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(72) Inventors:
• **Chan, Kai Chi**
Chaiwan
Hong Kong SAR (CN)
• **Ho, Man Ting**
Chaiwan
Hong Kong Sar (CN)

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(71) Applicant: **Defond Components Limited**
Hong Kong SAR (CN)

(74) Representative: **Jenkins, Richard Gavin et al**
Marks & Clerk
43 Park Place
Leeds LS1 2RY (GB)

(54) **Fluid pump**

(57) A fluid pump (10) comprises a chamber (230) and a plunger (410) extending into the chamber (230) and supported for sliding movement on a suction stroke to introduce fluid into the chamber (230) and on a discharge stroke to force fluid out of the chamber (230). A driver (300) slides the plunger (410) in opposite direc-

tions. A seal ring (700) is provided between the chamber (230) and the plunger (410) and yet permits the plunger's sliding movement. The seal ring (700) has an outer annular portion (710) of a generally flat cross-section (711) clamped fast in a wall of the chamber (230) and an inner annular portion (720) of a bulbous cross-section (721) in sliding sealing engagement with the plunger (410).

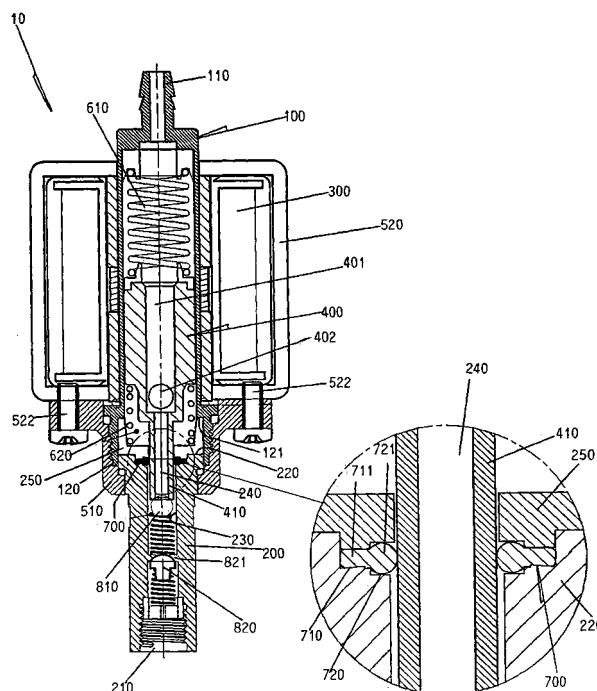


FIG. 3

FIG. 3A

Description

[0001] The present invention relates to a fluid pump and more particularly but not exclusively to an AC plunger pump for pumping water in a coffee maker for example.

BACKGROUND OF INVENTION

[0002] Seals, including seal rings or O-rings, are an integral part of piston and plunger pumps to separate the power fluid from the media that is being pumped or to separate high and low pressure chambers of the pumped media. The seals, the pistons or plungers and the cylinders must have a very tight control of tolerance in dimension.

[0003] In a perfect condition, an O-ring will only be subject to high fluid pressure from the high pressure side on only that (principal) side of the ring, as illustrated in Figure 6A. The resultant force is one that presses the ring in a direction substantially parallel to the direction of movement of the pumping member, without affecting pumping member's movement.

[0004] In an imperfect condition, due to production inaccuracy or wear-and-tear for example, high pressure fluid often gets behind the O-ring, on the outer side thereof, and presses and deforms the ring against the pumping member, as illustrated in Figure 6B. This will hinder the movement of the pumping member by excessive friction, and reduce the operating life of the ring.

[0005] The invention seeks to obviate or at least alleviate such a problem or shortcoming by providing an improved fluid pump.

SUMMARY OF THE INVENTION

[0006] According to the invention, there is provided a fluid pump comprising a chamber having an inlet and an outlet, and a pumping member extending into the chamber and supported for sliding movement 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 the opposite direction inwardly of the chamber to force fluid out of the chamber via the outlet. There is a driver for sliding the pumping member in said opposite directions. A seal ring is provided between the chamber and the pumping member and yet permits said sliding movement of the pumping member relative to the chamber. The seal ring has a first annular portion clamped fast in a wall of one of the chamber and pumping member and a second annular portion of a bulbous cross-section in sliding sealing engagement with a wall of the other of the chamber and pumping member.

[0007] Preferably, the bulbous cross-section is relatively thicker than the first annular portion.

[0008] It is preferred that the bulbous cross-section is at least part-circular.

[0009] Preferably, the first and the second annular portions have cross-sections that are symmetrical about a

common central axis.

[0010] It is preferred that the first annular portion has a cross-section that is generally flat.

[0011] It is preferred that the first annular portion has a cross-section that is generally T-shaped.

[0012] It is preferred that the first and the second annular portions have a combined cross-section that is generally dumbbell-shaped.

[0013] In a preferred embodiment, the seal ring has an outer annular portion as its first annular portion clamped fast in the wall of the chamber and an inner annular portion as its second annular portion in sliding sealing engagement with the wall of the pumping member.

[0014] More preferably, the seal ring is located at an opening of the chamber, through which the pumping member extends into the chamber.

[0015] Further more preferably, the opening coincides with the inlet of the chamber.

[0016] Preferably, a significant part of the second annular portion of the seal ring is also clamped in the wall of said one of the chamber and pumping member.

[0017] It is preferred that the pumping member has a bore that acts as the inlet of the chamber.

[0018] Preferably, the pumping member comprises a plunger.

[0019] It is preferred that the fluid pump includes one-way valves provided at the inlet and outlet respectively.

[0020] Preferably, the driver is an electro-mechanical driver.

[0021] More preferably, the driver is provided by a solenoid comprising an electro-magnetic coil surrounding a ferro-magnetic plunger whose front end acts as the pumping member.

BRIEF DESCRIPTION OF DRAWINGS

[0022] 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 front view of an embodiment of a fluid pump in accordance with the invention;

Figure 2 is a side view of the pump of Figure 1;

Figure 3 is a cross-sectional view of the pump of Figure 1;

Figure 3A is an enlarged cross-sectional view of a part of the pump of Figure 3, including a seal ring;

Figure 4 is a cross-sectional view equivalent to Figure 3A, illustrating how the seal ring is subject to fluid pressure;

Figure 5 is a cross-sectional side view of the seal ring in isolation;

Figure 6A is a cross-sectional view equivalent to Figure 4, illustrating how a conventional seal ring is subject to high fluid pressure in a perfect condition;

Figure 6B is a cross-sectional view corresponding to Figure 6A, illustrating how the seal ring is subject to high fluid pressure in an imperfect condition;

Figure 7 is a cross-sectional view of another, slightly different embodiment of a fluid pump in accordance with the invention; and

Figure 7A is an enlarged cross-sectional view of a part of the pump of Figure 7, including a seal ring.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0023] Referring to Figures 1 to 5 of the drawings, there is shown a fluid pump 10 embodying the invention, which has a slender cylindrical metal housing 100, a metal tube 200 connected endwise with the housing 100 from below, a coil 300 surrounding the housing 100 and an elongate slider 400 inside the housing 100. The housing 100 has a small tubular inlet 110 protruding from its upper one end for connection to a water tank by a hose for example. The lower end of the tube 200 acts as an outlet 210 (internally screw-threaded) for supplying water to an electric boiler for example. Adjacent open ends 120 and 220 of the housing 100 and tube 200 are joined together by means of a screw-threaded cylindrical coupler 510. The coupler 510 also supports a casing 520 for the coil 300, with the use of a pair of screws 522.

[0024] The slider 400 is supported and guided by the housing 100 for axial sliding movement, like piston-in-cylinder, in opposite upward and downward directions. The coil 300 is an electro-magnetic coil that acts upon and drives the slider 400, which is made of a ferro-magnetic material, together forming an electro-mechanical device i.e. a solenoid. The slider 400 is positioned by a pair of upper and lower coil springs 610 and 620 at opposite ends coacting with respective upper and lower ends of the housing 100, such that the slider 400 stays at rest downwardly offset from the coil 300.

[0025] Upon energization by the AC mains power source, the coil 300 intermittently moves to align the slider 400 upwardly against the action of the springs 610 and 620, whereby the slider 400 is driven into reciprocation vertically along the housing 100.

[0026] The lower end of the slider 400 is reduced into a much thinner section that acts as a plunger 410. The tube 200 defines a cylindrical chamber 230 into which, at the open end 220 thereof, the plunger 410 extends. At this open end 220 there is provided a seal ring 700 acting between the chamber 230 and the plunger 410 and yet permitting sliding of the plunger 410 relative to the chamber 230.

[0027] The slider 400 has a through bore 401 along its

central axis, which extends from the uppermost end of the slider 400 through to the lowermost end of the plunger 410. The bore 401 through the plunger 410 has a correspondingly reduced diameter, acting as an inlet 240 of the chamber 230 which is situated within, or coincides with, the chamber's open end 220.

[0028] The bore 401 as a whole allows water from the interior of the housing 100 above the slider 400, entered via the inlet 110, to flow through the slider 400 down into the chamber 230. A bottom side hole 402 of the slider 400 joining the bore 401 allows communication and thus pressure balance of the interior of the housing 100 below the slider 400 with that above the slider 400.

[0029] Inside the chamber 230, a spring-loaded one-way valve including a ball 810 acts from below upon the lowermost end of the plunger 410 i.e. the inlet 240 of the chamber 230. Another spring-loaded one-way valve is employed in the lower part of the chamber 230 for the outlet 210 of the chamber 230, which is implemented by a valve member 820 acting from below upon a valve seat 821 provided by an annular flange of the chamber wall.

[0030] Upon the aforesaid vertical reciprocation of the slider 400 by the electro-magnetic coil 300, the plunger 410 performs a pumping action within the chamber 230.

More specifically, the plunger 410 slides on an upward suction stroke outwardly of the chamber 230 to introduce water into the chamber 230 via its inlet 240, with the inlet valve (810) being opened while the outlet valve (820) remains shut. Alternately, the plunger 410 slides on a downward discharge stroke inwardly of the chamber 230 to force water out of the chamber 230 via its outlet 210, with the outlet valve (820) being opened then while the inlet valve (820) is now shut.

[0031] The seal ring 700 is circular, having integrally an outer annular portion 710 of a generally flat rectangular cross-section 711 and an inner annular portion 720 of a bulbous cross-section 721. The two cross-sections 711 and 721 are symmetrical about a common central axis as shown. The bulbous cross-section 721 is circular or at least part-circular, and is slightly thicker than the adjoining flat cross-section 711 by an amount H on each opposite side.

[0032] The seal ring 700 has its outer annular portion 710 clamped fast in the wall of the chamber 230, at the upper end 220 thereof, whilst the inner annular portion 720 is in sliding sealing engagement with the wall of the plunger 410. To clamp the seal ring 700, an inverted cap-like clamp member 250 is employed, which fits from above upon the open upper end 220 of the tube 200 and clamps the seal ring 700 therebetween. The clamp member 250 has a central aperture for the plunger 410 to pass through. The member 250 is pressed firmly against the tube 200 while being supported by an annular shoulder 121 within the lower end 120 of the housing 100, upon tightening of the screw-threaded coupler 510 joining the tube 200 to the housing 100.

[0033] Confronting surfaces of the tube 200 and clamp member 250 are suitably stepped to clamp the entire

outer annular portion 710 tightly and to accommodate by sandwiching a substantial part of the inner annular portion 720 of the seal ring 700, with the outermost part of the inner annular portion 720 exposed for engaging the plunger 410.

[0034] The design of the seal ring 700 only allows high pressure water to push the ring 700 upwards, and no water can get around to the outermost edge of the ring 700 and therefore no pressure can build up there to act on and press the ring 700 against the plunger 410.

[0035] By reducing the valve of H, it is possible to limit the amount of high water pressure flowing around and acting upon the outer edge of round cross-section 721. This can further avoid the seal 700 from being pressed against the plunger 410 during high water pressure.

[0036] Reference is now made to Figures 7 and 7A, which show another fluid pump 10A embodying the invention, which has almost the same construction and operates in exactly the same way as the first fluid pump 10 described above, with equivalent parts designated by the same reference numerals suffixed by a letter "A".

[0037] The only difference lies in the design of the seal ring 700A, together with the confronting parts of the clamp member 250A and the tube end 220A that clamp and fix the ring 700A. The ring 700A likewise has an integral circular structure, which consists of an outer annular portion 710A of a generally T-shaped cross-section 711A and an inner annular portion 720A of a bulbous cross-section 721A. The T-shaped cross-section 711A lies on one side and shares a common central axis of symmetry with the other cross-section 721A as shown. The bulbous cross-section 721 is circular or at least part-circular, and is slightly thicker than the adjoining part of the T-shaped cross-section 711A.

[0038] The seal ring 700A is located and fixed by having its outer annular portion 710A clamped within the wall of the chamber 230A by and between the clamp member 250A and the tube end 220A, whose confronting clamping surfaces are made to have a cross-section of a shape substantially complementary to that of the outer annular portion 710A for clamping the same tight. The inner annular portion 720A is also accommodated or received between the said confronting clamping surfaces, with its outermost part exposed for sliding sealing engagement with the wall of the plunger 410A.

[0039] The two annular portions 710A and 720A have a combined cross-section that is shaped generally like a dumbbell such that the seal ring 700A can be clamped relatively more securely by its middle of a reduced thickness, compared with the first seal ring 700.

[0040] It is envisaged that the subject invention is applicable to all kinds of fluid (liquid or gas) pumps including reciprocating positive displacement pumps, whether they are direct- or indirect-acting, simplex or duplex, single- or double-acting, or power pumps.

[0041] 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.

5 Claims

1. A fluid pump comprising:

a chamber having an inlet and an outlet;
a pumping member extending into the chamber and supported for sliding movement 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 the opposite direction inwardly of the chamber to force fluid out of the chamber via the outlet;
a driver for sliding the pumping member in said opposite directions; and
a seal ring provided between the chamber and the pumping member and yet permitting said sliding movement of the pumping member relative to the chamber;

characterized in that the seal ring has a first annular portion clamped fast in a wall of one of the chamber and pumping member and a second annular portion of a bulbous cross-section in sliding sealing engagement with a wall of the other of the chamber and pumping member.

2. The fluid pump as claimed in claim 1, **characterized in that** the bulbous cross-section is relatively thicker than the first annular portion.

3. The fluid pump as claimed in claim 1, **characterized in that** the bulbous cross-section is at least part-circular.

4. The fluid pump as claimed in claim 1, **characterized in that** the first and the second annular portions have cross-sections that are symmetrical about a common central axis.

5. The fluid pump as claimed in claim 1, **characterized in that** the first annular portion has a cross-section that is generally flat.

6. The fluid pump as claimed in claim 1, **characterized in that** the first annular portion has a cross-section that is generally T-shaped.

7. The fluid pump as claimed in claim 1, **characterized in that** the first and the second annular portions have a combined cross-section that is generally dumbbell-shaped.

8. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the seal ring has an outer

annular portion as its first annular portion clamped fast in the wall of the chamber and an inner annular portion as its second annular portion in sliding sealing engagement with the wall of the pumping member.

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9. The fluid pump as claimed in claim 8, **characterized in that** the seal ring is located at an opening of the chamber, through which the pumping member extends into the chamber.

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10. The fluid pump as claimed in claim 9, **characterized in that** the opening coincides with the inlet of the chamber.

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11. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** a significant part of the second annular portion of the seal ring is also clamped in the wall of said one of the chamber and pumping member.

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12. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the pumping member has a bore that acts as the inlet of the chamber.

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13. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the pumping member comprises a plunger.

14. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** it includes one-way valves provided at the inlet and outlet respectively.

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15. The fluid pump as claimed in any one of claims 1 to 7, **characterized in that** the driver is an electro-mechanical driver.

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16. The fluid pump as claimed in claim 15, **characterized in that** the driver is provided by a solenoid comprising an electro-magnetic coil surrounding a ferromagnetic plunger whose front end acts as the pumping member.

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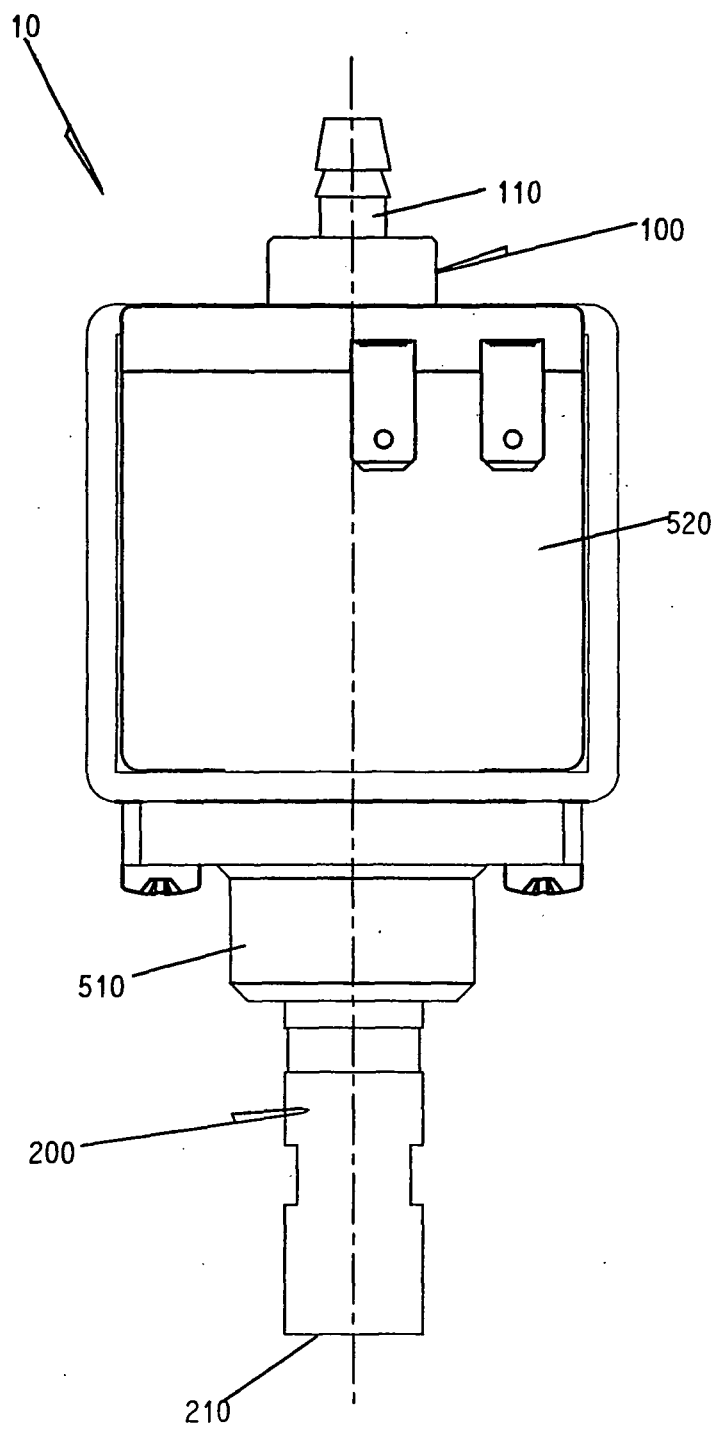


FIG. 1

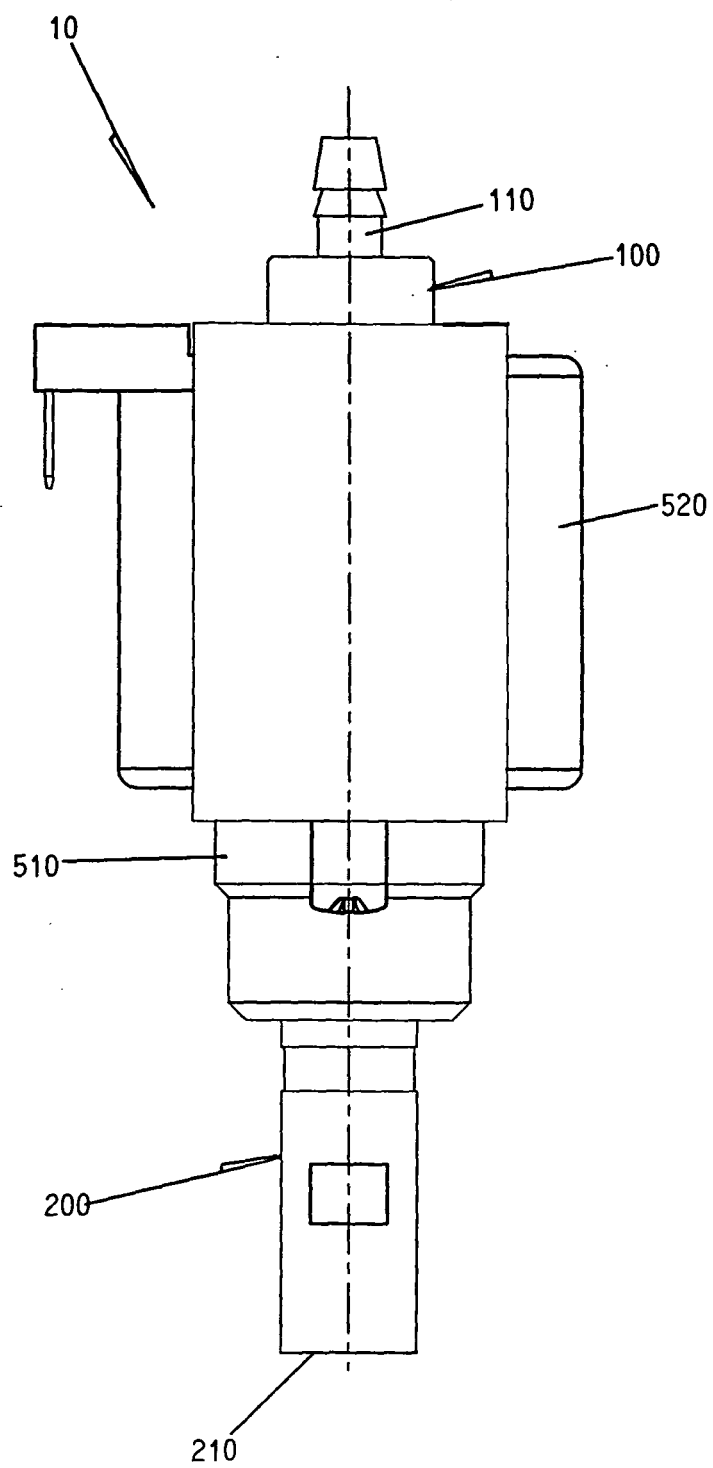


FIG. 2

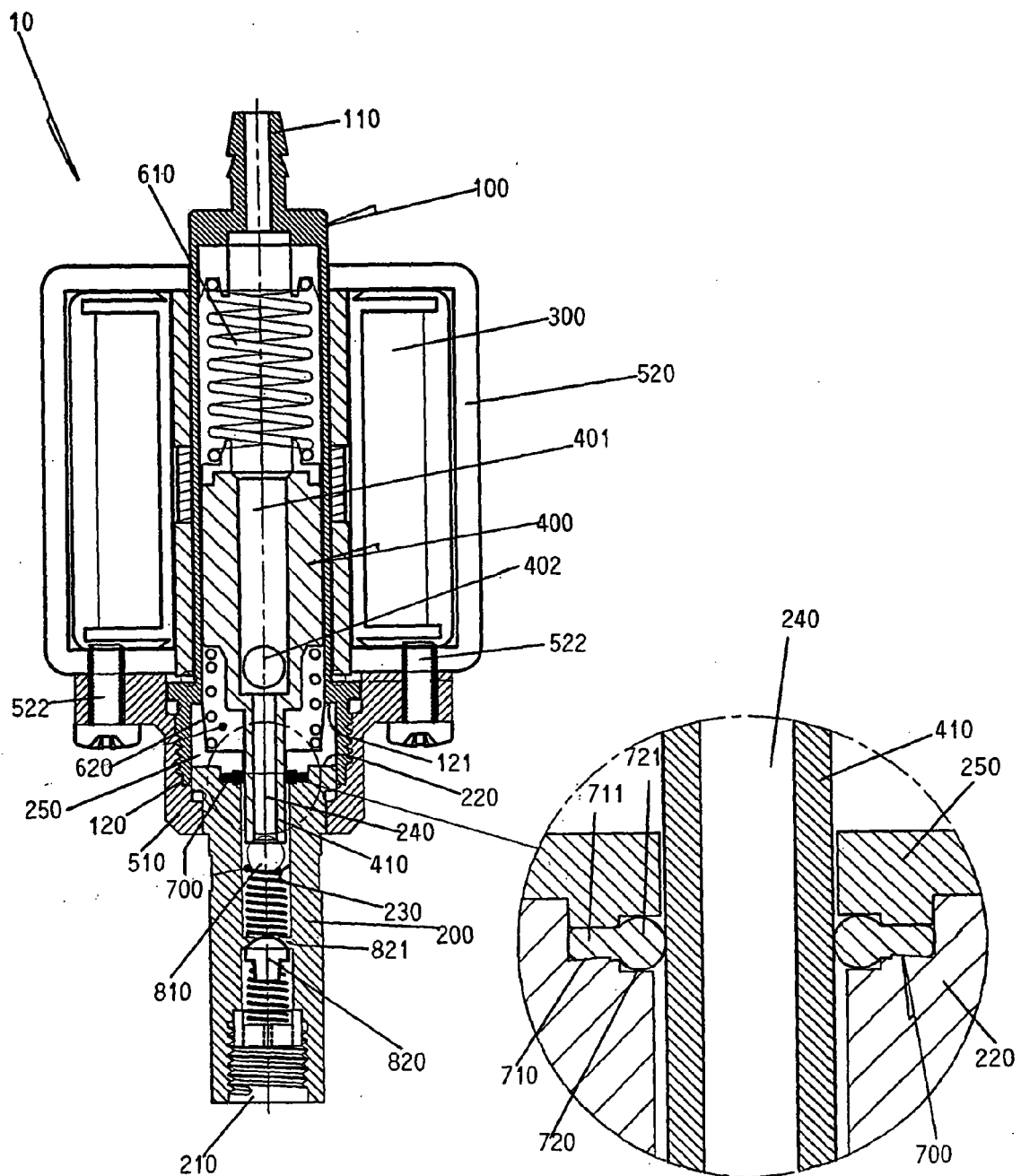


FIG. 3

FIG. 3A

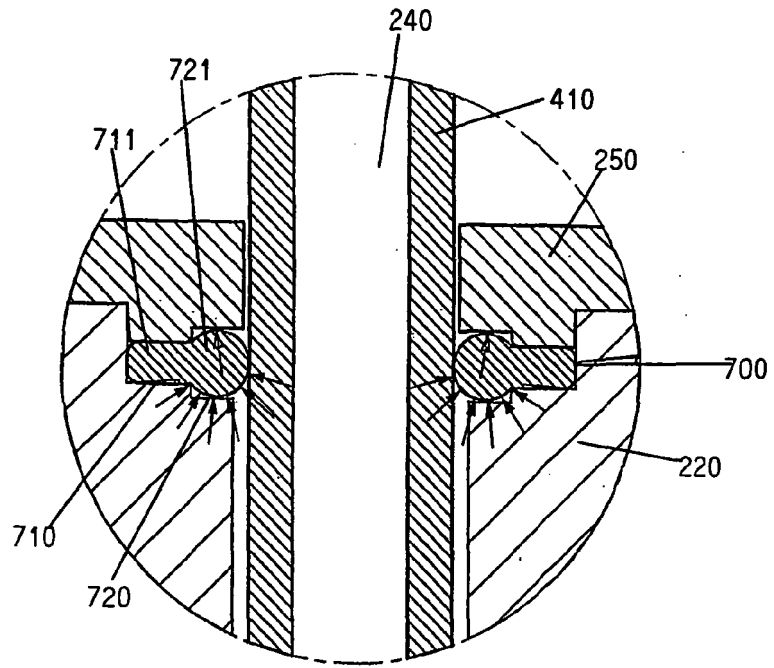


FIG. 4

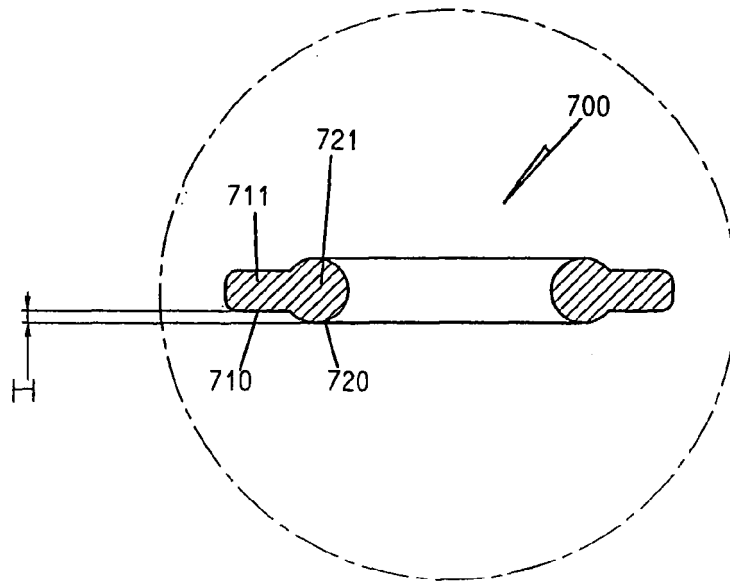


FIG. 5

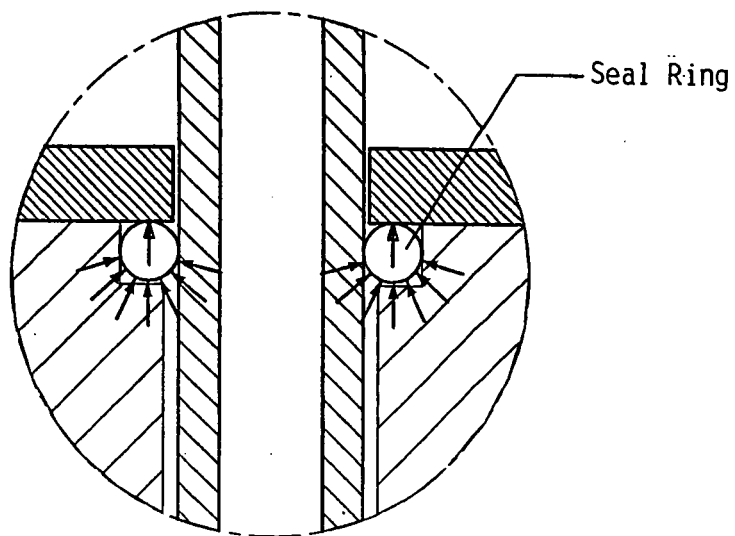


FIG. 6A

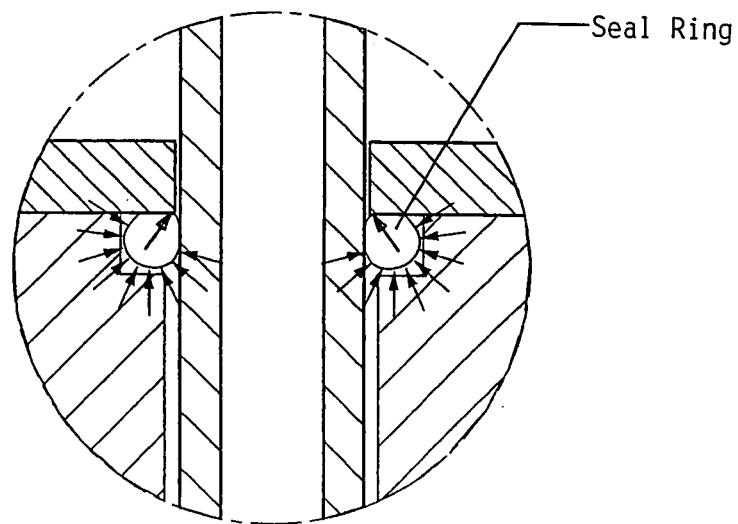


FIG. 6B

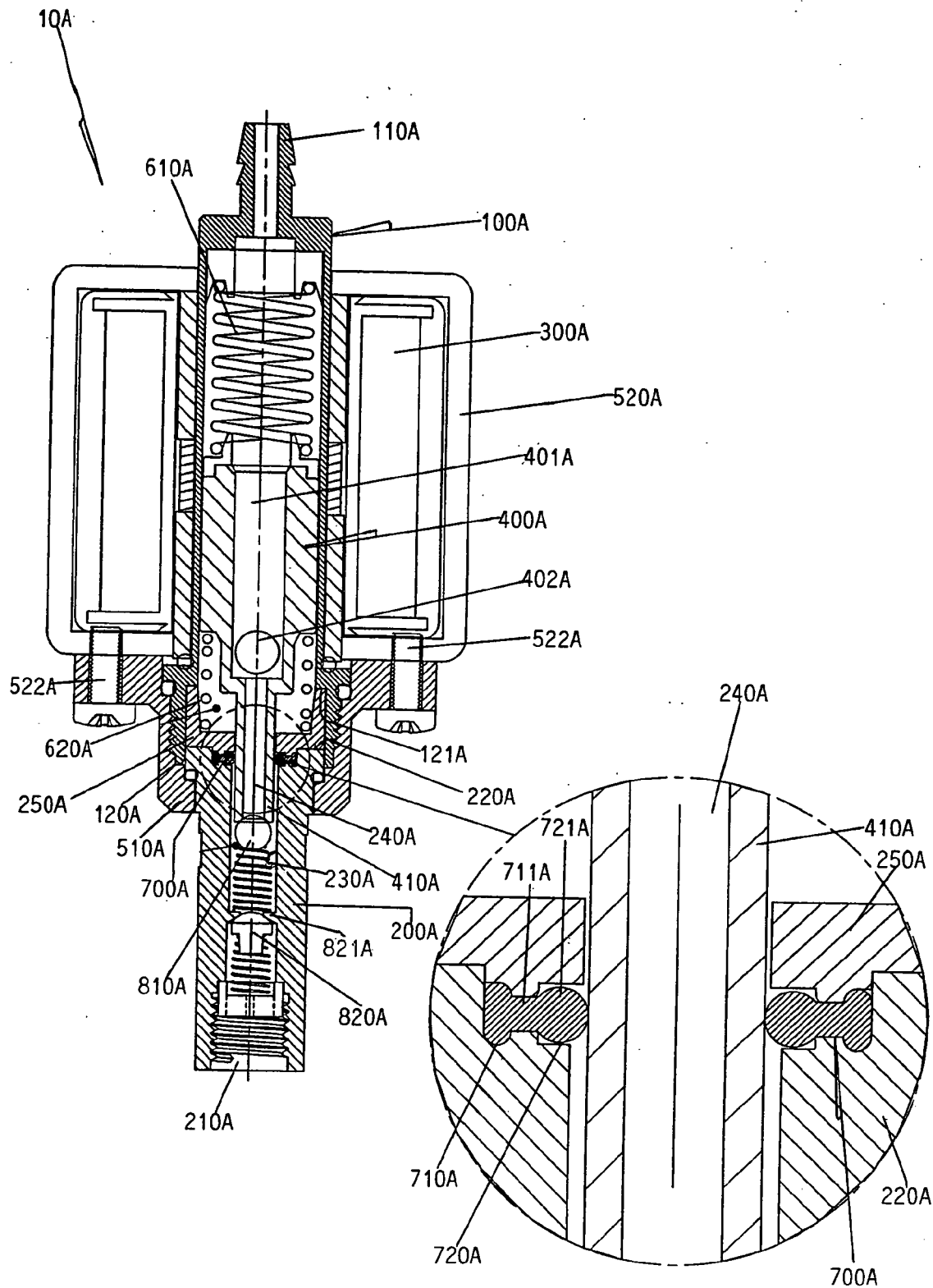


FIG. 7

FIG. 7A