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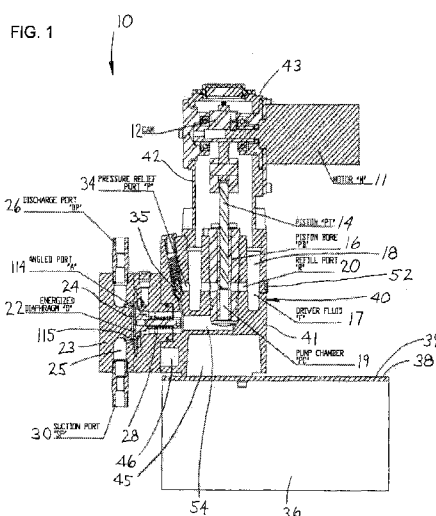
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(54) Title: ENERGY EFFICIENT VARIABLE DISPLACEMENT DOSING PUMP



(57) Abstract: An improved diaphragm type chemical dosing pumps can be designed as both a variable displacement accurate dosing pump and a fixed displacement accurate dosing pump. The improved dosing pump provides a required supply of pressurized fluid, to be called hereafter as process fluid, to an injection point against varying gas or liquid pressures. By eliminating the use of elastomeric sealing, the failing of the pump due to seal wear is eliminated. An internal pressure relief valve protects the pump mechanicals from premature failure. Use of a spring assisted suction assists positive suction for very accurate dosing. The working fluid is a driver fluid that is used to lubricate working components of the pump. The angled ports minimize friction losses to further improve pump efficiency and also eliminate building up of air pockets.

ENERGY EFFICIENT VARIABLE DISPLACEMENT DOSING PUMP

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application asserts priority from provisional application 61/400,392, filed on July 27, 2010 which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to dosing pumps. More specifically, the present invention relates to diaphragm actuated dosing pumps, and particularly variable displacement dosing pumps, which use less energy and/or are subject to reduced cavitation problems compared to many conventional designs. The pump employs a vertical design as opposed to conventional horizontal design which positively influences the refill and depressurization of the driver fluid and thus makes the pump more efficient wherein vertical movement of the piston creates uniform pathways for the lubricating driver fluid around the piston to thereby enhance pump life. Further, the piston never touches the bore so there will be no wear, and the diaphragm is pre-energized so it maintains constant NPSHR which is independent of the positive suction caused by the piston.

BACKGROUND OF THE INVENTION

[0003] Dosing pumps are well known and are used in a wide variety of applications. Dosing pumps have commonly been employed in industrial applications where very accurate dosing is expected. Traditionally piston pumps were used in gas field applications which were powered by compressed air or pressurized sour gas. They are not very precise or energy efficient and moreover, the vented sour gas is an environmental hazard.

[0004] However, while this type of dosing pump, and in particular diaphragm actuated pump, can provide several advantages over piston type pumps or other pumps, they do suffer from some disadvantages. In particular, diaphragm dosing pumps can break down if a suction or discharge port is blocked during operation and/or can suffer from cavitation effects which, over time can damage components of the pump and especially the diaphragm.

[0005] This prompted an invention of a pump powered by renewable energy which can work efficiently for months without having to be repaired or requiring replacement of the seal. This also prevents over pumping of the process fluid and thus saves costly chemicals and also avoids polluting the land where it is pumped into.

[0006] It is an object of the present invention to provide a novel dosing pump which obviates or mitigates at least one disadvantage of the prior art.

SUMMARY OF THE INVENTION

[0007] According to a first aspect of the present invention, a dosing pump is provided for pressurizing a driver fluid, comprising: a pump housing with a pumping chamber and having an inlet port and an outlet port in fluid communication with a pump head on the pump process side; a piston reliably mounted within the pump chamber and having an eccentric cam rotating inside the pump chamber and being mounted concentrically with respect to the pump chamber such that the rotation of the cam pushes the piston in and out of the pumping chamber causing the diaphragm to successively move forward and reverse inside the pump to cause the process liquid to enter the inlet port of the process side head and be expelled through the outlet port as the motor rotates. The motor operates to rotate the cam and in turn reversibly pushes or drives the piston to pressurize the driver fluid which drives a balanced diaphragm to thereby pressurize the process fluid by means of the balanced diaphragm.

[0008] The pump includes a refill port, relief port and a pumping chamber wherein the refill, relief and the pumping chamber are connected which eliminates the need for multiple areas for supply and storage of operating fluid.

[0009] The present invention provides a novel and useful improvement to dosing pumps, both variable displacement dosing pumps and fixed displacement dosing pumps, by providing a means of pressure equalization and refill from the same port. Pressure relief is against the gravity and gravity assisted refill further increases the efficiency of the pump.

[0010] Other objects and purposes of the invention, and variations thereof, will be apparent upon reading the following specification and inspecting the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Preferred embodiments of the present invention will now be described, by way of example only, with reference to the attached figures, wherein:

[0012] Figure 1 is a side cross sectional view of a dosing pump of the invention.

[0013] Figure 2 is a perspective view thereof.

[0014] Figure 3 is an enlarged cross-sectional of the motor-cam unit.

[0015] Figure 4 is an enlarged cross-sectional view of the pump chamber.

[0016] Figure 5 is a partial perspective view thereof.

[0017] Figure 6 is an end view of a bearing-cam assembly.

[0018] Figure 7 is a side cross-sectional view as taken along section line 8-A of Figure 6.

[0019] Figure 8 is a side view of a liner sleeve sub-assembly for the diaphragm pump.

[0020] Figure 9 is a cross-sectional view thereof as taken along line B-B of Figure 8.

[0021] Figure 10 is a connecting rod sub-assembly.

[0022] Figure 11 is an end view of the connecting rod sub-assembly.

[0023] Figure 12 is an end view of a front bearing holder sub-assembly.

[0024] Figure 13 is a side cross-sectional view as taken along line 13-13 of Figure 12.

[0025] Figure 14 is an end view of a head sub-assembly.

[0026] Figure 15 is a side cross-sectional view of the head sub-assembly as taken along line 15-15 of Figure 14.

[0027] Certain terminology will be used in the following description for convenience and reference only, and will not be limiting. For example, the words "upwardly", "downwardly", "rightwardly" and "leftwardly" will refer to directions in the drawings to which reference is made. The words "inwardly" and "outwardly" will refer to directions toward and away from, respectively, the geometric center of the arrangement and designated parts thereof. Said terminology will include the words specifically mentioned, derivatives thereof, and words of similar import.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Before describing the present invention, prior art variable displacement dosing pumps generally have included a closed housing with a cam rotated by a drive shaft causing a reciprocating movement of the piston in the pumping chamber causing a driver fluid to be pressurized and depressurized and thus creating movement of a diaphragm. These known diaphragm pumps work horizontally causing inefficient refill and piston lubrication.

[0029] Generally, as to the present invention, Figure 1 illustrates an inventive diaphragm pump 10 which includes a motor "M" 11 that rotatably drives a cam 12 at a desired speed to move piston "PT" 14 vertically downwardly and upwardly inside the piston bore "PB" 16. A driver fluid "F" 17 is provided in a driver fluid chamber or reservoir 18 so as to communicate with a pump chamber "PC" 19 of the piston bore 16, wherein the driver fluid 17 enters through a refill port 20 that opens sidewardly or radially into the piston bore 16 to supply driver fluid 17 into the pump chamber 19. With continuing descent of the piston "P" 14 during motor operation, trapped driver fluid 17, which is located in the pump chamber 19 in front of the piston "PT" 14, is pressurized and thereby pressurizes an energized diaphragm "D" 22 movably supported in a pump head 23. Pressurized diaphragm "D" 22 moves forward into a process fluid chamber 24 and pushes out the process fluid 25 through a discharge port "DP" 26.

[0030] During the upward return stroke of the piston "PT" 14, the pressurized driver fluid 17 is depressurized when the piston 14 clears the refill port "R" 20. The diaphragm "D" 22 moves back to its original position by an attached spring 28 and a precise amount of process fluid 25 is filled inside the process chamber through the suction port "SP" 30. The discharge port 26 and suction port 30 are controlled by check valves so that process fluid flow is from the suction port 30 through to the discharge port 26.

[0031] In case of accidental overpressure of the driver fluid 17 behind the energized diaphragm "D" 22, a pressure relief port "P" 34 is provided which is controlled by a spring-biased pressure relief valve 35 that opens when overpressure is encountered to allow the excess driver fluid 17 to flow there through causing excess pressure to be expelled out into the driver fluid chamber 18 which is in fluid communication with the relief port 34.

[0032] In more detail as to Figure 1, the pump 10 comprises a generally U-shaped base plate 36 that is mountable to any suitable support surface by mounting flanges 37. The base plate 36 also includes a plate-like pump support 38 defining an upward-facing support surface 39. The pump

10 further comprises a housing unit 40 which comprises a main housing 41 that is directly mounted to the pump support 38. The top of the main housing 40 supports an intermediate housing body 42 which in turn supports an upper housing body 43. One side of the main housing 40 also supports the pump head 23 as will be described further.

[0033] First as to the main housing 40, as seen in Figures 1, 2 and 4, the main housing has a bottom end formed with a first chamber or pocket 45, and a second chamber or pocket 46. The first chamber 45 provides an air space between the base 36 and the portion of the main housing 40 that is disposed next to the piston bore 16 and pump chamber 19 which helps insulate these cavities from the surrounding environment. Similarly, the second chamber 46 is located next to the pump head 23 and provides additional thermal separation between the pump head 23 and the remaining portions of the main housing 40.

[0034] The main housing 40 includes an outer housing wall 48 and an inner chamber wall 49 which is radially spaced inwardly from the outer wall 48 to define the driver fluid reservoir 18 radially therebetween. The fluid reservoir 18 thereby has an annular shape surrounding the inner chamber wall 49. The outer wall 48 also includes a bore 51 which normally is closed by a set screw 52 (Figure 1) but is removable to help indicate the level of the driver fluid 17 within the reservoir 18.

[0035] The inner wall 49 further defines an open-ended central bore 53 (Figure 4) which opens vertically upwardly into the intermediate housing body 42 and opens downwardly into a transverse fluid passage 54 that allows the driver fluid 18 to flow transversely from the pump chamber 19 to the diaphragm 22 for operation thereof by reciprocation of the piston 14.

[0036] The transverse fluid passage 54 therefore has an inner end 55 receiving driver fluid 17 from the pump chamber 19, and an outer end 56 that widens into a secondary passage 55 so as to open into and fluidly communicate with the pump head 23 as will be described further hereinafter. Since the fluid passage 54 receives pressurized driver fluid 17, this fluid 17 is then able to communicate with the diaphragm 22 through communication with the secondary fluid passage 55.

[0037] If the fluid is over-pressurized, the aforementioned relief port 34 is provided that opens radially through the outer housing wall 48. In particular, the outer housing wall 48 includes an enlarged valve section 56 that is provided with a vertically elongate passageway 57 comprising a valve seat 58 that receives the tapered or pointed valve body 35A (Figures 4 and 5) of the relief valve 35 therein. This passageway 57 has a tapered inner end 59 that cooperates with the tapered end of the relief valve 35 so as to selectively block fluid flow therethrough. The passageway 57 at this location further communicates with a relief passage 60 that opens radially downwardly into the secondary fluid passage 55 described above. During over-pressurization, the driver fluid 17 is able to enter the relief passage 60 to unseat or move the relief valve body 35A upwardly away from the tapered passage end 59 and allow the driver fluid 18 to flow into the passageway 57, into the relief port 34 and then into the driver fluid reservoir 18 described above. Normally, the valve body 35A is maintained in a closed position by a spring 61 which allows the relief valve 35 to selectively open and close while automatically returning the valve 35 to the normally closed position. The spring force also sets the maximum pressure of the driver fluid 17 before pressure is released.

[0038] The passageway 57 is enclosed by a valve cap or closure 62 which prevents leakage of the driver fluid 17 from the passageway 57. As such, the relief valve 35 allows excess driver fluid 17 to be automatically returned to the reservoir 18 without affecting the desired operating pressure of the driver fluid 17 when operating the diaphragm 22. Once the operating pressure is returned to the desired operating level, the valve 35 would automatically close in response to the spring 61 or other biasing or closing means.

[0039] For the pumping operation, the inner chamber wall 49 is provided with a plurality of the refill ports 20 which are circumferentially spaced apart and open radially through the entire thickness of the inner wall 48.

[0040] To define the pump chamber 19 and piston bore 16, the inventive pump 10 includes a liner sleeve sub-assembly 65 (Figures 4, 8 and 9) which slidably fits downwardly into the central bore 53. The liner sleeve assembly 65 comprises a cylindrical holder 66 having an upper mounting flange 67, which includes a fastener bore 68 that allows for secure engagement to the inner chamber wall 49. The outer surface of the holder 66 includes circumferential grooves 69 that receive seals like O-rings therein to seal the holder 66 relative to the inside surface of the

central bore 53. The holder 66 includes a long cylindrical liner or sleeve 71 which is preferably formed of steel and defines the pump chamber 19 at the bottom end 72 thereof and the piston bore 16 at the upper end 73 thereof. To allow for entry of the driver fluid 18 through the refill ports 20 into the pump chamber 19, respective liner ports 75 and holder ports 76 are provided on diametrically opposite sides of the liner 71 and holder 66 so as to thereby align with the refill ports 20 and essentially define radial extensions of the refill ports 20. Hence, reference to the refill ports 20 herein comprises the actual ports 20 formed in the inner chamber wall 49 as well as the port extensions defined by the liner ports 75 and holder ports 76 which together define continuous radial passages between the reservoir 18 and the pump chamber 19.

[0041] As seen in Figure 4, piston 14 at the top end of stroke clears the refill ports 20 at least partially so as to allow a balanced level of the driver fluid 17 which can flow into the pump chamber 19 if necessary through the refill ports 20. During downward travel during the pump stroke, the bottom end of the piston 14 extends into the pump chamber 19 as diagrammatically represented by reference line 78 which thereby causes the piston 14 to close the refill ports 20 and drive the fluid 17 out of the pump chamber 19 and into the transverse fluid passage 54 for driving operation of the diaphragm 22. As the piston 14 travels upwardly through its return stroke, the bottom end of the piston 14 eventually clears the refill ports 20 at least partially to then release any fluid pressure in the pumped or driven fluid and allow the driver fluid 18 to refill the pump chamber 19 for subsequent pumping. Reciprocating operation of the piston 14 thereby causes the driver fluid 18 to reciprocatingly drive the diaphragm 22 as will be described further herein. All of the refill ports 20, pump chamber 19 and pressure relief port 34 are in common communication with the reservoir 18 so that separate systems are not required to accommodate the separate functions of refilling the pump chamber 19, driving the driver fluid 17 with the piston 14, and releasing over-pressurization through the relief valve 35. Further, it is not necessary to seal the driver fluid 17 within this fluid system so that wear-susceptible seals between the piston 14 and the liner 71 are avoided, which avoids any wear problems or leakage of fluid which might occur if a piston were to require elastomeric seals or other types of seals to prevent leakage of a driven fluid.

[0042] To effect driving of the piston 14, the motor 11 is provided with a cam assembly 79 (Figure 3) which connects a rotatable drive shaft 80 of the motor 11 with the piston 14. More particularly as to Figures 10 and 11, the piston 14 is formed as part of a piston sub-assembly 81

which comprises a piston rod 82 that mounts within a support bracket 83. The support bracket 83 includes a connector pin 84 that pivotally joins the support bracket 83 to a drive collar 85 having a central cam-receiving bore 86 extending there through.

[0043] Referring to Figures 3 and 4, the motor drive shaft 80 is supported by a first bearing 88 that provides support to the shaft 80 on the upper end of the upper housing body 43. The bearing 88 is supported within a motor flange 89 that in turns mounts with the motor 11 to the housing body 43 by mounting plate assembly 90. The inboard free end of the motor shaft 80 supports a cam sub-assembly (Figures 3, 6 and 7) for driving operation of the piston assembly 81. In particular, the cam assembly 79 has a cam body 91 through which passes a central axis 92 that defines a rotation axis 93 for the cam assembly 79 during shaft rotation. The motor-driven end of the axle 92 includes a shaft-receiving bore 94 that receives the motor shaft 80 therein (Figure 3) which is then secured therein by a set screw 95. This end of the axle 92 has the bearing 98 mounted thereon to support such end, while the axle 92 has a free end 97 opposite the driven end 96 which is configured to receive an additional bearing 98 thereon.

[0044] To drive the piston assembly 81, the cam body 91 is formed with an outer, radially-projecting hub 99 that has a circular outer surface which extends about a center hub axis that is positioned eccentric to the rotation axis 93. As such, the hub 99 is formed eccentrically relative to the shaft axis 93 so that the hub 99 effectively works as a cam. The circular hub 99 is rotatably fitted within the circular bore 86 of the drive collar 85 so that rotation of the cam body 91 causes reciprocating vertical motion of the piston assembly 81 during rotation of the motor shaft 80.

[0045] Referring to Figures 3, 12 and 13, the axle end 97 is supported by a bearing sub-assembly 101 which comprises a mounting cover 102 formed with a shallow bearing seat 103 for receiving the aforementioned bearing 98 therein. The bearing seat 103 includes a spring 104 to ensure proper axial positioning of the bearing 98. The cover 102 has an outer mounting flange 105 formed with holes for receiving fasteners there through that secure to the upper housing body 43.

[0046] Next as to Figure 3, the upper housing body 43 also includes a removable top cap 106 that allows for the driver fluid 17 to be poured into the open vertical column or passageway defined internally by the intermediate housing body 42 and upper housing body 43. Preferably,

the driver fluid 17 is any suitable type of oil or other working fluid which can be poured through the top cap 106 to appropriately fill the reservoir 18 to the appropriate level indicated by the set screw 52. Other types of fluids are suitable. Since this fluid is able to flow freely into and around the various components including the piston 14 itself, the driver fluid 17 not only serves as a pump driver for the diaphragm 22, but also serves as a lubricant that lubricates the movable components including the piston 14 as it moves relative to the opposing interior surface of the steel liner 71 and the interior liner surface which forms the piston bore 16 and pump chamber 19.

[0047] Next as to the pump head 23, said pump head 23 is best illustrated in Figures 5, 14 and 15. The pump head 23 comprises an inner head body 110 and an outer head body 111 which define opposing interior faces 112 and 113 defining an interface therebetween. The surfaces 112 and 113 have central cavities which face in opposing relation and define a circular, thin cavity that defines the process fluid chamber 24. The fluid chamber 24 on the outboard side communicates with the discharge port 26 and suction port 30 by angled ports 114 and 115, wherein the angled ports minimize friction loss so as to further improve pump efficiency and also eliminate build-up of air pockets. The inner and outer head bodies 110 and 111 are joined together by fasteners 117 extending through fastener bores 118. The outer head body 111 also includes an indicator 119 showing the flow direction which would be dictated by the check valves in the discharge port 26 and suction port 30.

[0048] The diaphragm 22 preferably comprises a flexible, circular disk 121 which is formed from elastomeric Teflon and has an outer rib 122 that seats within opposing grooves formed in the head body faces 112 and 113. The rib 122 is sandwiched or compressed between the interface of the inner and outer head bodies 110 and 110 and defines a fluid-tight seal therebetween. The disk 121 thereby sealingly separates the process fluid chamber 24, which is on the outboard side of the diaphragm 22, from an inner driver fluid chamber 123, which is on the inboard side of the diaphragm 22, such that axial flexing of the diaphragm disk 121 effects variations, i.e. increases and decreases in the volume of the pump chamber 24 and thereby effects pumping operation of the process fluid 25 that passes through the angled ports 114 and 115 into and out of the process fluid chamber 24.

[0049] The diaphragm 122 includes a stainless steel drive head 125 on the driven fluid side which drive head 125 has a connector collar 126 that is threadedly engaged with the shaft 126 of

a bolt 127. The head 128 of the bolt 127 has a spring 129 disposed in compression between the bolt head 128 and a divider wall 130 to normally bias the diaphragm 122 axially rightwardly in Figure 15. This divider wall 130 includes passages 131 (Figure 5) which allows for driver fluid to flow into the driver fluid chamber 123 adjacent the inboard side of the diaphragm 22.

[0050] To mount the pump head 23 to the main housing body 41, the inner head body 110 has an inboard flange 135 which fits in sealed engagement into a corresponding cavity in the main housing body 41 (Figure 2). The flange 135 defines a fluid passage 136 which aligns with and opens into the corresponding fluid passage 55 of Figure 4. As such, the driver fluid 17 during pump operation is driven through the passages 54, 55, 136 and 131, and into the pump chamber 123 so as to pressurize the inboard side of the diaphragm 22 and effect axial displacement or deformation of the central portion of the diaphragm 122 leftwardly in Figure 15 during the pumping stroke of the piston 14. During the return stroke of the piston 14, the driver fluid 17 can then flow out of these passages so that the spring-energized diaphragm 22 is then driven rightwardly by the aforementioned spring 129. The diaphragm 22 therefore is energized to provide for spring-assisted suction of the process fluid into the process fluid chamber 24 during the return stroke which provides for positive suction and very accurate dosing of the process fluid.

[0051] Hence, reciprocating upward and downward movement of the piston 14 causes a corresponding reciprocating horizontal movement of the diaphragm 22 to effect pumping of the process fluid. The improved dosing pump 10 provides a required supply of pressurized process fluid 25 to an injection point even against varying gas or liquid pressures. This pump 10 eliminates the use of elastomeric sealing within the piston configuration, and eliminates failing of the pump due to seal wear. Further the internal pressure release valve 35 protects the pump structures from premature failure, and providing the driver fluids 17 as a lubricant thereby lubricates the working components of the pump.

[0052] The above-described embodiments of the invention are intended to be examples of the present invention and alterations and modifications may be effected thereto, by those of skill in the art, without departing from the scope of the invention which is defined solely by the claims appended hereto.

What is claimed is:

1. A diaphragm dosing pump comprising a pump housing having a process side head including an inlet port in fluid communication with a liquid supply reservoir through a suction valve, and an outlet port in fluid communication with a supply line through a discharge valve configured to be driven in a pumping direction, wherein said pump housing includes a pre-energized diaphragm having a driven side and a driver side, a pump chamber defining a pump piston bore, and a piston in said pump piston bore on the driver side which advances inside the pump piston bore during a discharge stroke, said piston being driven by an eccentric cam housed in the pump housing concentrically with respect to the pump chamber such that as the cam is driven in a pumping direction, a measured volume of driver fluid is pushed by the piston behind the pre-energized diaphragm on the driver side and the pressure is transmitted by the pre-energized diaphragm to a process fluid on the driven side of the pump which is in communication with the inlet and discharge port, and expels a measured amount of process fluid through the discharge port, wherein when the cycle of the piston reverses, the piston moves up in the pump chamber and the pressurized driver side liquid depressurizes as the piston clears the pressure chamber to receive the driver fluid from a reservoir through a refill port.

2. The dosing pump of Claim 1 wherein the pump chamber positively refills automatically by gravity.

3. The dosing pump of Claim 2 wherein a process fluid passageway which is provided between the pre-energized gasket and each of the inlet port and outlet port, and is angled relative to each other in the process side head to eliminate air entrapment and minimize frictional losses.

4. The dosing pump of Claim 3 wherein each said passageway is properly sized to supply a desired volume of process fluid without restriction, to a displacement chamber adjacent the pre-energized diaphragm for being efficiently drawn and expelled through the suction and discharge ports.

5. The dosing pump of claim 4 wherein the dosing pump further comprises a motor drive which rotates the eccentric cam at desired rotation per minute to attain the desired

displacement rate.

6. The dosing pump of claim 1 further comprising a pressure control valve strategically placed at a location within the pump housing, to protect the pump from over pressurization by eliminating excess driver fluid through an energized relief valve to protect the pump mechanical components from damage.

7. The dosing pump of claim 6 further wherein said pressure control valve is in fluid communication with a fluid passage on the driven side of said pre-energized diaphragm and said reservoir to protect the pump from over pressurization by permitting the excess driver fluid to flow through the energized relief valve to the reservoir to protect from damage.

8. A diaphragm dosing pump comprising:
a pump housing having a process side head including an inlet port receiving process fluid, and an outlet port receiving said process fluid from said inlet port and a pre-energized diaphragm which has a driver side and a driven side and operates to pump said process fluid located on said driven side from said inlet port to said outlet port;
said pump housing including a fluid passage on said driver side of said pre-energized diaphragm, a pump chamber defining a pump piston bore which communicates with said fluid passage, and a piston in said pump piston bore on the driver side which advances inside the pump piston bore during a discharge stroke to pump driver fluid into said fluid passage to actuate said pre-energized diaphragm, said piston being driven by an eccentric cam housed in the pump housing such that as the cam is driven in a pumping direction, a measured volume of the driver fluid is pushed by the piston toward the pre-energized diaphragm on the driver side and the pressure is transmitted by the pre-energized diaphragm to the process fluid on the driven side for pumping said process fluid between said inlet port and said outlet port, to thereby expel a measured amount of process fluid through the outlet port, said pump housing including a refill reservoir disposed exteriorly of said pump piston bore and a refill port allowing the driver fluid to flow into said pump piston bore by gravity wherein when the cycle of the piston reverses, the piston moves up in the pump chamber and the pressurized driver side liquid depressurizes as the piston clears the refill port wherein said refill port is unblocked and receives the driver fluid from the reservoir through the refill port by gravity.

9. The dosing pump of Claim 8 wherein the dosing pump further comprises a motor drive which rotates the eccentric cam at desired rotation per minute to attain the desired displacement rate.

10. The dosing pump of Claim 8 further comprising a pressure control valve strategically placed at a location within the pump housing, to protect the pump from over pressurization by eliminating excess driver fluid through an energized relief valve to protect the pump mechanical components from damage.

11. The dosing pump of Claim 10 further wherein said pressure control valve is in fluid communication with a fluid passage on the driven side of said pre-energized diaphragm and said reservoir to protect the pump from over pressurization by permitting the excess driver fluid to flow through the energized relief valve to the reservoir to protect from damage.

12. The dosing pump according to Claim 8, wherein said piston moves vertically and said refill port opens sidewardly into said pump piston bore to allow free flow of said driver flow from said reservoir into said pump piston bore.

13. The dosing pump according to Claim 12, wherein said pre-energized diaphragm moves horizontally.

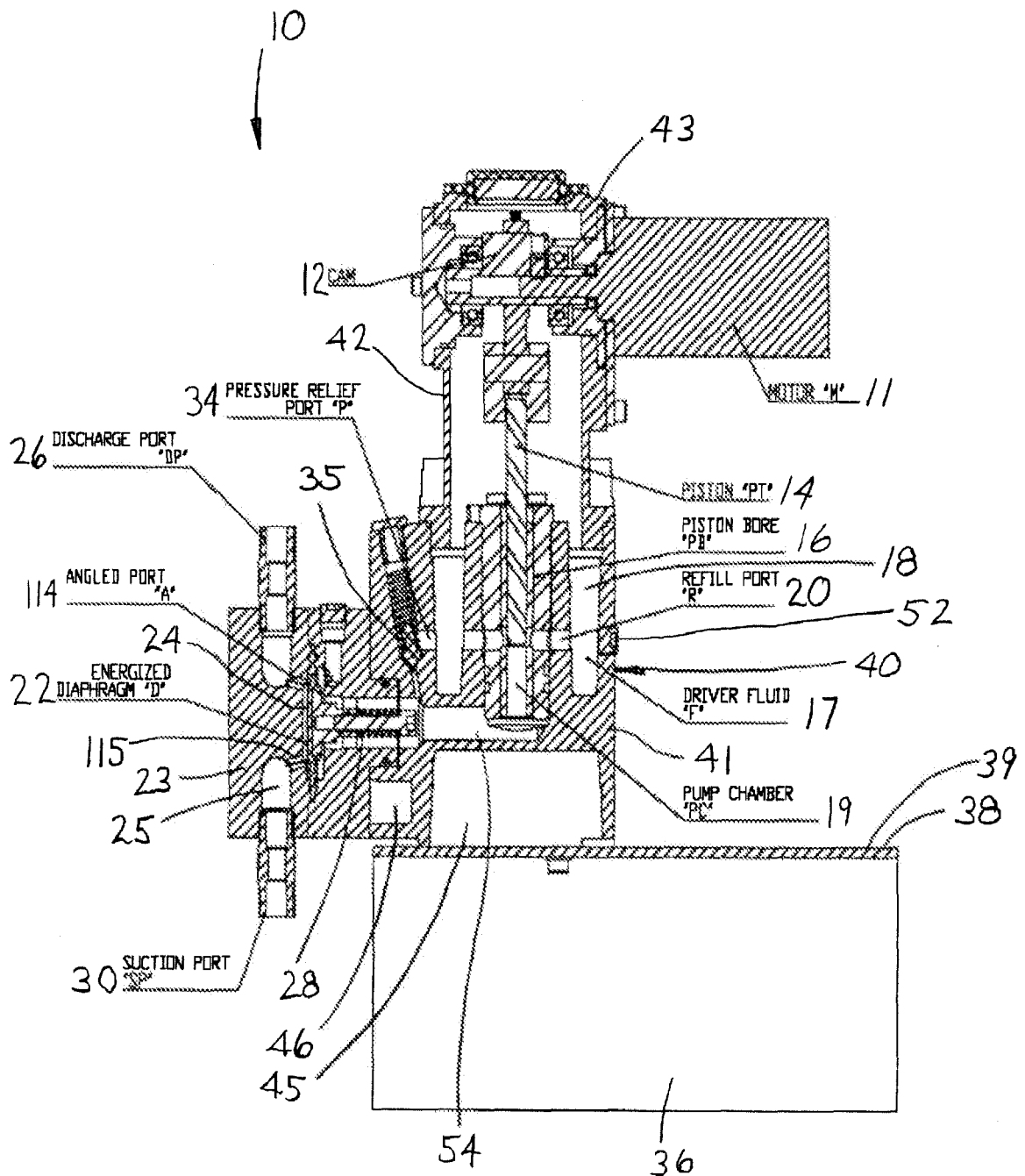
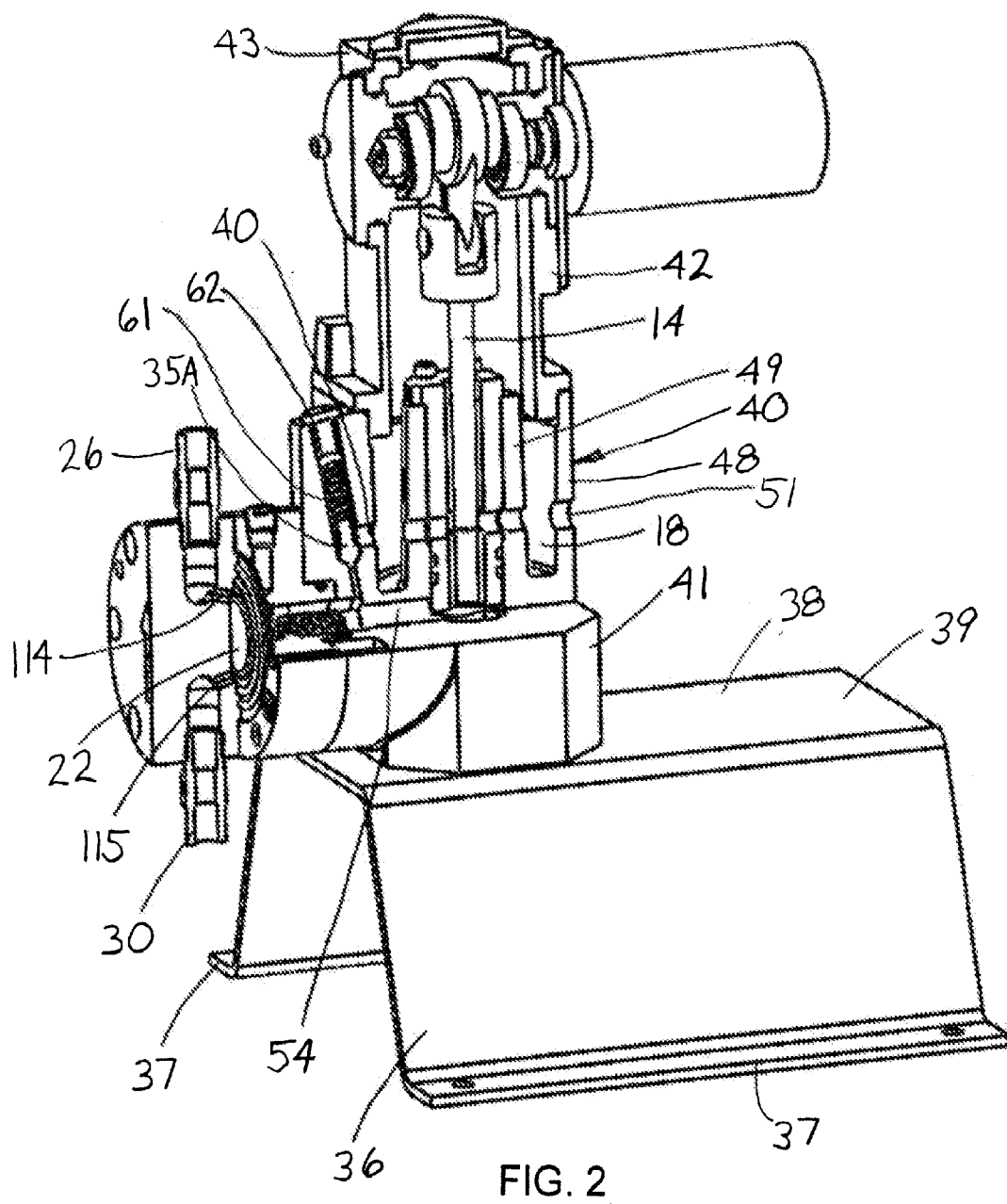
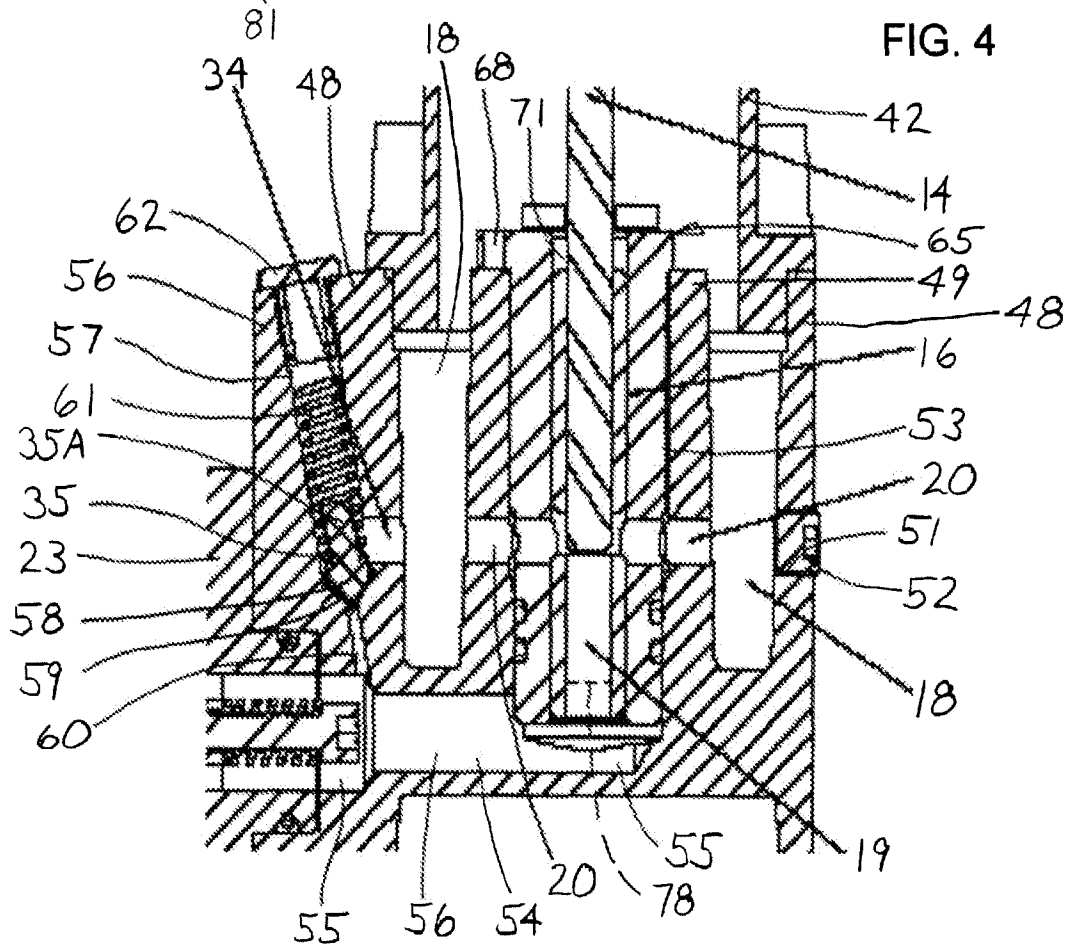
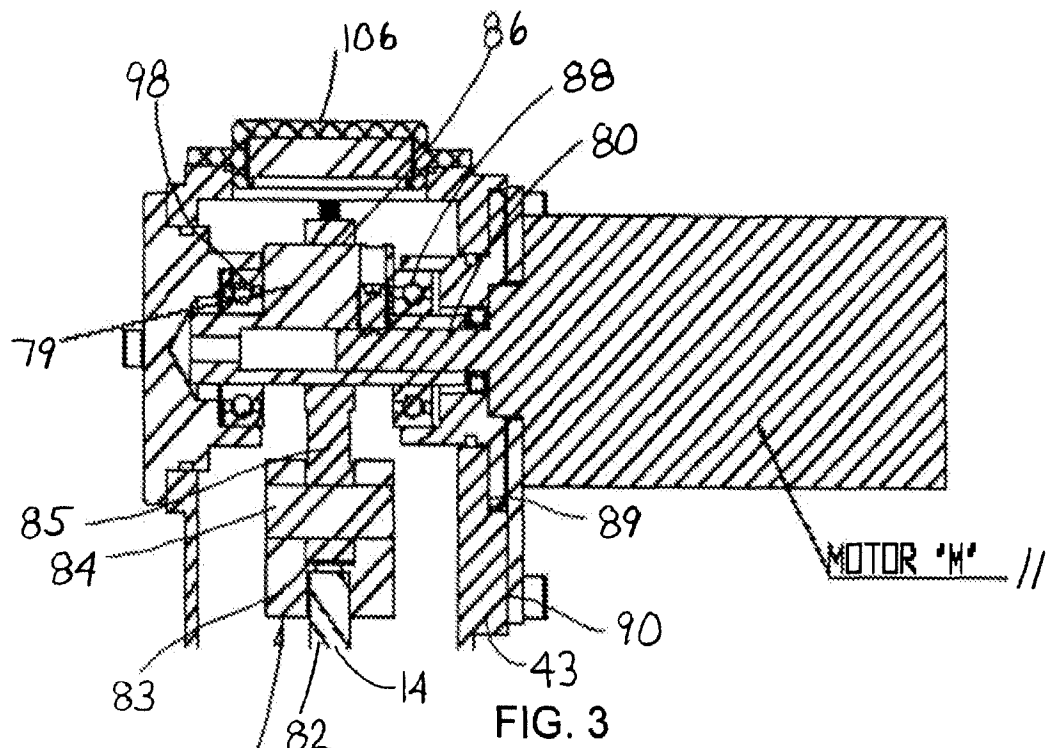


FIG. 1





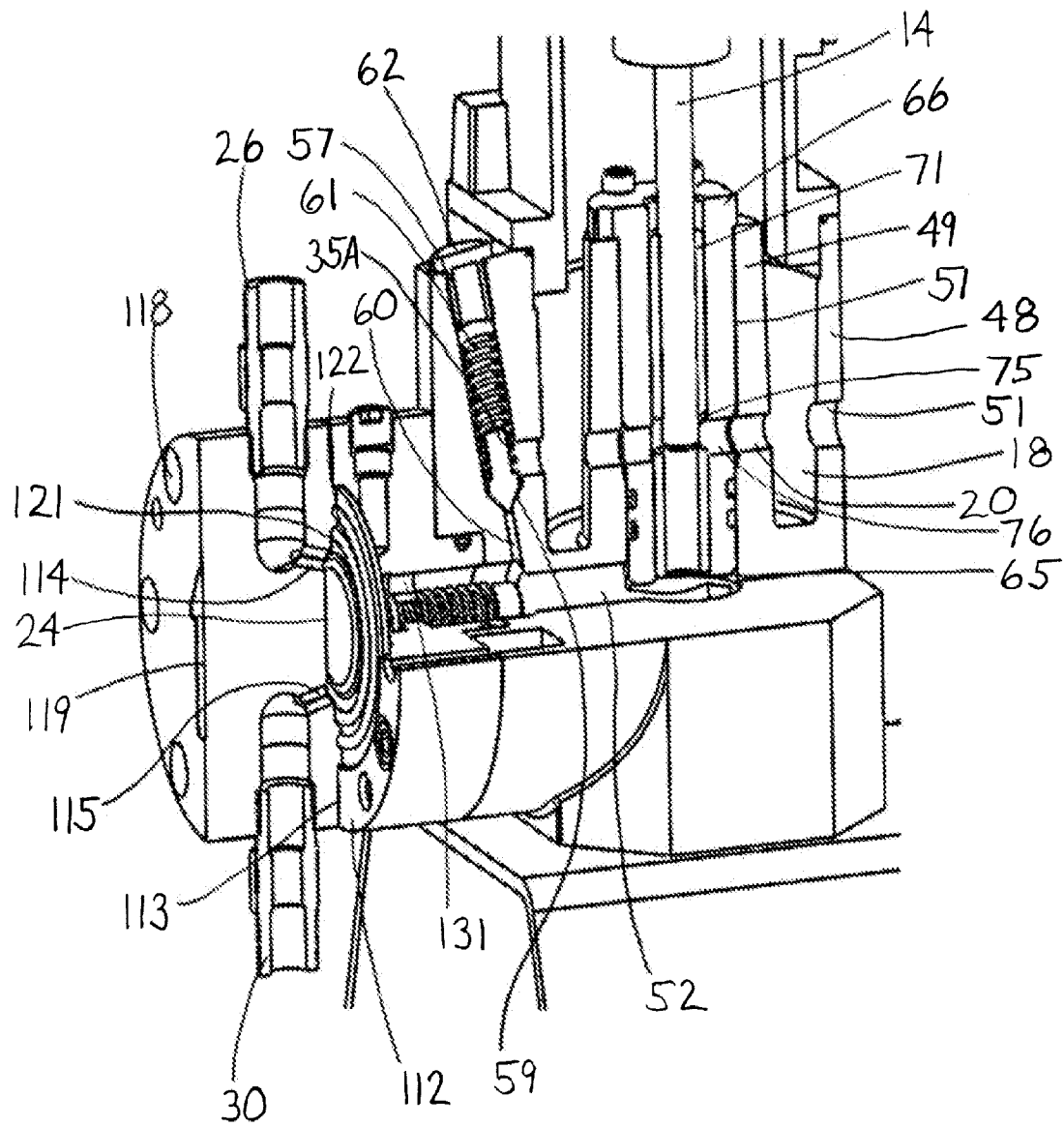


FIG. 5

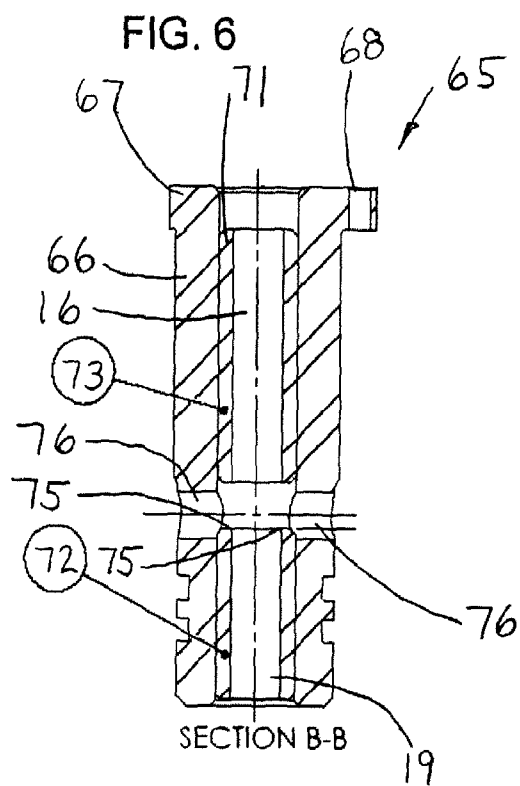
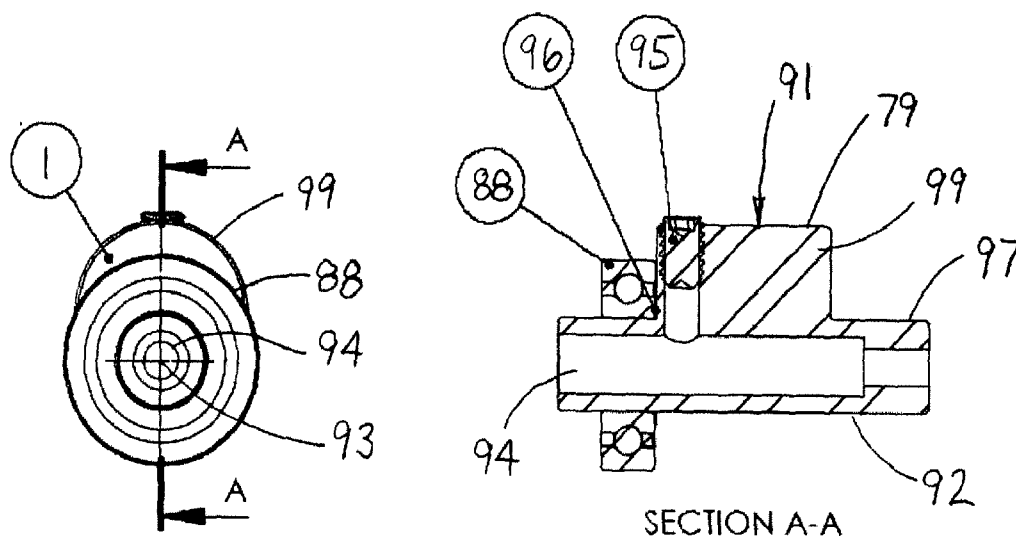


FIG. 9

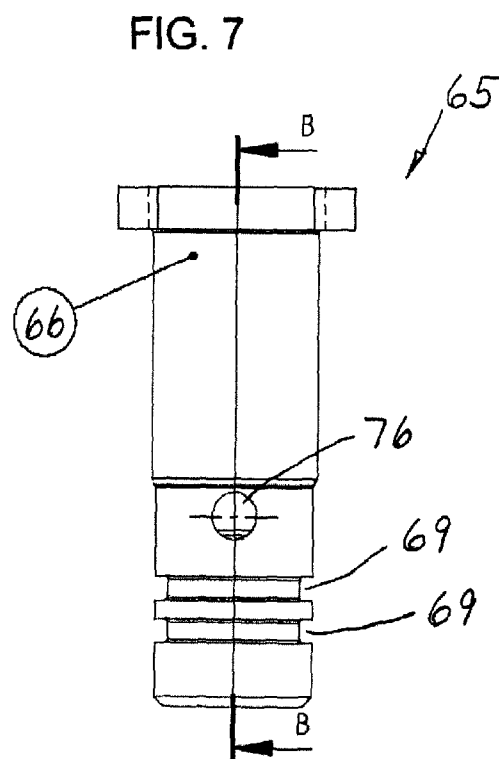


FIG. 8

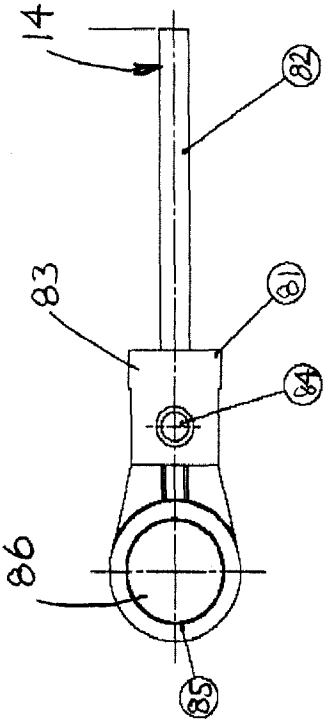


FIG. 10

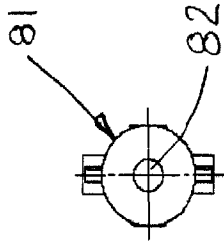


FIG. 11

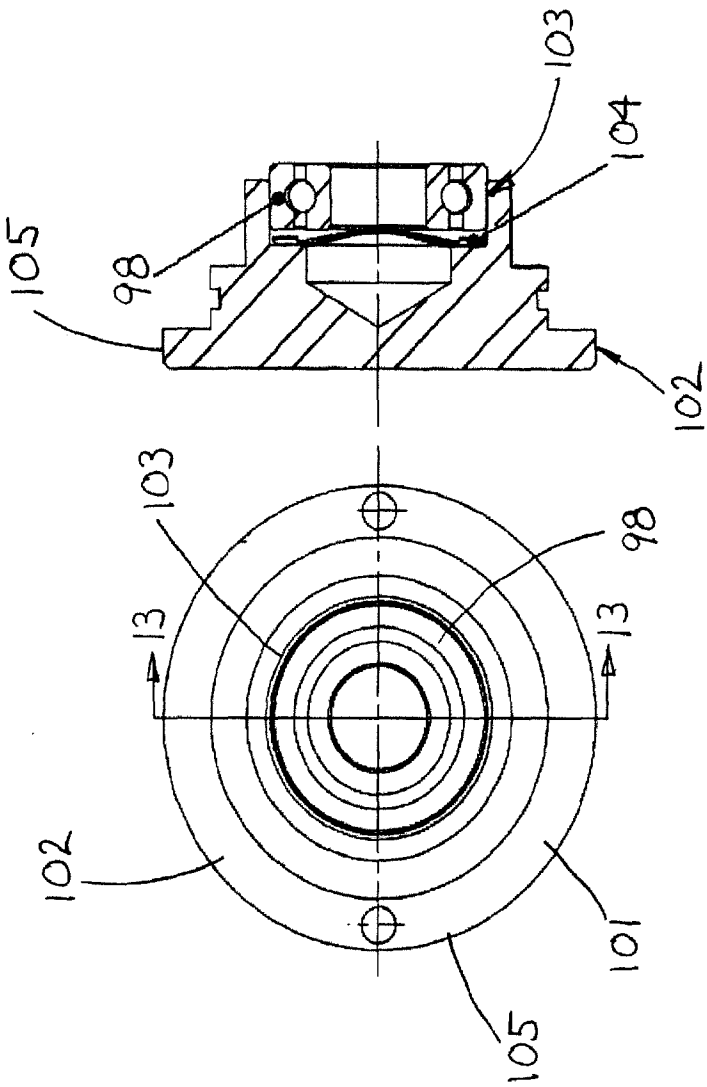


FIG. 13

FIG. 12

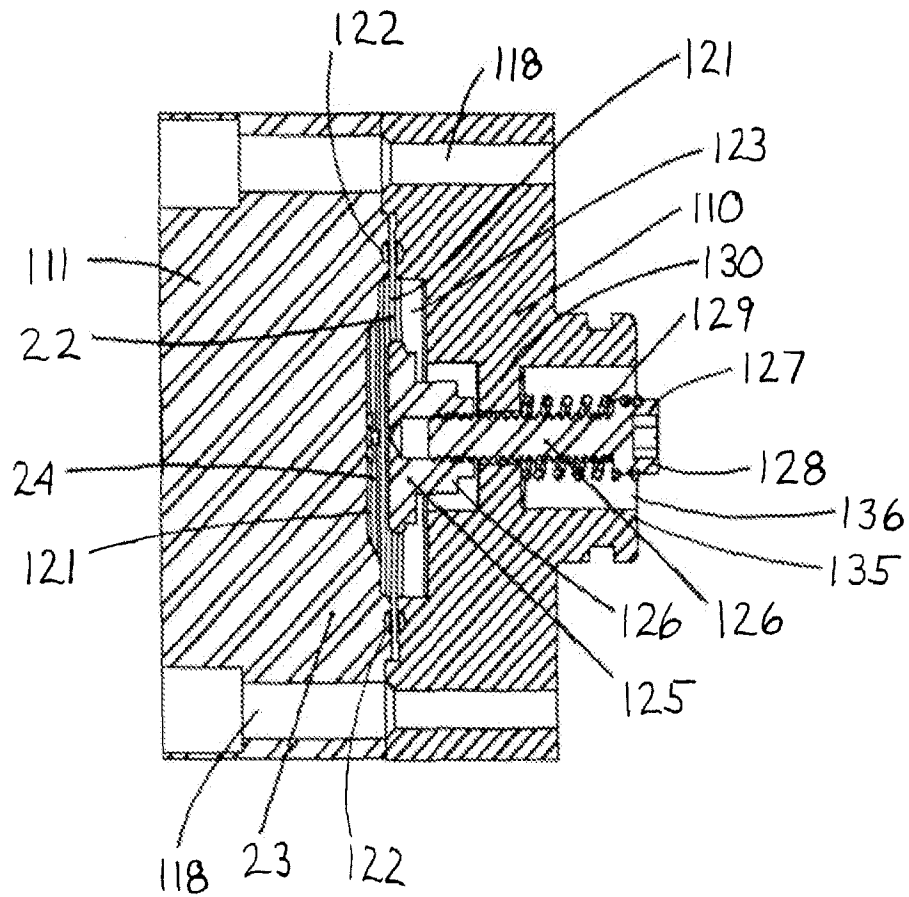


FIG. 15

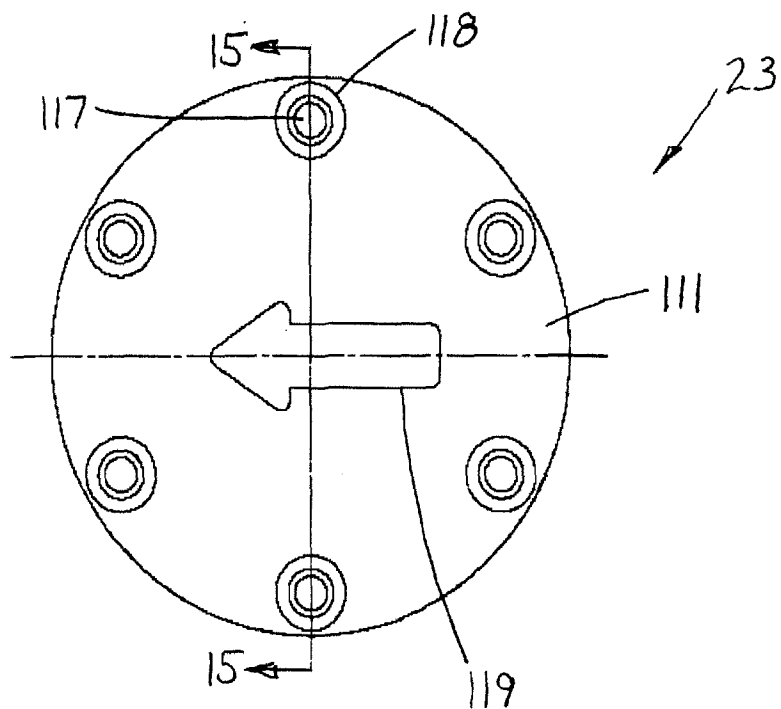


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/045547

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04B43/067
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 20 863 A1 (OTT KG LEWA [DE]) 21 December 1995 (1995-12-21) column 3, line 37 - column 5, line 16 -----	1-13
A	US 5 860 793 A (MUSCARELLA STEPHEN B [US] ET AL) 19 January 1999 (1999-01-19) claim 1 -----	1,8
A	US 6 086 340 A (EDWARDS PHILLIP M [US] ET AL) 11 July 2000 (2000-07-11) column 3, line 62 - line 67 -----	1,8
A	EP 0 386 754 A1 (BRAN & LUEBBE [DE]) 12 September 1990 (1990-09-12) column 4, line 37 - column 5, line 7 ----- -/--	1,8

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

17 October 2011

Date of mailing of the international search report

25/10/2011

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/045547

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

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International application No

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