(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 375 920 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.01.2004 Bulletin 2004/01

(51) Int Cl.[7]: **F04B 53/10**, F04B 1/00, F04B 9/04

(21) Application number: **03253726.8**

(22) Date of filing: **12.06.2003**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **21.06.2002 US 177086**

(71) Applicant: **HYPRO CORPORATION**
New Brighton, Minnesota 55112-3288 (US)

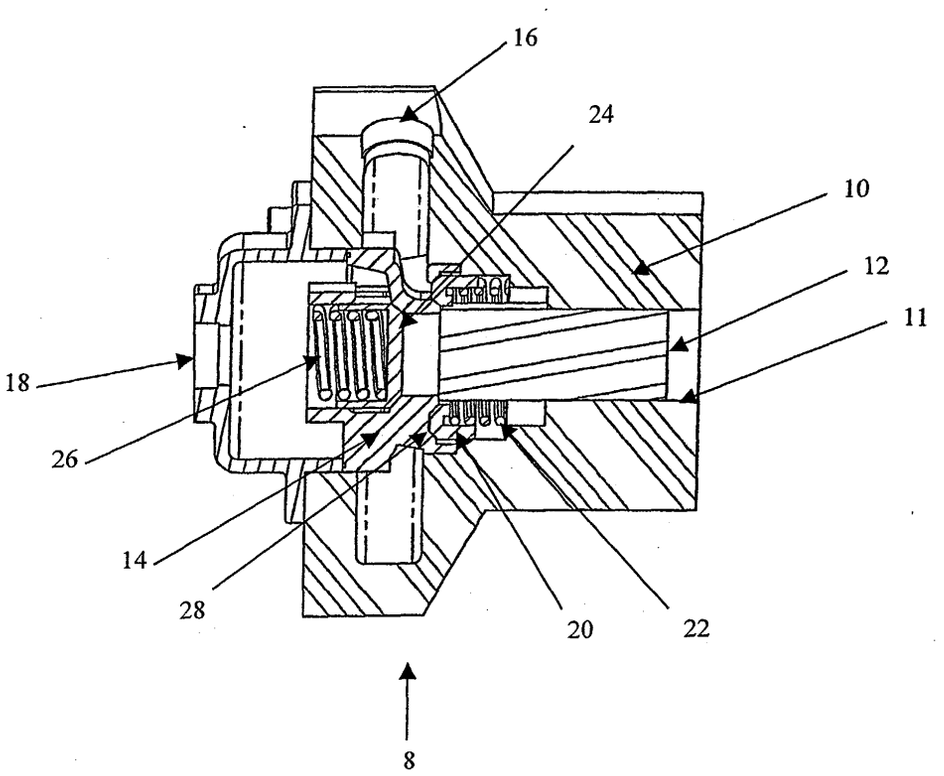
(72) Inventor: **Maki, Bruce A**
Hugo, Minnesota 55110 (US)

(74) Representative: **Charig, Raymond Julian et al**
Eric Potter Clarkson,
Park View House,
58 The Ropewalk
Nottingham NG1 5DD (GB)

(54) Aspiration valve assembly for piston pumps or compressors

(57) A high aspiration compound valve enabling controlled fluid flow from a piston pump. It is comprised of a somewhat cylindrical housing containing a compound valve seat body creating a seal with either a suction valve or a discharge valve based upon the position of the piston's stroke within the housing. Fluid is drawn in during the down stroke of the piston through the open suction valve concentrically placed around the center housing cavity. The fluid is then pumped through the housing by the piston and utilizes a direct in-line discharge valve.

FIG. 1



EP 1 375 920 A1

Description

Background of the Invention

I. Field of the Invention:

[0001] The invention relates generally to a high aspiration compound valve for controlling the flow of fluids to and from a pumping chamber in a piston or diaphragm pump. More particularly, it relates to a compound valve which is part of a positive displacement pump assembly and creates easy suction without great concern for the discharge of fluid forced by the piston. The valve of the invention provides a unique design having a generous area of opening which allow for capable operation of a pump at high speeds when at large displacements or when pumping viscous fluids.

II. Discussion of the Prior Art:

[0002] Typically, positive displacement piston and diaphragm pumps are designed with one of two valve arrangements. These arrangements are either plate porting or valves.

[0003] Plate porting is commonly used in hydraulic pumps having a swash plate drive and operates when the bores in a piston barrel rotate over holes in a precision mounted aperture plate to allow the entry and exit of fluid from the piston. This porting arrangement is only practical for very clean fluids with good lubricating qualities such as highly filtered hydraulic oils.

[0004] Valves are used in piston/plunger and diaphragm pumps having a non-rotating cylinder block. Typically, spring loaded check valves which use balls, disks, or small pistons to enable the opening and closing of a valve are used. For each multi-cylinder piston on a piston pump, two separate valves are used, one for fluid entry, and one for fluid discharge. There are two major problems with traditional valves of this type. First, they pose major restrictions in the entry fluid path to the pump cylinders on the suction stroke. Second, the valve is not mounted directly over a piston bore and is usually on a passage offset from the piston. This mounting position causes further restriction to the entrance of fluid into the piston and cylinder during the suction phase. Additionally, the valve return spring adds to the force required to open the valves.

[0005] In compressors requiring check type valves, similar comments can be made regarding traditional valves. If the gas being compressed is restricted when entering the piston chamber for compression, then the efficiency of the device is compromised.

[0006] Over the years, a wide variety of valve structures, including unitary inlet and outlet valves have been used to control fluid flow. There are several prior art arrangements in which unitary inlet and outlet valves with alternating pressure strokes are utilized.

[0007] Prior art also exists teaching a direct, in-line, suction and discharge poppet valves. The Pareja patent 4,032,263 describes a valve device that is somewhat similar to the present invention, but its construction and operational features are quite different from the present invention. A central difference results from the selection of which component becomes the suction valve and which becomes the discharge valve. In U.S. Pat. No. 4,032,263, the suction valve is the central poppet and the discharge valve is the annular poppet surrounding the central poppet. In the present invention, the situation is reversed. The suction poppet is the annular ring and the discharge poppet is centrally disposed. By making this reversal, the suction characteristics of the new valve design are greatly improved. Generally, the new valve is designed to achieve a larger open area for fluid flow with less restrictions, especially in the suction valve. It is also designed to minimize the valve travel to limit backflow during the reverse of the stroke of the pump having alternating suction and pressure cycles. This permits the pump to operate at higher speeds and increased flow rates.

SUMMARY OF THE INVENTION

[0008] The present invention provides for a high aspiration compound valve for regulating fluid flow to and from a chamber by coordinated interaction between a piston and the compound valve. The compound valve is generally made up of a cylindrical housing into which the piston fits, a valve body which remains stationary within the housing, a discharge valve centrally located, a suction valve annularly located outside the discharge valve, a suction valve return spring, and a discharge valve return spring. The stationary valve body provides two different sets of seats that cooperate with the suction and discharge poppet to seal at least one of either the discharge valve or the suction valve, depending upon the movement of the piston in its reciprocating travel within the cylindrical housing. The above-listed components work together in conjunction with the aid of the discharge valve return spring and suction valve return spring to enable an improved valve design for transferring gas or liquid from the suction inlet of the housing to the discharge outlet. It provides very smooth, relatively turbulent free flow from the pump and is capable of operating at high speeds when at very large displacements or when pumping viscous fluids.

[0009] The combination valve operates by first drawing fluid in the housing during the piston's down stroke when the suction valves are open. Next, when the piston completes travel to the bottom of its down stroke and begins the discharge stroke it rapidly closes due to the combination of the suction valve spring expanding and the flow direction of the fluid in the cylinder reversing. This limits backflow to a minimum, and improves the pump's volumetric efficiency. As the piston/plunger continues upwards motion, the discharge valve is forced open permitting the fluid to flow out of the discharge port.

After the piston reaches the top of its stroke and reverses direction to initiate the suction stroke, the combination of the discharge valve return spring expanding and the reversal in direction of the fluid flow rapidly closes the discharge valve. The piston/plunger will continue the downward stroke and the entire cycle is repeated.

[0010] These and other objects, features, and advantages of the present invention will become readily apparent to those skilled in the art through a review of the following detailed description in conjunction with the claims and accompanying drawings in which like numerals in several views refer to the same corresponding parts.

DESCRIPTION OF THE DRAWINGS

[0011]

Figure 1 is a longitudinal sectional view of the valve assembly in a pump or compressor;
Figure 2 is a perspective exploded isometric view showing the basic valve parts;
Figure 3 is a sectional view of the valve assembly during the suction stroke;
Figure 4 is a sectional view of the valve assembly at the bottom of the suction stroke;
Figure 5 is a sectional view of the valve assembly during the discharge stroke;
Figure 6 is a sectional view of the valve assembly at the top of the discharge stroke.
Figure 7 is a sectional view of an alternative embodiment of the valve assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] The present invention represents broadly applicable improvements for valve design in positive displacement pumps. The embodiments herein are intended to be taken as representative of those in which the invention may be incorporated and are not intended to be limiting.

[0013] Referring first to Figure 1, there is shown in cross-section a valve assembly 8 comprised of a valve housing 10 having a cylinder bore 11, a pump or compressor piston 12, compound valve body 14, suction or fluid inlet port 16, fluid outlet or discharge port 18, suction valve 20, suction valve return spring 22, discharge valve 24, and discharge valve return spring 26. The piston/plunger 12 is reciprocally driven in the cylinder bore 11 by a suitable pump drive assembly (not shown). Those wishing further information on a complete pump design in which the valve arrangement of the present invention are referred to the Maki et al application serial no. _filed_, and entitled "Variable Displacement Positive Displacement Pump", the teachings of which are hereby incorporated by reference.

[0014] Referring next to Figure 2, there is shown a perspective exploded isometric view of the basic valve parts. It is observed that all elements of the compound valve are aligned concentrically around a central axis 27. The valve body 14 has its largest diameter ring segment 34 near its center. In general, the valve body 14 is of a cylindrical shape, containing three ring segments 33, 34, and 36 of differing diameters.

[0015] The individual elements comprising the preferred embodiment will be analyzed more closely, beginning with the suction return valve spring 22 shown in the lower left-hand corner of the drawing of Figure 2 and, moving diagonally upward and to the right.

[0016] The suction valve return spring 22 is a cylindrical, metal, compression spring which is coiled into approximately five convolutions of constant diameter. The spring's outer diameter is slightly less than the inner diameter of the annular suction poppet 20, allowing it to fit within the confines of the annular poppet 20. The diameter of spring 22 is also large enough so that the piston 12 can reciprocate within it during its pumping action without the spring contacting the piston. It is a resilient structure and is fairly resistant to deformation.

[0017] Suction poppet 20 is the element to which the suction valve return spring 22 is joined. The suction poppet 20 is an annular, substantially cylindrical member. One of the distinctive features on the valve includes a lip 28 on the diagonally upward facing end in Figure 2. This lip 28, extends in an inward concentric manner about three times the depth of the outer wall diameter of the suction poppet 20. The lip 28 also extends downward slightly so as to form an annular pocket 30 within the suction poppet 20 inner diameter. This pocket 30 is the abutment point for the suction valve return spring 22. The valve lip also has two concentric, tapered valve seats 29 and 31 for sealing the suction valve 20 along its outermost edges when it closes against a complementary surface of ring segment 32 of valve body 14. The outside and inside valve seats 29 and 31 form a cone-like section on poppet 20 which narrows toward its center and is able to be matched to an opposing seat 33 on the valve body 14 at the proper time in the piston stroke cycle. This is an adaptation of a feature generally known as a conical seat valve. It provides the conical seal on the outside of a ring completely around the annular opening defined by ring segment 32.

[0018] Referring once more to Figure 2, the valve body 14 is made up of three cylindrical rings which are formed into one structure but mounted concentrically and in axially spaced relation by integrally molded ribs or spokes. The basic rings include a lower ring 32, an outer ring 34, and an inner ring 36 that are linked together by a plurality or radial ribs as at 37. As mentioned, the lower ring 32 has a frustoconical tapered seat 33 comprising the suction valve seat. There is also an annular passageway 38 defined by these seats, through which fluid is suctioned in when the valve body seat 33 is not engaged against the suction poppet seats 29 and 31 as shown by the flow arrows in Figure 3.

[0019] The outside ring 34 of the valve body 14 pro-

vides the base for the outside dome-shaped cylindrical wall of the upper discharge chamber 35 of the valve. Concentric with this wall is another cylindrical segment forming inner ring 36, which is co-axially mounted to the walls of outside ring 34 by ribs 37. Inner ring 36 is used to house the discharge poppet 24 and the discharge valve return spring 26. The fluid pumped into valve body 14 will pass between the walls of the outside ring 34 and the walls of the inner ring 36 between the ribs 37. The valve body 14 also contains a valve seat 39 (Figure 3) which mates with the valve seat on the discharge poppet 24. The seat surface of the valve seat 39 tapers concentrically inward from the outer portion of the valve body 14 at the same angle as the taper on the discharge poppet 24.

[0020] Discharge poppet 24 is a cylindrical cup-shaped segment which has a seat surface 41 which is angled inward to form a conical seat. It is capable of sealing against the opposing seat 39 on the valve body 14 when the piston is in the suction stroke of its cycle. Poppet 24 has a relatively thin cylindrical wall thickness with an inner diameter slightly greater than the diameter of the discharge valve return spring 26. As such, the return spring is contained within the cup-shaped discharge valve 24.

[0021] The discharge valve return spring 26 may preferably be a metal spring of a slightly smaller diameter than the suction valve return spring 22. This spring 26 has approximately four convolutions, a constant outer diameter, and, as stated, fits within the inner concentric cylinder of discharge poppet 24. The spring is stationed against the retaining cap 40 and retracts and compresses against it when the piston is in the discharge stroke of the pump cycle.

[0022] The retaining cap 40 is annular and fits tightly against the top of the inner cylinder 36 of the valve body, and contains two grooved surfaces around its outer rim.

[0023] Figures 3-6 illustrate the disposition of the valve parts during the intake and discharge strokes of the pump's piston. In Figure 3, fluid is being drawn in suction port 16 during the down stroke of the piston 12. The fluid is drawn into the lower chamber cavity 42 through an open suction valve 20. Discharge valve 24 remains seated at this point in the cycle.

[0024] The valve housing 10 can also be observed in Figure 3. The lower portion of the housing shown is a cylindrical shape and contains a bore slightly larger than the piston diameter, allowing reciprocating movement of the piston/plunger therein. Moving upward, the interior bore widens to a width wide enough to house the suction valve return spring 22. After only a short distance, the bore in the valve housing widens again to accommodate the outer dimensions of suction poppet 20. In this segment of the bore, the outer diameter of the housing 10 widens outward in a somewhat funnel shape. The interior width of the bore continues for a distance equal to the height of the suction poppet 20 before yet another wider bore is needed to accommodate the bottom of the valve body 14. At an elevation near the completion of this bore diameter, the outer diameter of the housing 10 regains a vertical cylindrical shape. The interior bore widens to a substantial cavity surrounding the valve body 14. This opening is contained within the housing 10 except for a suction port 16 which is seen on the left-hand side of the figure. The interior bore narrows again above the cavity to a width appropriate for the upper section of the housing. This bore diameter continues until the completion of the lower section of the housing. The housing is then topped by its second section 35 which is roughly a dome shape and has lower diameter wall which partially slides into the bore diameter. In the top of the second section 35 is a discharge port 18.

[0025] Figure 4 shows the valve when the piston 12 has reached the bottom of its stroke. When the suction force of the downwardly moving piston drops to zero at the bottom of the stroke, the suction valve return spring 22 is able to expand to force the suction poppet 20 to close against the valve body 14. The suction poppet 20 and the valve body 14 have mating angled valve seats 44 and 46, respectively. When seated to one another, they provide a good seal for fluid on either side of the chamber cavity.

[0026] Figure 5 demonstrates a next step in the operating sequence in which the piston 12 moves upward in a discharge stroke. This upward motion causes fluid to push against the discharge poppet 24 and to compress the discharge return spring 26. These actions cause the discharge valve 24 to be forced open and fluid is forced to flow into the upper chamber 48 and out the discharge opening 18 of the housing 10. The suction valve is forced closed by its spring 22 and by fluid pressure.

[0027] Figure 6 illustrates the last step in the operation sequence of the valve. Here, the piston 12 has reached the top of its stroke. At this point, the fluid pressure is such as to allow the discharge valve return spring 26 to again expand and close the discharge poppet 24. This sealed condition is reached when the angled discharge valve seal seat 50 mates with the conical upper seat 52 on the valve body 14. The valve operation sequence repeats once the piston again starts its downward suction stroke (Figure 3).

[0028] The foregoing is a specific embodiment of the present invention. It should be appreciated that this embodiment is described for purposes of illustration only, and that numerous alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended that all such modifications and alterations be included insofar as they come within the scope of the invention claimed or the equivalents thereof.

ALTERNATIVE EMBODIMENT

[0029] Figure 7 contains an alternative embodiment of the present invention. This figure generally shows a compound valve assembly for enabling controlled fluid

flow. The main components of the device are the valve housing 110 having a cylinder bore 111, pump or compressor piston 112, compound valve body 114, suction or fluid inlet port 116, fluid outlet or discharge port 118, suction valve poppet 120, suction valve return spring 122, discharge valve poppet 124, and discharge valve return spring 126. The piston/plunger 112 is reciprocally driven in the cylinder bore 111 by a suitable pump drive assembly such as that in the aforereference's Maki et al application.

[0030] The valve housing 110 is largely responsible for the overall shape of the valve assembly and contains the main elements within it. The lower portion of the housing is a cylindrical shape and contains a bore lined with an insert 154 whose inside diameter is slightly larger than the piston outside diameter, allowing reciprocating movement of the piston/plunger therein. Moving upward, the interior bore widens to a diameter wide enough to house the suction valve return spring 122 within insert 154. This diameter continues until the upper end of insert 154 is reached where the interior cavity widens for a small segment just below the lower end of the valve body 114. Attached above the valve body 114 is a discharge manifold 119. This portion caps the valve body opening and contains the discharge port 118 through which fluid is expelled under pressure. The outside of the valve housing, generally, is cylindrical and increases in diameter in moving from the bottom of Figure 7 upward. There is also an additional outwardly protruding ring 121 approximately one quarter the distance up the side of the housing.

[0031] The suction valve return spring 122 is a cylindrical, metal, compression spring which is coiled into convolutions of constant diameter. The number of convolutions of this spring is a function of the spring rate and how far one wishes to allow the suction poppet 120 to move, being careful to balance suction spring tension in a way to prevent causing too great of a restriction to the ability of the poppet 120 to open. This is particularly important in applications requiring suction lift. The spring's outer diameter is slightly less than the outer diameter of the annular suction poppet 120 and fits up against it. The diameter of spring 122 is also large enough so that the piston 112 can reciprocate within it during its pumping action without the spring contacting the piston. It is a resilient structure and is fairly resistant to deformation.

[0032] Suction poppet 120 is the element with which the suction valve return spring 122 coacts. Suction poppet 120, in the embodiment of Figure 7, is a flat disc containing a circular opening at its center. It is capable of sealing the outer concentric, annular inlet port 116 when in the upper closed position. A flat suction poppet of this type has the advantage of easy manufacture and no concentricity issues. Other types of poppets which could be applied to this design are inwardly tapered poppets and outwardly tapered poppet valves. The suction poppet 120 is limited in its downward travel by a stop provided by insert 154, positioned around the interior bore of the housing 110. The stop limits the suction travel of the poppet 120 and the tension placed on spring 122 to minimize the force needed to open the poppet, particularly in applications requiring suction lift.

[0033] The valve body 114 is made up of three cylindrical rings which are formed into one structure but mounted concentrically and in axially spaced relation by integrally molded ribs or spokes. There is also an annular passageway 138, through which fluid is suctioned in when the suction poppet 120 is not sealed against the lower end of the valve body 114. The outside ring of the valve body 114 provides the base for the upper segment 119 of the valve assembly.

[0034] Valve body 114 surrounds the discharge poppet 124 and the discharge valve return spring 126. The fluid pumped into valve body 114 from annular passageway 138 force the discharge poppet 124 open and will pass over and around the discharge poppet 124 and discharge valve return spring 126. The valve body 114 contains a valve seat 127 which mates with the tapered periphery forming the valve seat on the discharge poppet 124. The seat surface of the valve seat tapers concentrically inward from the outer portion of the valve body 114 at the same angle as the taper on the discharge poppet 124.

[0035] Discharge poppet 124 has a head portion which has a tapered seat surface which is angled inward to form a conical seat. It is capable of sealing against the opposing seat on the valve body 114 when the piston 112 is in the suction stroke of its cycle. Extending from the head of the discharge poppet, opposite the conical seat, is a concentrically located stem of small diameter. This stem fits inside the discharge valve return spring 126 and slides along a guide bore 156 within the discharge manifold 119. This guide bore 156 restricts and gives direction to the discharge poppet 124. It could be replaced with a cage to serve a similar function.

[0036] The discharge valve return spring 126 surrounding the stem of the discharge poppet 124 may preferably be a metal spring of a smaller diameter than the suction valve return spring 122. This spring 126 has a constant outer diameter. It is compressed between the discharge manifold 119 and the head of the discharge poppet 124 when the piston is in the discharge stroke of the pump cycle.

[0037] The operation of this device occurs in a series of steps governed by the reciprocating movement of piston 112. In the first step, fluid is drawn in suction port 116 during the down stroke of the piston 112. This fluid is drawn into the housing bore, above the piston 112, through a now open suction poppet 120. Discharge poppet 124 remains seated at this point in the cycle by action of its associated spring 126.

[0038] Once fluid has been suctioned into the housing cavity and the piston has reached the bottom of its stroke, the suction force of the downwardly moving piston drops to zero and the suction valve return spring 122

is able to expand to force the suction poppet 120 to close against the seat in the valve body 114.

[0039] The piston 112 then begins to move upward in a discharge stroke. This upward motion causes fluid to push against the discharge poppet 124 and to compress the discharge return spring 126. These actions cause the discharge valve 124 to be forced open and fluid to be forced into the discharge manifold 119 and out the discharge opening 118. At this time, the suction valve is forced closed by its spring 122 and by fluid pressure acting on the poppet 120.

[0040] The last step in the operation sequence of the valves occurs when the piston has reached the top of its stroke. At this point, the fluid pressure is such as to allow the discharge valve return spring 126 to again expand and close the discharge poppet 124. This sealed condition is reached when the angled surface of discharge poppet 124 mates with the seat on the valve body 114. The operation sequence repeats once the piston again starts its downward suction stroke.

Claims

1. A valve assembly for a positive displacement piston/plunger pump comprising:

(a.) a valve body comprising first, second, and third coaxially aligned, longitudinally displaced, interconnected ring members, each of a predetermined diameter, the first ring member and a bottom surface of the second ring member defining a first valve seat with an annular gap therebetween and a further surface of the second ring member defining a second valve seat;
(b.) a valve housing having a cavity for receiving the valve body therein, the valve housing having a piston/plunger receiving bore formed coaxially with said cavity and with an inlet port in fluid communication with the annular gap;
(c.) a suction poppet disposed in the cavity and adapted to seal against the first valve seat at the termination of a suction stroke of a piston/plunger moving in the piston/plunger receiving bore;
(d.) a discharge poppet mounted within the third ring member for sealing against the further valve seat at the termination of a discharge stroke of a piston/plunger moving in the piston/plunger receiving bore in the valve housing; and
(e.) a discharge chamber having a discharge port formed therein, the discharge chamber being in fluid communication with the piston/plunger receiving bore during the discharge stroke.

2. The valve assembly as recited in claim 1, further including a retaining cap aligned concentrically and placed in surrounding relation to the discharge poppet, said cap defining the discharge chamber and discharge port.

3. The valve assembly as recited in claim 1, wherein the suction poppet allows free flow of a fluid to be pumped into the housing piston/plunger receiving bore during the suction stroke of the piston/plunger over 360 degrees.

4. The valve assembly as recited in claim 1, wherein the discharge poppet, allows for relative unobstructed flow from the cylinders during the discharge stroke of the piston/plunger.

5. The valve assembly as in claim 1, wherein the second and third ring members are joined by a continuous, integrally formed wall.

6. The valve assembly as in claim 5, wherein the first and second ring members are held together in coaxial relation by circumferentially spaced ribs therebetween.

7. The valve assembly as in claim 1, and further including a compression spring cooperating between the suction poppet and the valve housing for urging the suction poppet against the first valve seat at the termination of the suction stroke.

8. The valve assembly as in claim 1, and further including a compression spring cooperating with the discharge poppet for urging the discharge poppet against the further valve seat at the termination of the discharge stroke.

9. The valve assembly as in claim 7, wherein the suction poppet comprises a tube having first and second ends, the first end being an inwardly directed portion conforming in shape to the first valve seat, the compression spring disposed within said tube and engaging the inwardly directed portion.

10. The valve assembly as in claim 8, wherein the discharge poppet comprises a cylindrical tube having one open end and one closed end and an outside diameter that provides a predetermined clearance fit with an inner diameter of said third ring.

11. The valve assembly as in claim 10, wherein the compression spring fits within the cylindrical tube.

12. The valve assembly in claim 1, wherein the suction poppet comprises a flat, annular disk.

13. The valve assembly as in claim 8 wherein the discharge poppet comprises a cylindrical head having

a chamfered periphery and a centrally disposed stem member projecting outwardly from the head, said compression spring disposed in surrounding relation to the stem member.

14. The valve assembly as in claim 13 wherein the stem member slides in a guide bore in said discharge chamber.

FIG. 1

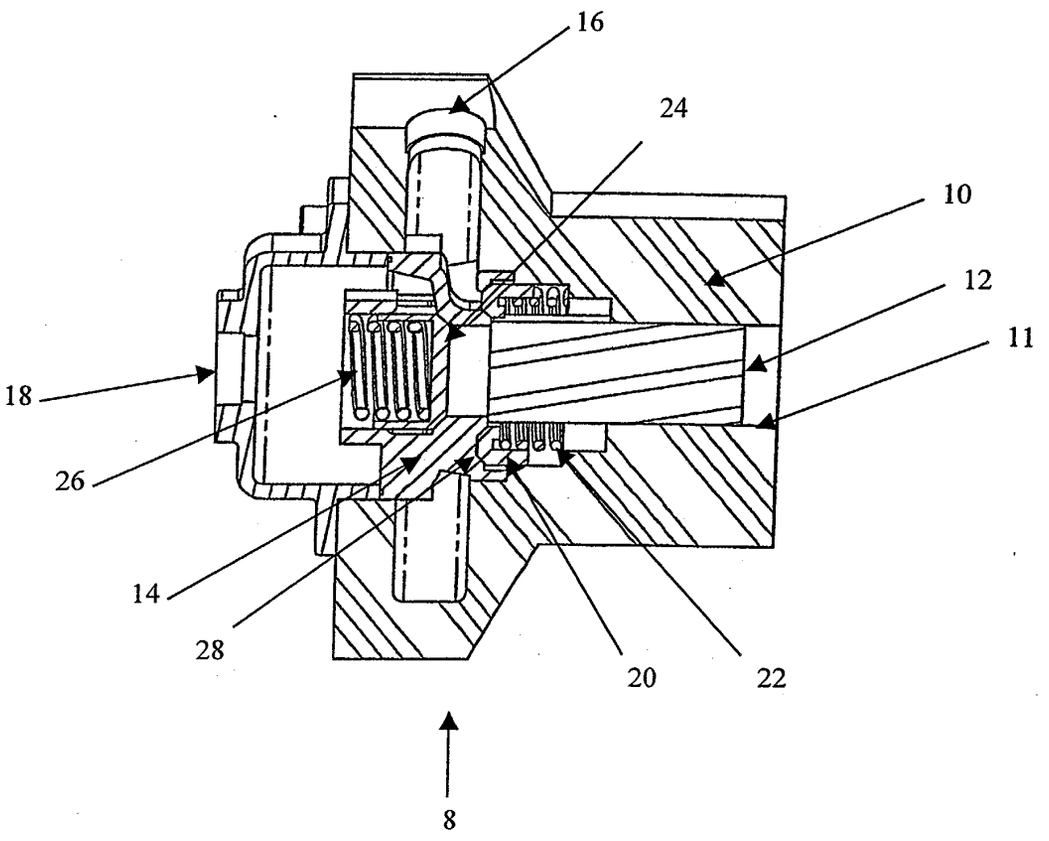


FIG. 2

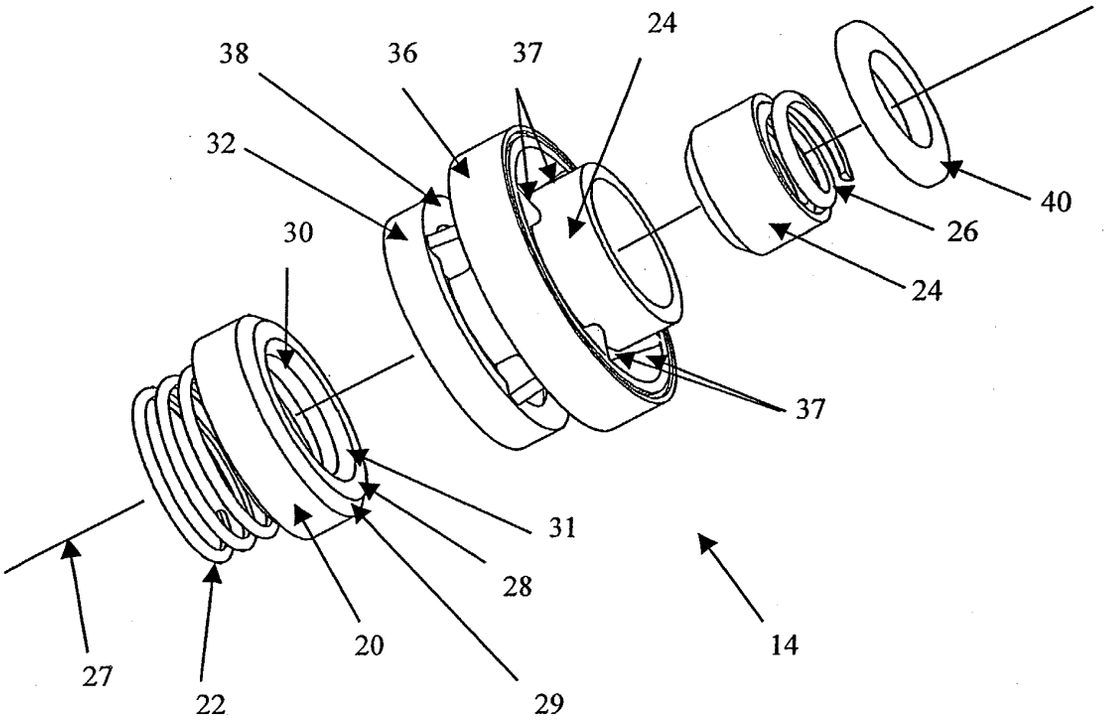


FIG. 3

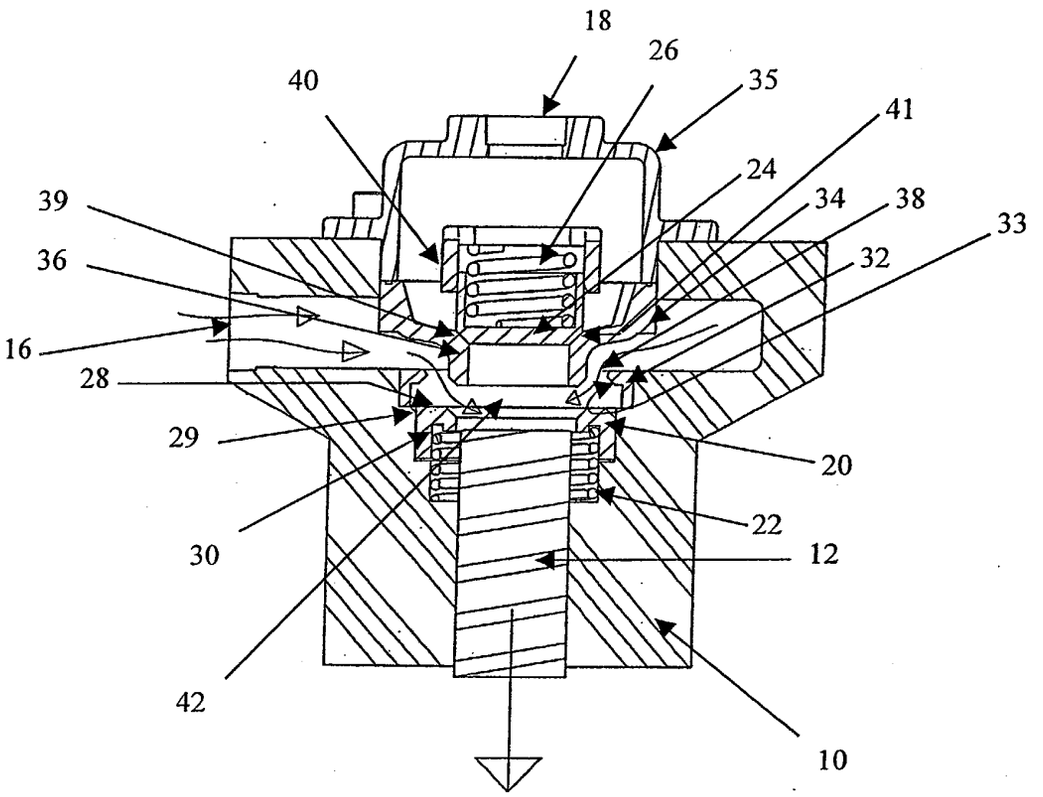


FIG. 4

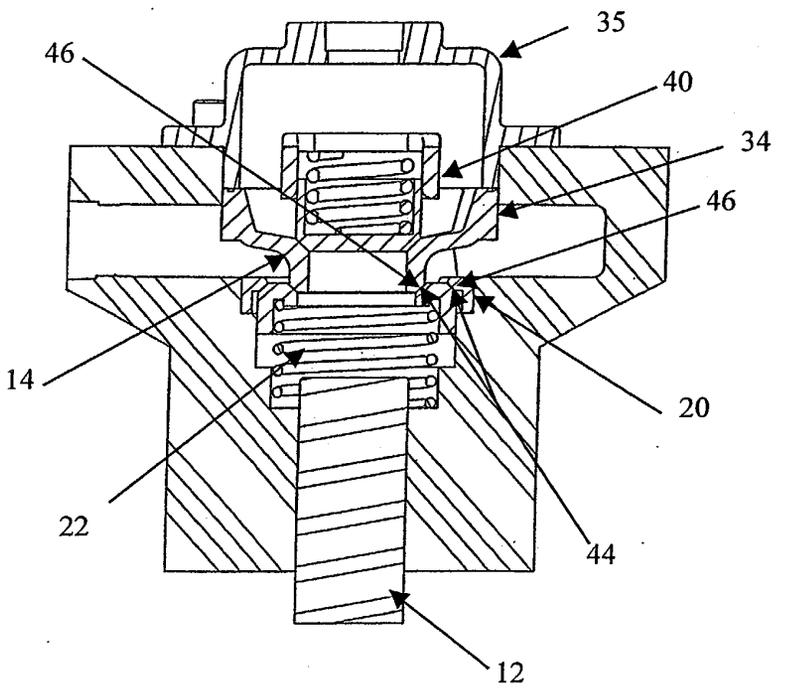


FIG. 5

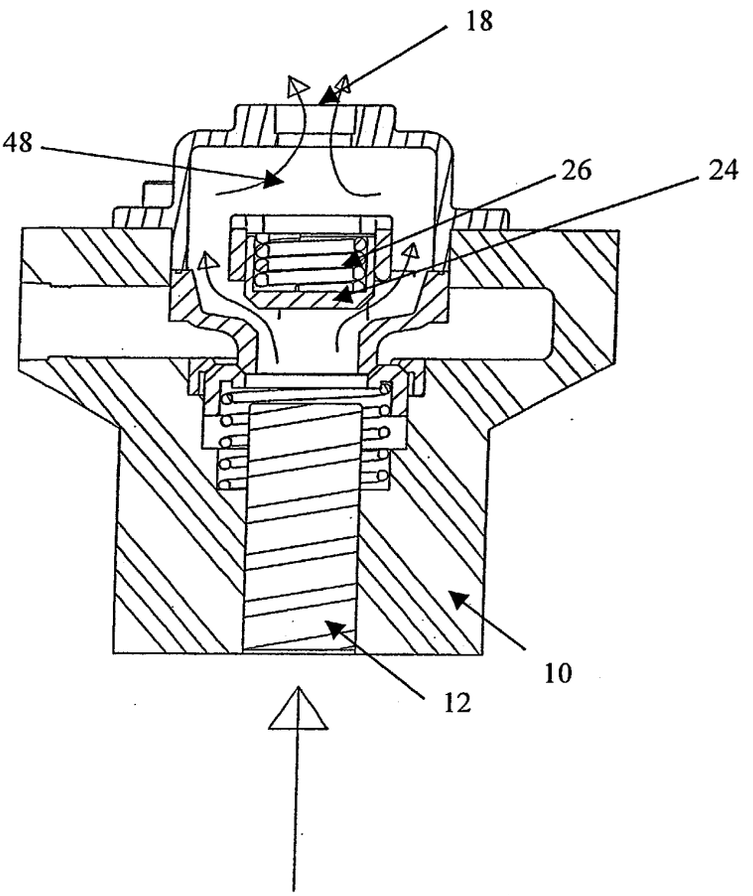


FIG. 6

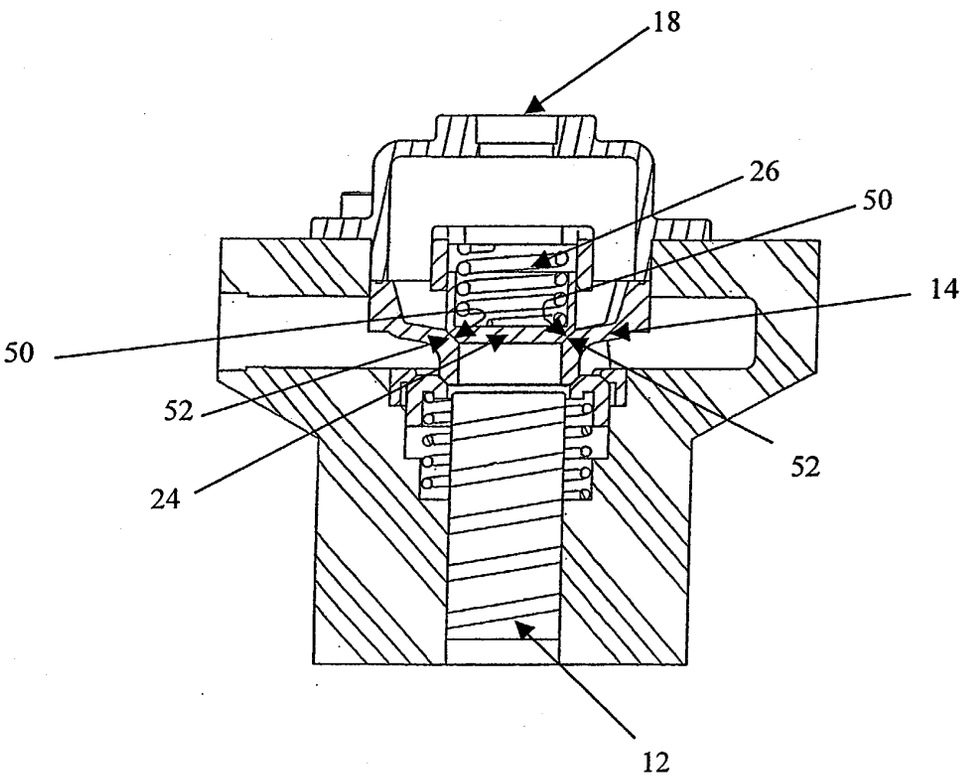
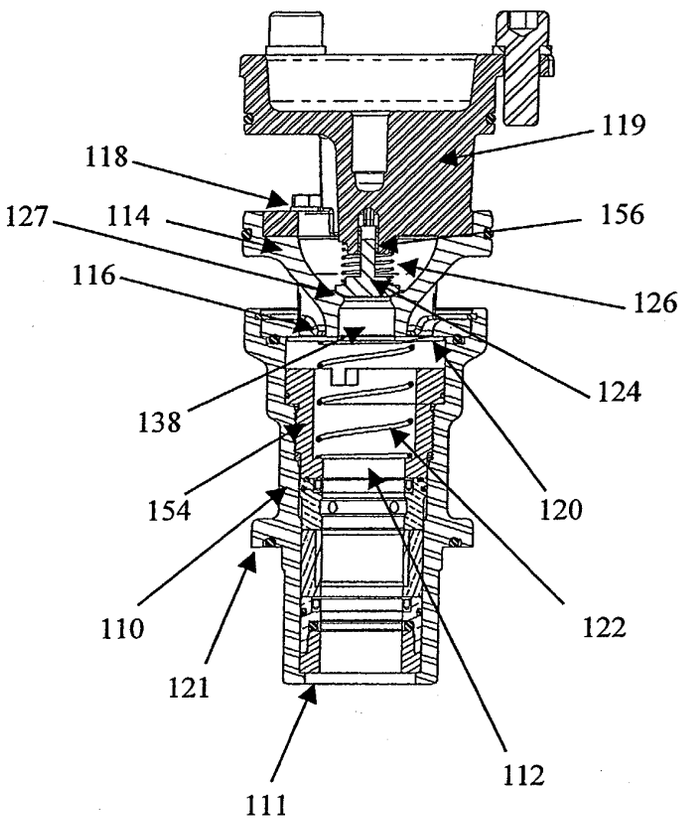


FIG. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 3726

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A,D	US 4 032 263 A (PAREJA RAMON) 28 June 1977 (1977-06-28) * column 1, line 29 - column 2, line 2; figures 3,4 *	1-14	F04B53/10 F04B1/00 F04B9/04
A	US 4 878 815 A (STACHOWIAK J EDWARD) 7 November 1989 (1989-11-07) * column 2, line 33 - column 3, line 57 * * column 6, line 8 - column 7, line 37 *	1-14	
A	EP 0 035 570 A (ARIMITSU IND) 16 September 1981 (1981-09-16) * abstract *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	11 September 2003	Fistas, N

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 25 3726

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-09-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4032263 A	28-06-1977	CH 594135 A5	30-12-1977
		DE 2635166 A1	31-03-1977
		GB 1503108 A	08-03-1978
		JP 1007171 C	31-07-1980
		JP 52040802 A	30-03-1977
		JP 54044121 B	24-12-1979
		SE 7607579 A	26-03-1977
US 4878815 A	07-11-1989	NONE	
EP 0035570 A	16-09-1981	DE 3069616 D1	20-12-1984
		EP 0035570 A1	16-09-1981
		WO 8100890 A1	02-04-1981

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82