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(54) Fluid pump

(57) A fluid pump (10) has a chamber (230) having an inlet (240) and an outlet (210), first and second valves (801 & 802) associated with the inlet and outlet (240 & 210) respectively, and a pumping member (410). The pumping member (410) extends into the chamber (230) and is supported for movement relative to the chamber (230) on a suction stroke in one direction outwardly of the chamber (230) to introduce fluid into the chamber (230) via the inlet (240) and on a discharge stroke in an opposite direction inwardly of the chamber (230) to displace fluid out of the chamber (230) via the outlet (210). A driving mechanism causes said movement of the pumping member (410) in opposite directions relative to the chamber (230). The second valve (802) is located in the path of movement of the first valve (801) for displacement by the first valve (801) to open at least in an abnormal situation where the second valve (802) is stuck.

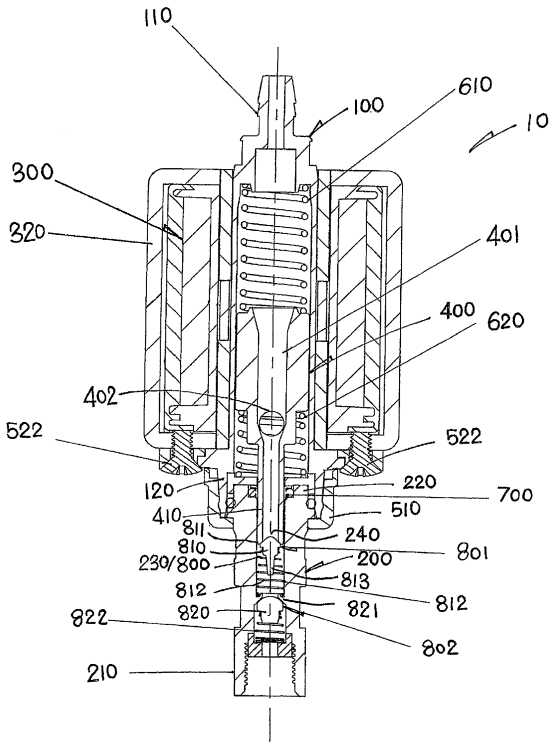

FIG 1

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Description

BACKGROUND OF INVENTION

[0001] Fluid pumps are of course known. For pumping pressurized water in a small electrical appliance, AC plunger pumps are often used, noticeably, in coffee machines or makers and in particular capsule coffee machines. Such plunger pumps are compact in size and are used with narrow hoses or pipes at their outlets where small valves are fitted for controlling the flow of water. Unless the coffee machines are used every day or regularly, the outlet valves are vulnerable to blockage or getting stuck by water minerals and/or deposit if the pumps are left in a dry condition for too long.

[0002] The invention seeks to obviate or at least alleviate such a problem or shortcoming by providing an improved fluid pump.

SUMMARY OF THE INVENTION

[0003] According to the invention, there is provided a fluid pump comprising a chamber having an inlet and an outlet, a first valve associated with the inlet, a second valve associated with the outlet, and a pumping member. The pumping member extends into the chamber and is supported for movement relative to the chamber on a suction stroke in one direction outwardly of the chamber to introduce fluid into the chamber via the inlet and on a discharge stroke in an opposite direction inwardly of the chamber to displace fluid out of the chamber via the outlet. A driving mechanism is adapted to cause said movement of the pumping member in opposite directions relative to the chamber. The second valve is located in the path of movement of the first valve for displacement by the first valve to open at least in an abnormal situation where the second valve is stuck.

[0004] Preferably, the fluid pump includes a solid part located between the first valve and the second valve, by means of which solid part the second valve is to be displaced by the first valve to open in at least said abnormal situation.

[0005] More preferably, the solid part is connected with the first valve and faces the second valve.

[0006] Further more preferably, the solid part is an integral part of the first valve.

[0007] It is preferred that the solid part is oblong and extends in a direction across the first valve and the second valve.

[0008] It is further preferred that the solid part has a cross-section considerably smaller than that of the first valve and the second valve.

[0009] Preferably, the first valve and the second valve are operable in the same first direction and closed in the same second direction opposite the first direction.

[0010] In a preferred embodiment, the pumping member has an open end extending into the chamber and a hollow passage which terminates at the open end and through which fluid is to be introduced into the chamber, with the open end acting as the inlet.

[0011] More preferably, the first valve comprises a first valve member and a first valve seat with which the first valve member is co-operable for valve operation, the first valve seat being provided by the open end of the pumping member.

[0012] It is preferred that the second valve comprises a second valve member and a second valve seat with which the second valve member is co-operable for valve operation, the second valve seat being provided by a restricted section of the chamber.

[0013] It is preferred that the second valve is located in the path of movement of the first valve for displacement by the first valve to open only in the situation where the second valve is stuck.

[0014] It is preferred that the second valve is located in the path of movement of the first valve for displacement by the first valve to open in all situations, including normal operation of the fluid pump.

[0015] It is preferred that the driving mechanism comprises an electro-mechanical driving mechanism.

[0016] It is further preferred that the driving mechanism comprises a solenoid having an electro-magnetic coil surrounding a ferromagnetic slider whose front end acts as the pumping member.

BRIEF DESCRIPTION OF DRAWINGS

[0017] The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional side view of an embodiment of a fluid pump in accordance with the invention;

Figure 2 is a cross-sectional side view corresponding to Figure 1, showing the fluid pump in an "initial position" condition;

Figure 2A is an enlarged view of part A of the fluid pump of Figure 2;

Figure 3 is a cross-sectional side view corresponding to Figure 1, showing the fluid pump in a "CONTACT POINT" condition;

Figure 3A is an enlarged view of part A of the fluid pump of Figure 3;

Figure 4 is a cross-sectional side view corresponding to Figure 1, showing the fluid pump in a "DRY OPERATION" condition;

Figure 4A is an enlarged view of part A of the fluid pump of Figure 4;

Figure 5 is a cross-sectional side view corresponding to Figure 1, showing the fluid pump in a "PRESSURIZED FLOW / FREE FLOW" condition; and

Figure 5A is an enlarged view of part A of the fluid pump of Figure 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0018] Referring initially to Figure 1 of the drawings, there is shown a fluid pump 10 embodying the invention, which has a slender cylindrical primary housing 100 (shown in an upright position), a tubular secondary housing 200 connected co-axially with and underneath the primary housing 100, a coil 300 surrounding the primary housing 100 and an elongate slider 400 located generally within the primary housing 100. The fluid pump 10 is intended to be used in a capsule coffee machine for supplying pressurized hot water, at for example 9 to 10 Bars of pressure, to pass through and brew finely ground coffee held in a coffee capsule.

[0019] The secondary housing 200 has an interior that defines a generally cylindrical chamber 230 having, at opposite ends thereof, an inlet 240 and an outlet 210. There are a first valve 801 associated with the inlet 240 and a second valve 802 associated with the outlet 210, both valves 801 and 802 being a one-way valve openable in the direction of flow of fluid through the fluid pump 10.

[0020] The primary housing 100 has a small tubular inlet 110 at its upper end for connection by means of a hose to a source of fluid e.g. a water tank in a capsule coffee machine as described herein. The lowermost end of the secondary housing 200 acts as the outlet 210 of the water pump 10 for supplying pressurized hot water via a pipe to a coffee capsule in this example. Adjacent open ends 120 and 220 of the primary and secondary housings 100 and 200 are joined together by means of a round coupler 510, which is in turn fixed by screws 522 to a cylindrical shell 320 that encloses the coil 300.

[0021] The slider 400 has a round cross-section and is made of a ferromagnetic material. It is supported in and guided by the primary housing 100 for axial sliding movement in opposite upward and downward directions, as in a piston-in-cylinder arrangement. The slider 400 is positioned by a pair of upper and lower coil springs 610 and 620 at opposite ends, compressed and co-acting internally with upper and lower ends of the primary housing 100 respectively, such that the slider 400 stays at rest downwardly offset relative to the coil 300.

[0022] The coil 300 is an electro-magnetic coil which surrounds the ferromagnetic slider 400 and acts upon the slider 400 to drive the same, together constituting an electro-mechanical driving mechanism that comprises a solenoid.

[0023] Upon energization by the AC mains power, the coil 300 intermittently, during each positive half cycle of the AC current, attracts to pull the slider 400 upwardly against the action of the upper spring 610, which is thus compressed, and a forward stroke is performed. During each negative half cycle, the AC current is cut by electronic control or a simple diode to de-energize the coil 300 and in turn release the spring 610. The spring 610 will upon release push the slider 400 back in the opposite downward direction, thereby returning the slider 400 to its original lower position, resulting in a backward stroke. The lower spring 620 provides a buffer for soft landing of the slider 400.

[0024] The lower, front end of the slider 400 is reduced into a much thinner tube acting as a plunger-like pumping member 410 which extends into the chamber 230 in the secondary housing 200 via the latter's open end 220. At this open end 220 there is fitted a seal ring 700 sealing off the annular gap between the chamber 230 and the pumping member 410, yet permitting sliding of the pumping member 410 relative to the chamber 230.

[0025] While being guided by the primary housing 100 for axial sliding movement in opposite directions, the slider 400 carries with it the pumping member 410 for corresponding sliding movement relative to the chamber 230. The slider 400 with the pumping member 410 is to be driven by the coil 300 of the driving mechanism into reciprocation axially, or in opposite directions vertically as shown, along the primary housing 100.

[0026] The slider 400 has along its central axis a through bore 401 which extends from the uppermost end of the slider 400 through to the lowermost end of the pumping member 410. The bore 401 is a hollow passage that terminates at its lowermost end that is lowermost end 240 of the pumping member 410 and acts as the inlet 240 to the chamber 230, through which water is to be introduced into the chamber 230. The chamber 230 shares the same outlet 210 as the overall fluid pump 10, situated at the lowermost end of the secondary housing 200.

[0027] The bore 401 allows water from the interior of the primary housing 100 above the slider 400, entered via the inlet 110, to flow lengthwise through the slider 400, including the pumping member 410, downstream into the chamber 230. A side hole 402 through the wall of the slider 400 intersecting the bore 401 allows communication and thus pressure balance between the interior of the primary housing 100 above and below the slider 400.

[0028] Water enters the chamber 230 via the inlet 240 and associated inlet valve 801, and exits via the outlet 210 and associated outlet valve 802. The two valves 801 and 802 are one-way valves that are openable in the same direction of flow of water through the chamber 230 and are closed in the same reversed direction.

[0029] The inlet valve 801 has an inlet valve member 810 and an inlet valve seat 811, with which the valve member 810 is co-operable for valve operation, under the action of a coil spring 812 that resiliently biases the valve member 810 upwards against the valve seat 811. The valve seat 811 is provided by the open end 240 of

the pumping member 410. The outlet valve 802 is formed by an outlet valve member 820 and an outlet valve seat 821, with which the valve member 820 is co-operable for valve operation, under the action of anther coil spring 822 that resiliently urges the valve member 820 upwards against the valve seat 821. The valve seat 821 is provided by a restricted section of the chamber 230, in the form of an annular inner flange around the chamber's inner wall surface.

[0030] The chamber 230 occupies the space in the section of the second housing 200 between the inlet valve 801 and the outlet valve 802. The inlet valve 801 is located upstream (above as shown) of the outlet valve 802. The inlet and outlet valves 801 and 802, with their valve members 810 and 820, are aligned co-axially with each other and with the central axis of the secondary housing 200 and hence the chamber 230.

[0031] Referring specifically to the inlet valve 801, the valve member 810 includes at its bottom an oblong solid part in the form of a spike 813. The spike 813 is preferably an integral part of the valve member 810, or alternatively it may be a distinct part connected thereto. The spike 813 has a cross-section considerably smaller than that of the inlet and outlet valve members 810 and 820. The spike 813 is connected with the inlet valve member 810 and faces or points vertically downwardly, through the associated spring 812, at the outlet valve member 820. The spike 813 extends in a direction (i.e. vertical direction) across, or passing through, the inlet and outlet valves 801 and 802.

[0032] In operation, upon the vertical reciprocation of the slider 400 by the electro-magnetic coil 300 as described above, the pumping member 410 performs pumping actions within the chamber 230, co-operating with the inlet and outlet valves 801 and 802, in repeated cycles of suction and discharge strokes.

[0033] On a suction stroke in the upward direction outwardly of the chamber 230, the pumping member 410 withdraws to introduce water by suction into the chamber 230 via the inlet 240, with the inlet valve 801 being opened as the pumping member 410 and hence the valve seat 811 recedes from the valve member 810, while the outlet valve 802 remains shut. Right afterward, on a discharge stroke in the opposite direction inwardly of the chamber 230, the pumping member 410 charges forward to compress the water in the chamber 230 and then, when the water pressure sufficiently builds up (i.e. reaching the threshold pressure) to open the outlet valve 802, displaces the pressurized water out of the chamber 230 via the outlet 210, while the inlet valve 801 now remains shut.

[0034] The strength of the outlet valve spring 822 is a key factor that determines the extent to which water is to be pressurized, for example to a pressure in the range of 0.7 Bar to 10 Bars. The distance of travel of the pumping member 410 dictates the volume of water to be discharged per pumping cycle.

[0035] The spike 813 of the inlet valve 801 points at the outlet valve member 820 of the outlet valve 802 coaxially below it. The length of the spike 813 is determined such that it will hit and displace the valve member 820 of the outlet valve 802, thereby opening the outlet valve 802, at least in an abnormal situation where the outlet valve 802 is stuck or immovable.

[0036] For this function, the outlet valve 802 is located in the path of movement of the inlet valve 801 and in particular its valve member 810. The spike 813 is a solid part located between the inlet valve 801 and the outlet valve 802, by means of which solid part, i.e. spike 813, the outlet valve 802 is to be displaced by the inlet valve 801 to open in at least said abnormal situation.

[0037] Such an abnormal situation where the outlet valve 802 is stuck or becomes immovable often arises when the fluid pump 10 has not been used for a prolonged period of time or, in particular, during first use of the capsule coffee machine after purchase. In such circumstances, the water pump 10 is dry (i.e. dry operation) and/or clotted by minerals or deposit from water.

[0038] In this particular embodiment, for normal operation, dependent upon the requirements on pressure of water and design of the water pump 10, such as the diameter and length (i.e. separation between its inlet 240 and outlet 210) of the chamber 230, the spike 813 is arranged to reach short of (i.e. not to reach) the valve member 820 of the outlet valve 802. The spike 813 will only reach and hit the outlet valve member 820 when, and only when, initially the outlet valve member 820 is stuck or becomes immovable during dry operation at the start of the water pump 10.

[0039] Figures 2 and 2A show the initial condition of the water pump 10 before operation, in which the following legends denote the positions of the lowermost end of the pumping member 410 (i.e. the outlet 210) from near to far:

"INITIAL POSITION"

- start-up or rest position

"PRESSURIZED FLOW / FREE FLOW"

- forward-most position during normal (pressurized) operation or free flow (unpressurized test) condition

"CONTACT POINT"

- spike 813 just reaching outlet valve member 820 (assumed stationary), by physical measurement

"DRY OPERATION"

- forward-most position during dry operation

[0040] During normal operation, at the moment when the water in the chamber 230 reaches the threshold pres-

sure and forces open the outlet valve 802, the spike 813 will only have traveled so far as to reach a position corresponding to the "PRESSURIZED FLOW / FREE FLOW" position (Figures 5 and 5A) upstream of the "CONTACT POINT" position (Figures 3 and 3A). Hence, the spike 813 will not hit the outlet valve member 820, as shown in Figures 5 and 5A.

[0041] It is noted that the pumping member 410 pushing the inlet valve member 810 that includes the spike 813 will travel over roughly the same distance during both normal (pressurized) operation and free flow (unpressurized test) condition. Thus, the "PRESSURIZED FLOW" and "FREE FLOW" positions are generally the same. The free flow condition only occurs during test, with the pump's outlet 210 disconnected such that water leaving the outlet 210 is unpressurized.

[0042] At start-up during dry operation in case the outlet valve member 820 is stuck or immovable, in the absence of (incompressible) water in the chamber 230, the spike 813 is able to travel farther along and reach a position corresponding to the "DRY OPERATION" position beyond the "CONTACT POINT" position, thereby hitting and pushing the outlet valve member 820 to open the outlet valve 802, as shown in Figures 4 and 4A. Once the outlet valve 802 has been released, it will function normally in subsequent pumping cycles.

[0043] One may encounter the abnormal situation (i.e. the outlet valve 802 being stuck) again after the fluid pump 10 has been stored away for a relatively long period of time e.g. a few months. With the use of the subject fluid pump 10, as such problems can be solved automatically even without notice, this is never an issue to the users.

[0044] It is not expected that the outlet valve 802 of the subject pump 10 would get stuck through regular use of the relevant coffee machine, as while the pump 10 has not been left in a dry condition for too long, the water minerals or deposit are unlikely to clot up too hard. The likelihood that the outlet valve 802 gets stuck when there is water in the chamber 230, e.g. during a short break between operations of the pump 10, is even more remote because the water minerals or deposit can hardly clot up when wet.

[0045] In a different embodiment, to cater for the said remote scenario, the spike 813 is made relatively longer such that during pumping operation it will reach slightly beyond a position corresponding to the "CONTACT POINT" position, just sufficient for the spike 813 to hit and release the outlet valve member 820 in case the valve member 820 gets stuck unexpectedly.

[0046] During normal operation, the spike 813 will not reach or contact the outlet valve member 820 because the outlet valve member 820 is arranged to depart from the associated valve seat 821 (i.e. water reaching the threshold pressure) before the spike 813 arrives at the position corresponding to the "CONTACT POINT" position. This avoids unnecessary bombardment between the pump's components during normal operation.

[0047] In yet another embodiment, the spike 813 is made sufficiently long such that during pumping operation it will reach beyond a position corresponding to the "CONTACT POINT" position, sufficient for the spike 813 to hit and release the outlet valve member 820 not only in case the valve member 820 gets stuck unexpectedly but also during normal operation. In this arrangement, water in the chamber 230 reaches the threshold pressure almost at the time when the spike 813 arrives at the position corresponding to the "CONTACT POINT" position. Hence the spike 813 will hit and displace the outlet valve member 820 to open in all situations, including normal operation of the fluid pump 10.

[0048] The invention has been given by way of example only, and various other modifications of and/or alterations to the described embodiments may be made by persons skilled in the art without departing from the scope of the invention as specified in the appended claims.

Claims

1. A fluid pump comprising:

   a chamber having an inlet and an outlet;
   a first valve associated with the inlet;
   a second valve associated with the outlet;
   a pumping member extending into the chamber and supported for movement relative to the chamber on a suction stroke in one direction outwardly of the chamber to introduce fluid into the chamber via the inlet and on a discharge stroke in an opposite direction inwardly of the chamber to displace fluid out of the chamber via the outlet; and
   a driving mechanism adapted to cause said movement of the pumping member in opposite directions relative to the chamber;
   characterized in that the second valve is located in the path of movement of the first valve for displacement by the first valve to open at least in an abnormal situation where the second valve is stuck.

2. The fluid pump as claimed in claim 1, **characterized in that** it includes a solid part located between the first valve and the second valve, by means of which solid part the second valve is to be displaced by the first valve to open in at least said abnormal situation.

3. The fluid pump as claimed in claim 2, **characterized in that** the solid part is connected with the first valve and faces the second valve.

4. The fluid pump as claimed in claim 3, **characterized in that** the solid part is an integral part of the first valve.

5. The fluid pump as claimed in claim 2, **characterized in that** the solid part is oblong and extends in a direction across the first valve and the second valve.

6. The fluid pump as claimed in claim 5, **characterized in that** the solid part has a cross-section considerably smaller than that of the first valve and the second valve.

7. The fluid pump as claimed in claim 1, **characterized in that** the first valve and the second valve are operable in the same first direction and closed in the same second direction opposite the first direction.

8. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the pumping member has an open end extending into the chamber and a hollow passage which terminates at the open end and through which fluid is to be introduced into the chamber, with the open end acting as the inlet.

9. The fluid pump as claimed in claim 8, **characterized in that** the first valve comprises a first valve member and a first valve seat with which the first valve member is co-operable for valve operation, the first valve seat being provided by the open end of the pumping member.

10. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the second valve comprises a second valve member and a second valve seat with which the second valve member is co-operable for valve operation, the second valve seat being provided by a restricted section of the chamber.

11. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the second valve is located in the path of movement of the first valve for displacement by the first valve to open only in the situation where the second valve is stuck.

12. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the second valve is located in the path of movement of the first valve for displacement by the first valve to open in all situations, including normal operation of the fluid pump.

13. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the driving mechanism comprises an electro-mechanical driving mechanism.

14. The fluid pump as claimed in claim 13, **characterized in that** the driving mechanism comprises a solenoid having an electro-magnetic coil surrounding a ferromagnetic slider whose front end acts as the pumping member.

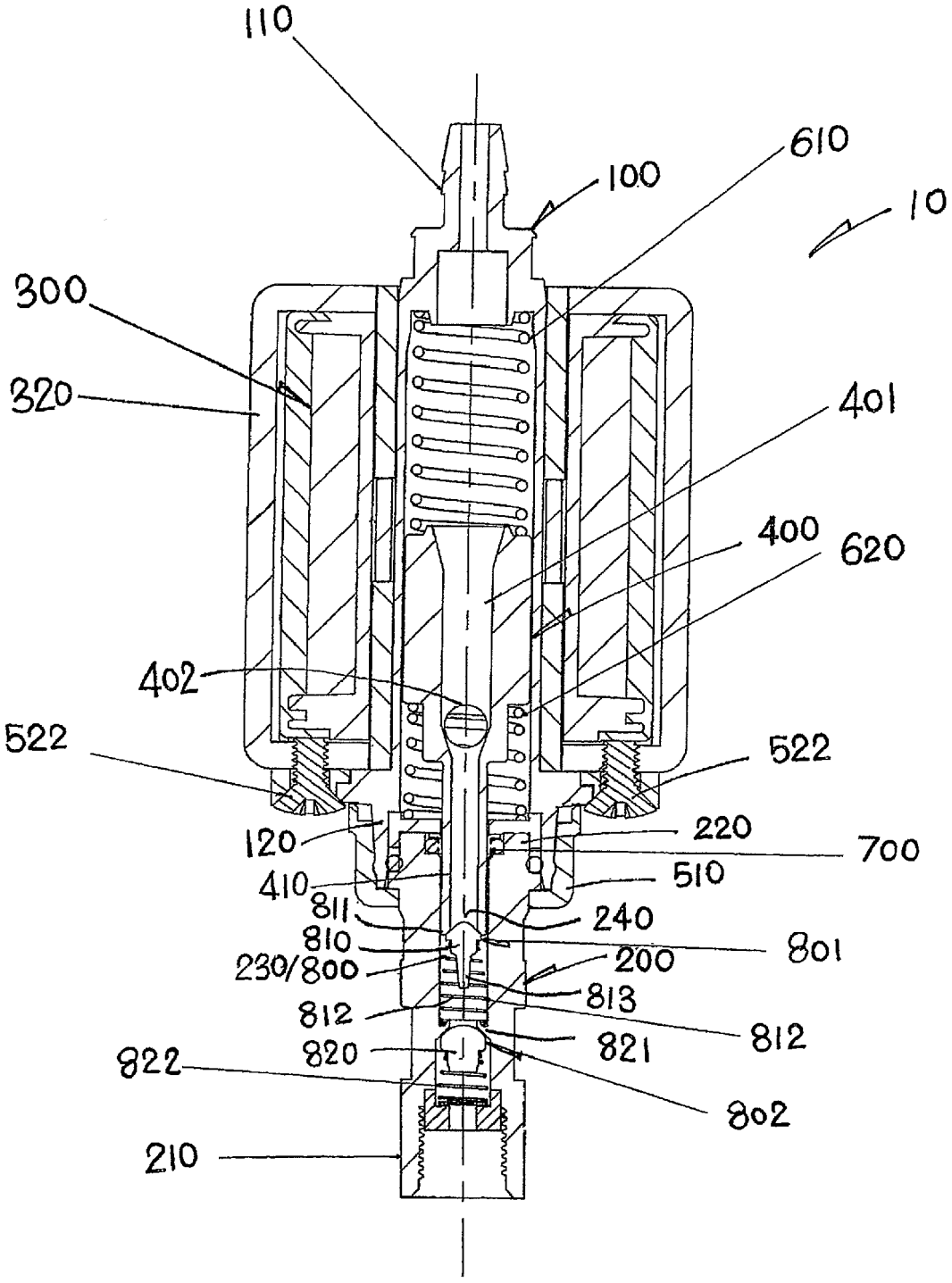
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FIG 1

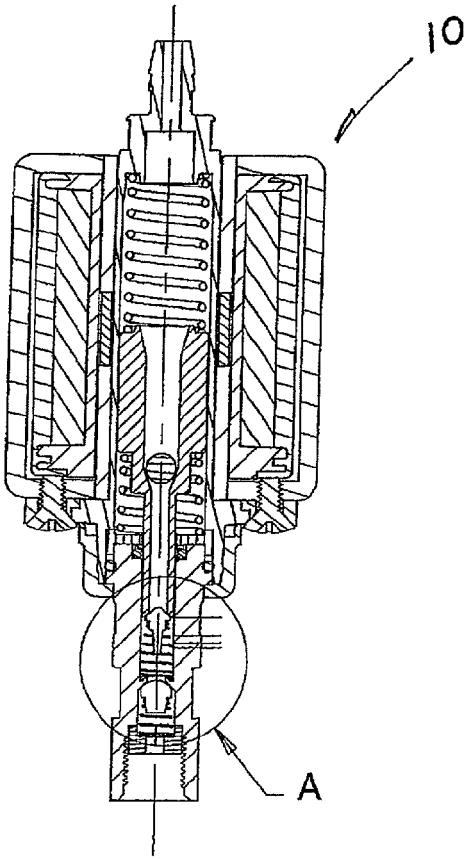

FIG 2

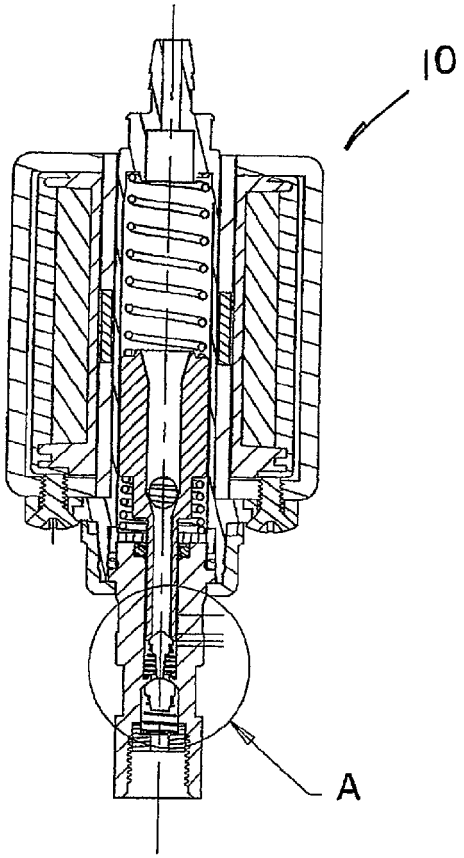

FIG 3

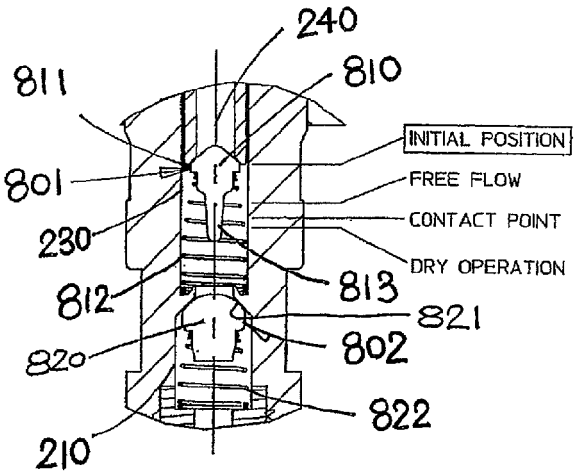

FIG 2A

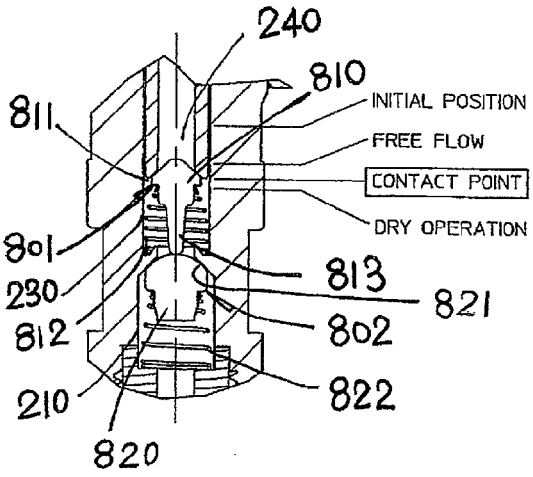

FIG 3A

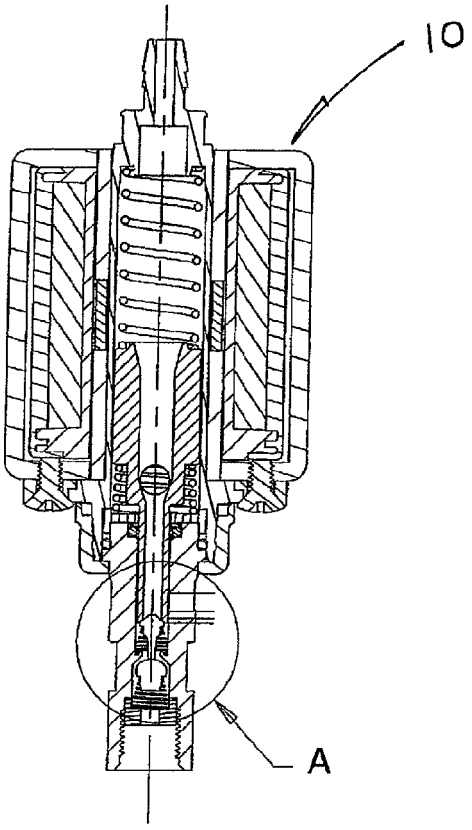

FIG 4

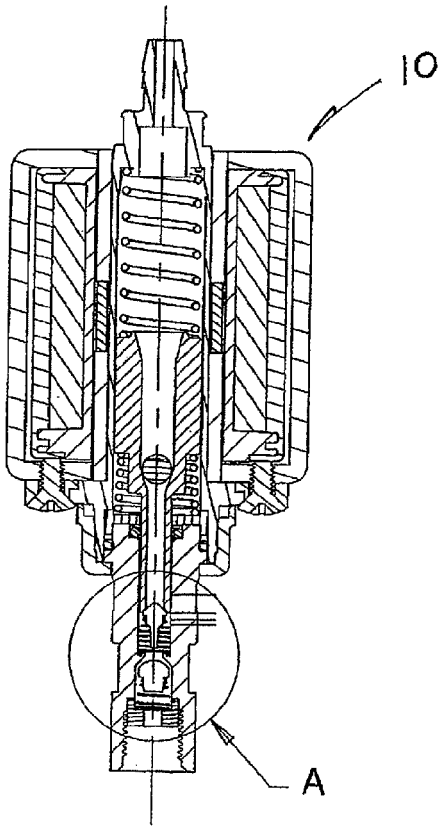

FIG 5

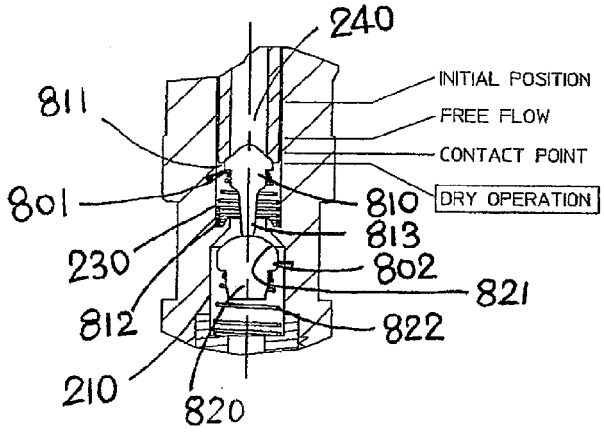

FIG 4A

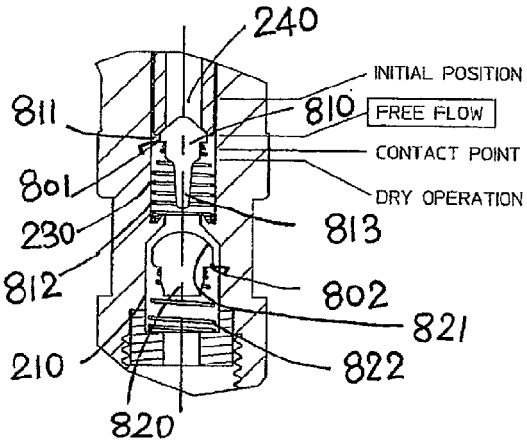

FIG 5A

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EUROPEAN SEARCH REPORT

Application Number
EP 13 19 3046

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 2 711 548 A2 (ARS ELETTROMECCANICA S R L [IT]) 26 March 2014 (2014-03-26) * paragraphs [0004], [0020], [0092] - [0094] *	1-14	INV. F04B17/04 F04B53/14 F04B11/00
A	EP 1 818 538 A2 (DEFOND COMPONENTS LTD [CN]) 15 August 2007 (2007-08-15) * claim 1 *	1	
A	WO 2013/004620 A1 (WIK FAR EAST LTD [CN]; MAYORAZ PIERRE [CH]; DAYER GAETAN [CH]; DOVAT L) 10 January 2013 (2013-01-10) * abstract *	1	
A	EP 1 205 663 A1 (C E M E ENGINEERING S P A [IT]) 15 May 2002 (2002-05-15) * claim 1 *	1	
A	EP 2 101 059 A1 (MSG MECHATRONIC SYSTEMS GMBH [AT]) 16 September 2009 (2009-09-16) * paragraph [0004] - paragraph [0016] *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 April 2014	Fistas, Nikolaos

CATEGORY OF CITED DOCUMENTS

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