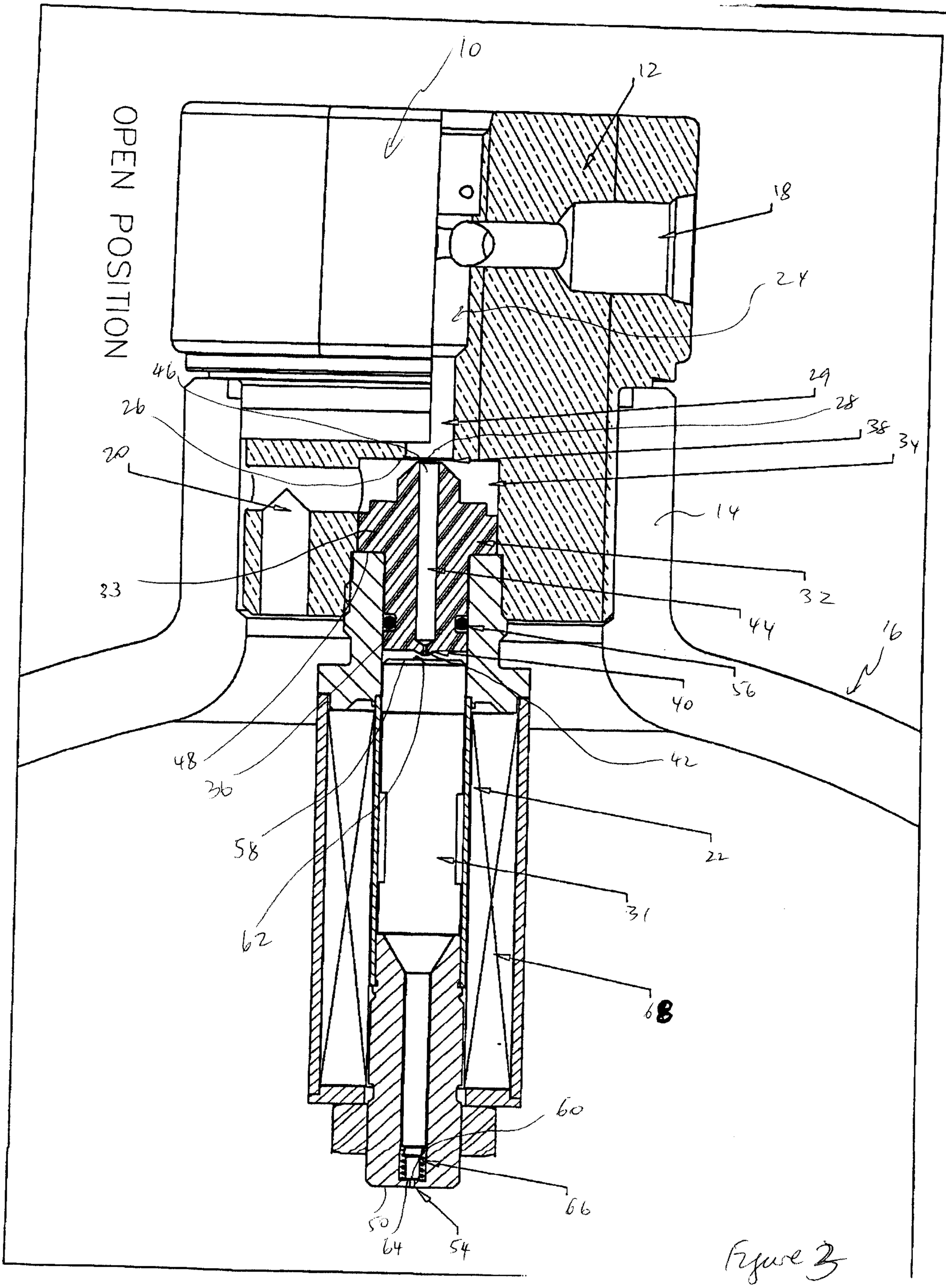
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Figure 3

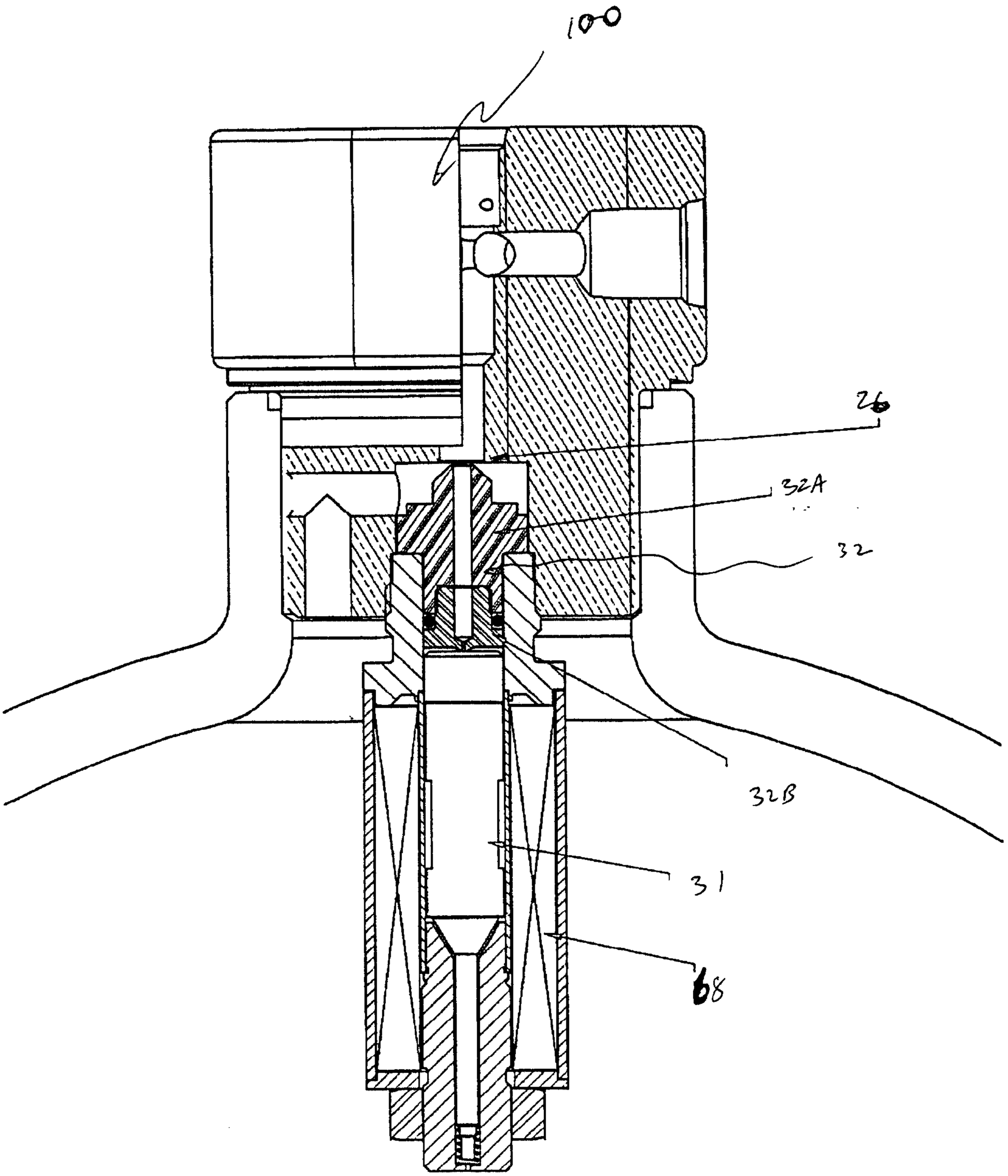

FIGURE 4

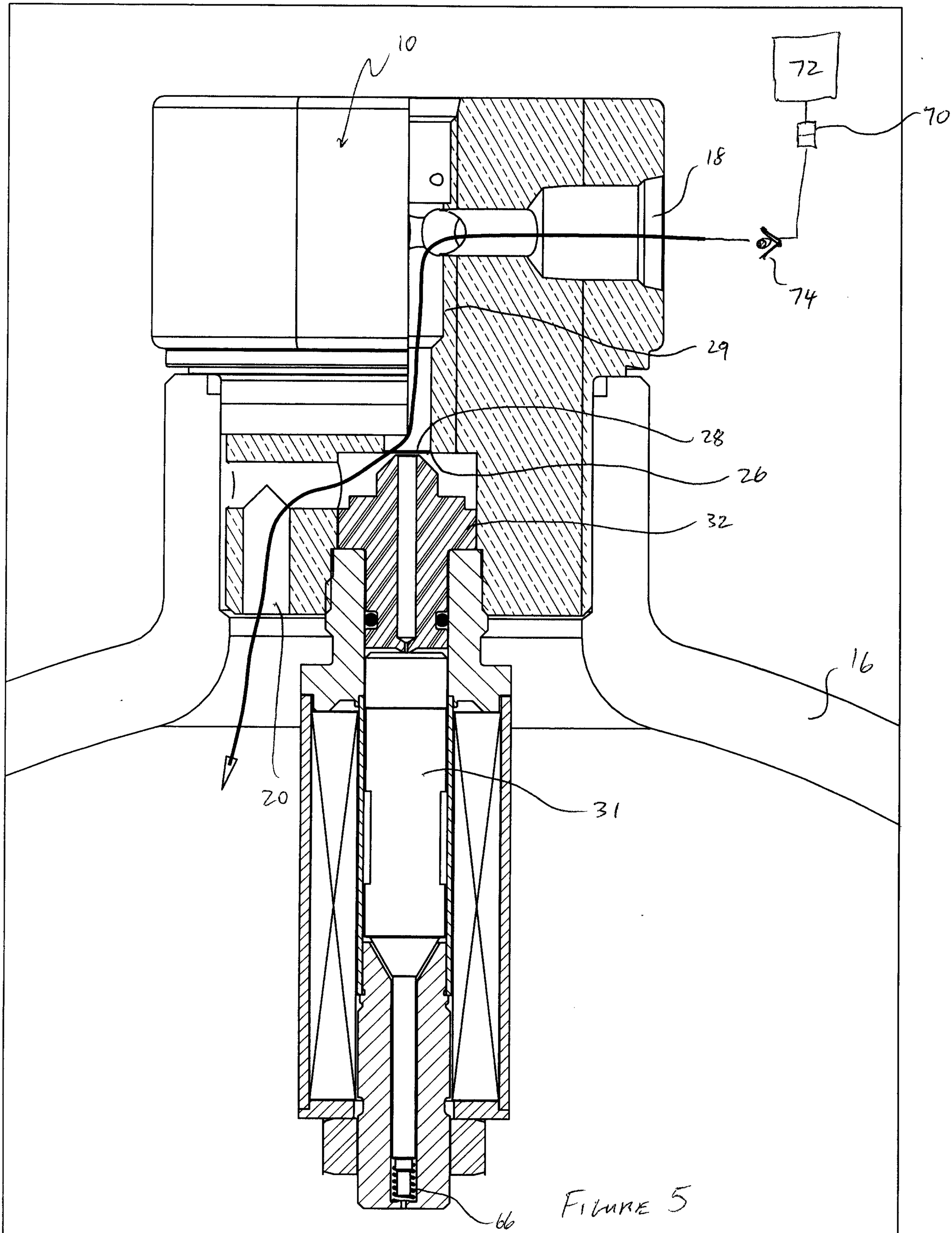

FIGURE 5

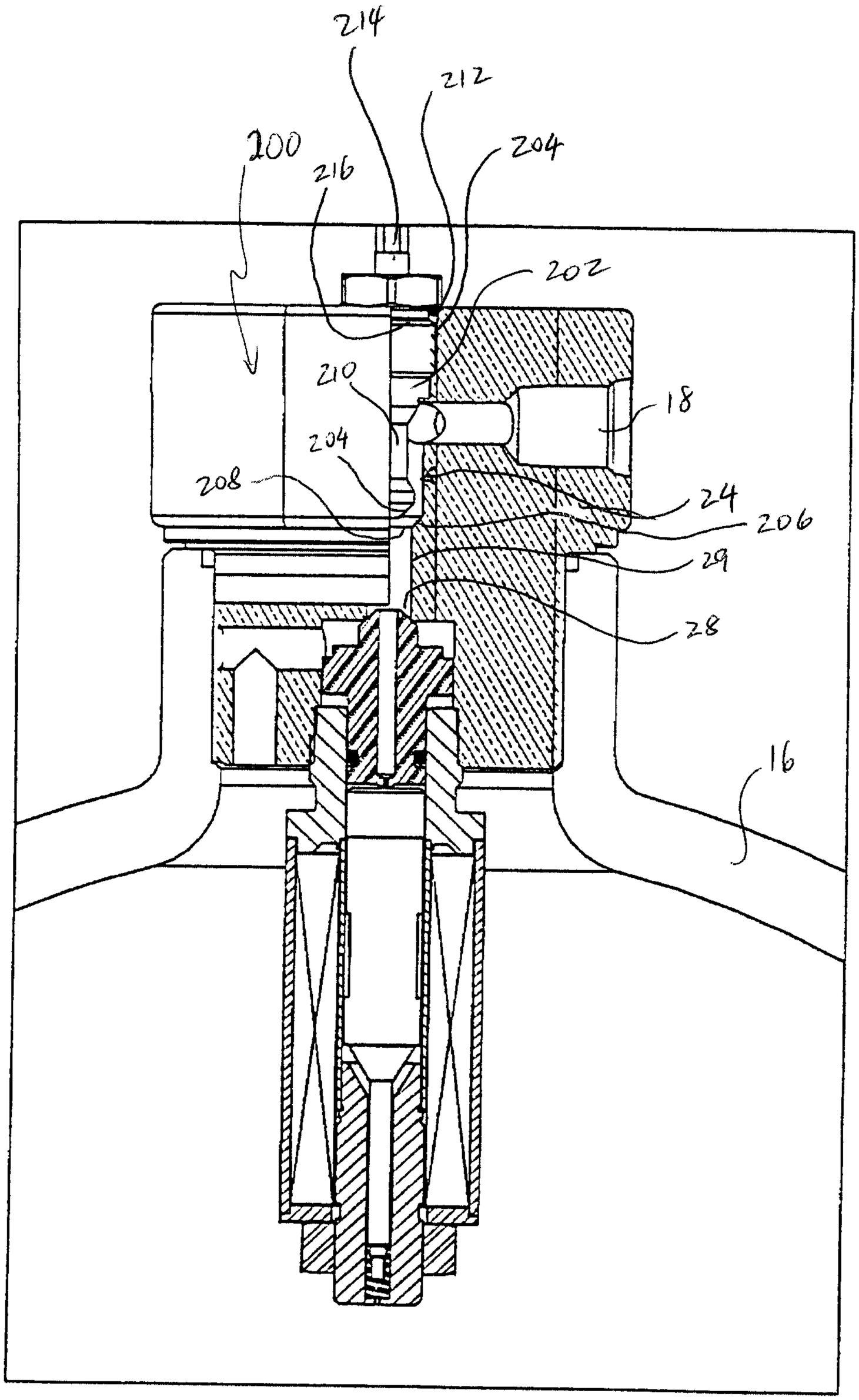

FIGURE 6

CLOSED POSITION