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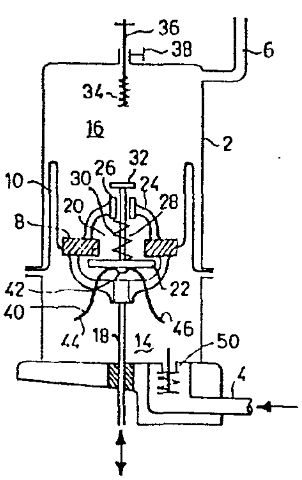
(54) **Fluid-driven reciprocating motor.**

(57) A fluid-driven reciprocating motor comprises a cylinder (2) and a displaceable piston (8) formed with a valve opening (20) therethrough and carrying a valve member (22) effective to close the valve opening (20) during the forward strokes and to open it during the return strokes. A stop (36) at the outlet end of the cylinder (2) is engageable with the valve member (22) at the end of the forward strokes to cause the valve member (22) to open the valve opening (20) to start the return strokes. The stop (22) includes a spring (34) effective, when engaged by the valve member (22) at the end of the forward strokes, to yield and thereby to store energy, which energy is transferred to the engaged valve member (22) at the start of the return strokes to maintain the valve member (22) in its open position for a short interval until the pressure in the inlet and outlet chambers (14, 16) has been substantially equalized at the start of the return strokes by the opening of the valve member (22).

FIG. 1



# FLUID-DRIVEN RECIPROCATING MOTOR

The present invention relates to fluid driven reciprocating motors, particularly to the type including a cylinder and a displaceable member reciprocatable within the cylinder through forward and return strokes.

Reciprocating motors of the foregoing type are widely used in many diverse applications, such as reciprocating drives for pumps and other devices. However, efforts are continuously being made to simplify the construction of such reciprocating motors, reduce their manufacturing cost, and increase their efficiencies.

An object of the present invention is to provide a fluid driven reciprocating motor having a novel construction providing advantages in one or more of the above respects.

According to a broad aspect of the present invention, there is provided a fluid driven reciprocating motor, comprising: a cylinder having an inlet and an outlet at opposite ends; a displaceable member reciprocatable within said cylinder and dividing its interior into an inlet chamber communicating with said inlet, and an outlet chamber communicating with said outlet; said displaceable member being movable, during forward strokes, by the pressurized fluid applied to said inlet chamber in the direction to expand said inlet chamber and to contract said outlet chamber, and being movable during return strokes in the reverse direction to expand said outlet chamber and to contract said inlet chamber; said displaceable member being formed with a valve opening therethrough; a valve member carried by said displaceable member and effective during said forward strokes to close said valve opening; and a stop at the outlet end of said cylinder and engageable with one of said members at the end of the forward strokes to cause said valve member to open said valve opening to start said return strokes; said stop including yieldable means effective, when engaged by said one member at the end of the forward strokes, to yield and thereby to store energy, which energy is transferred to said one member at the start of the return strokes to maintain said valve member in its open position for a short interval at the start of the return strokes until the pressure in the inlet and outlet chambers has been substantially equalized by said valve member opening said valve opening.

Several embodiments of the invention are described below for purposes of example to illustrate various forms that the invention may take. Thus, the mentioned stop may engage the valve member or the displaceable member at the end of the forward strokes; and the displaceable member may be biased by the weight of its load or by a return spring to move through its return strokes.

According to a further described feature, the motor may include a second stop at the inlet end of the cylinder engageable with the displaceable member at the end of the return strokes to cause the valve member to close the valve opening and thereby to start the forward strokes. Peferably, the second stop includes spring means effective, when engaged by the displaceable member at the end of the return strokes and after the valve member has closed, to cushion the displaceable member at the end of its return strokes.

According to a still further feature, the inlet to the motor may include a kinematic valve responsive to the rate of flow of the pressurized fluid therethrough, so as to open during the forward strokes when the rate is relatively low, and to close during the return strokes when the rate is relatively high.

It has been found that the foregoing features of the invention permit the construction of reciprocating motors having but a few simple parts and capable of operating at relatively high efficiency.

Further features and advantages of the invention will be apparent from the discription below.

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 schematically illustrates one form of fluid driven reciprocating motor constructed in accordance with the present invention;

Fig. 1a illustrates the structure of a kinematic valve included in the inlet end of the reciprocating motor of Fig. 1;

Fig. 2 schematically illustrates another motor constructed in accordance with the present invention; and

Figs. 3 and 4 are longitudinal sectional views illustrating two further forms of reciprocating motors constructed in accordance with the present invention.

The reciprocating motor illustrated in Fig. 1 comprises a cylinder 2, having an inlet 4 and an outlet 6 at opposite ends. A disc 8, mounted within cylinder 2 by means of a rolling diaphragm 10, is reciprocatable within the cylinder and divides its interior into an inlet chamber 14 including inlet 4, and an outlet chamber 16 including outlet 6. As will be described more particularly below, disc 8 is driven by the pressurized fluid applied to the inlet chamber 14 via inlet 4, through forward strokes (in the upward direction in Fig. 1) expanding the inlet chamber 14 and contracting the outlet chamber 16; in the example illustrated in Fig. 1, disc 8 is driven in the reverse direction by the weight of its load through return strokes expanding the outlet chamber 16 and contracting the inlet chamber 14. These reciprocating movements of disc 8 are transmitted via an output shaft 18, to a pump or other device reciprocated by the illustrated paragraph.

Reciprocating disc 9 is formed with a valve opening 20 therethrough establishing communication between the inlet chamber 14 and the outlet chamber 16. This disc 8, however, also includes a valve member 22 which closes opening 20 during the forward strokes of the motor in order to permit the pressurized fluid applied via inlet 4 to drive disc 8 through its forward strokes (upwardly in Fig. 1). Valve member 22 is moved to its open position with respect to opening 20 during the return strokes of the motor to enable the weight of disc 8, together with the weight of the output shaft 18 and the load coupled to the disc via a bridge 24, to drive the disc (downwardly) through its return strokes.

For this purpose, reciprocating disc 8 is provided with a bridge member 24 formed with an opening 26 receiving the stem 28 of valve member 22. A spring 30 is interposed between bridge 24 and valve member 22 and normally biases valve member 22 to its open position with respect to valve opening 20 formed through the disc. Valve stem 28 is formed with an enlarged head 32 engageable with a coiled spring 34 carried at the end of a stop 36 at the end of cylinder 2 adjacent to its outlet 6. Stop 36 is adjustable by a screw 38 to fix the length of the forward strokes.

Valve member 22 further carries a U-shaped spring 40 secured by a fastener 42 to the underside of the valve member, and terminating at its oppostie ends by spring legs 44, 46 engageable with cylinder 2, or a member fixed thereto, at its end adjacent to its inlet 4.

Inlet 4 to the cylinder further includes a kinematic valve 50 responsive to the rate of flow of the pressurized fluid through inlet 4, so as to open during the forward strokes of the motor when the rate is relatively low, and to close during the return strokes when the rate is relatively high. Fig. 1a illustrates one known structure of kinematic valve which may be used for this purpose.

Thus, the kinematic valve illustrated in Fig. 1a comprises a cylindrical housing 51 having one end 52 connected to inlet 4, and the opposite end 53 leading into the inlet chamber 14. Housing 51 further includes a wall 54 formed with an opening 55 cooperable with a valve member 56 which is movable with respect to opening 55 either to open it (as shown in Fig.1a) or to close it. For this purpose, valve member 56 includes a stem 57 passing through a guide 58, the valve member being biased to its illustrated open position by a spring 59.

Kinematic valves as illustrated in Fig. 1a are well known. Thus, when the fluid is inletted into housing 51 via inlet 52 at a relatively low rate, spring 59 is sufficient to urge valve member 56 to its open position with respect to opening 55 as illustrated in Fig. 1a; however, when the rate of the fluid increases to a predetermined high value, the inletted fluid applies a force to valve member 56 sufficiently high to overcome the bias of spring 59 and to move the valve member to its closed position with respect to opening 55.

The reciprocating motor illustrated in Fig. 1 thus operates as follows:

The displaceable disc 8 would normally be at its lowermost position because of the weight of the disc, its output shaft 18, and whatever other load is coupled to the output shaft. In this position, valve member 22 is urged by spring 30 to its open position with respect to valve opening 20.

As soon as pressurized fluid is applied via inlet 4, the pressure built up in the inlet chamber 14 moves valve member 22 to its closed position with respect to opening 20. As the pressure within chamber 14 increases, disc 8 is driven upwardly, through its forward stroke carrying with it valve member 22, which valve member is maintained in its closed position by the pressure within inlet chamber 14.

At the end of the forward stroke of disc 8, head 32 of valve member stem 28 engages spring 34 of stop 36, thereby restraining the valve member from rising with the disc 8. This causes the valve member to open, so that the high pressure within chamber 14 is now communicated to the outlet chamber 16. This point marks the end of the forward stroke and the beginning of the return stroke: the return stroke is effected by the weight of disc 8, its output shaft 18, and the load coupled thereto. The end of the return stroke occurs when spring legs 44, 46 of spring member 40 engages the inlet end of cylinder 2, or some member fixed thereto, thereby moving valve member 22 to its closed position with respect to valve opening 20.

As described above, the end of the forward stroke occurs when the enlarged head 32 of valve stem 28 engages spring 34 of stop 36 to move valve member 22 to its open position with respect to valve opening 20. When stem head 32 first engages spring 34, the spring is compressed to store energy therein, while valve member 22 is moved to its open position with respect to valve opening 20. The energy thus stored in spring 34 is immediately transferred to head 32 of valve member 22 at the start of the return stroke to maintain the valve member in its open position for a short interval at the start of the return stroke until the pressure in the outlet chamber 16 is substantially equalized with that in the inlet chamber 14, at least sufficiently to maintain the valve member in its open position. This arrangement of providing a spring 34, or other yieldable means for storing energy at the end of the forward stroke, has been found very effective to prevent the possibility of the valve member immediately closing at the beginning of the return stroke, which would thereby prevent the disc from moving through its return strokes.

It will also be appreciated that during the forward strokes, when valve member 22 is closed, the rate of flow of the pressurized fluid into inlet 4 and through the kinematic valve 50 is relatively low, and therefore the kinematic valve is in its open condition. However, during the return strokes when valve member 22 is in open position with respect to valve opening 20, the rate of flow tends to be high, which causes kinematic valve member 56 (Fig. 1a) to be moved to close its valve opening 54, thereby preventing the wastage of considerable pressurized fluid during the return strokes of the reciprocating motor.

Fig. 2 schematically illustrates another embodiment of the invention wherein the displaceable member reciprocating within the cylinder, therein designated 102, is in the form of a piston 108, rather than in the form of a disc (8) including a rolling diaphragm (10) as in Fig. 1. Another variation included in the reciprocating motor of Fig. 2 is that the piston 108 is driven through its return strokes by a return spring 111 interposed between piston 108 and the outlet 106 end of the cylinder 102. A further variation is that the spring 134, for storing energy at the end of the forward strokes and for transferring same to the valve member 122 to maintain the latter in its open condition, is carried by stem 130 of the valve member, rather than by stop 136 at the outlet end of the cylinder 102. A still further variation is in the construction of the stop carried by valve member 122 for terminating the return strokes, this stop being in the form of two or more legs 140 carried by valve member 122 and including springs 144, 146 at their lower ends corresponding to spring legs 144, 146 in Fig. 1.

The reciprocating motor illustrated in Fig. 2 is otherwise of the same construction, and operates in the same manner by pressurized fluid applied via inlet 104, as described above with respect to the motor of Fig. 1, it being appreciated that piston 108 is driven through its return strokes by spring 111 which has been loaded during the forward strokes. It will also be appeciated that the motor of Fig. 2 includes a kinematic valve, corresponding to valve 50 in Figs. 1 and 1a, for limiting the rate of flow of the pressurized fluid into the inlet particularly during the return strokes when valve member 122 is in its open position with respect to valve opening 120.

Fig 3 also illustrates a motor of the type including a cylinder 202 and a reciprocating piston 208, but with further modifications. Thus, in the motor illustrated in Fig. 3, the valve member 222 cooperable with the valve opening 220 through the piston 208 overlies the piston and is directly connected to the output shaft 218 so that the valve member is normally biased to close valve opening 220, by its own weight, the weight of the output shaft 218, and the weight of the load on the output shaft. A spring 230 is interposed between piston 208 and valve member 222.

Another important variation is that the stop, which is carried at the outlet 206 end of cylinder 202, and which determines the end of the forward strokes, is in the form of a ring 236 engaged by the piston 208, rather than by the valve member as in the previously-described embodiments. Thus, at the end of the forward strokes the continued (upward) travel of piston 208 is restrained by ring 236, permitting valve member 222 to move upwardly and thereby to open valve opening 220, which equalizes the pressure within the inlet chamber 214 and the outlet chamber 216 to mark the beginnning of the return stroke. Stop ring 236 is yieldingly mounted by a plurality of springs 234 which absorb energy at the end of the forward strokes, and which transfer this energy back to the piston 208 at the beginning of the return strokes to keep the piston in open position with respect to valve member 222 until the pressure in the two chambers has been equalized.

A still further modification in the arrangement illustrated in Fig. 3 is that the inlet chamber 214 also includes a stop ring 240 mounted by springs 242 adjacent to the inlet 204 end out the cylinder. Thus, at the end of the return strokes, piston 208 engages ring 240, which ring restrains the piston while springs 242 are compressed, and valve member 222 closes valve opening 220. Piston 208, and also valve member 222 as well as output shaft 218 and the load coupler too, are thereby cushioned by the compression of springs 242 and also by the pressurized fluid trapped within the inlet chamber 214 when valve member 222 has closed valve opening 220.

In all other respects, the reciprocating motor illustrated in Fig. 3 operates in substantially the same manner as described above with respect to Figs. 1 and 2, and also, of course, includes the kinematic valve (50, Fig. 1) in order to prevent waste of the compressed fluid during the return strokes.

Fig. 4 illustrates a reciprocating motor very similar to that of Fig. 3, also including a piston 308 reciprocating within a cylinder 302. In the motor of Fig. 4, however, the return strokes are effected by a spring 311 interposed between the valve member 322 and the end wall of cylinder 302 adjacent to its outlet 306.

While the invention has been described with respect to several preferred embodiments, it will be appreciated in many other variations, modifications and applications of the invention may be made.

WHAT IS CLAIMED IS:

1. A fluid driven reciprocating motor, comprising:

a cylinder having an inlet and an outlet at opposite ends;

a displaceable member reciprocatable within said cylinder and dividing its interior into an inlet chamber communicating with said inlet, and an outlet chamber communicating with said outlet;

said displaceable member being movable, during forward strokes, by the pressurized fluid applied to said inlet chamber in the direction to expand said inlet chamber and to contract said outlet chamber, and being movable during return strokes in the reverse direction to expand said outlet chamber and to contract said inlet chamber;

said displaceable member being formed with a valve opening therethrough;

a valve member carried by said displaceable member and effective during said forward strokes to close said valve opening;

and a stop at the outlet end of said cylinder and engageable with one of said members at the end of the forward strokes to cause said valve member to open said valve opening start the return stroke;

said stop including yieldable means effective, when engaged by said one member at the end of the forward strokes, to yield and thereby to store energy, which energy is transferred to said one member at the start of the return strokes to maintain said valve member in its open position for a short interval at the start of the return strokes until the pressure in the inlet and outlet chambers has been substantially equalized by said valve member opening said valve opening.

2. The motor according to Claim 1, wherein said inlet includes a kinematic valve responsive to the rate of flow of the pressurized fluid therethrough, so as to open during the forward strokes when the rate is relatively low, and to close during the return strokes when the rate is relatively high.

3. The motor according to either of Claims 1 or 2, wherein said stop engages said valve member at the end of the forward strokes to cause same to open said valve opening.

4. The motor according to either of Claims 1 or 2, wherein said stop engages said displaceable member at the end of the forward strokes to cause the valve member to move with respect to the displaceable member and thereby to open said valve opening.

5. The motor according to any one of Claims 1-4, further including a second stop carried by the valve member and engageable with the cylinder at the end of the return strokes to move the valve member to its closed position with respect to the valve opening at the end of the return strokes.

6. The motor according to any one of Claims 1-4, further including a second stop at the inlet end of said cylinder engageable with said displaceable member at the end of the return strokes to cause said valve member to close said opening and thereby to start said forward strokes.

7. The motor according to Claim 6, wherein said second stop includes a ring secured via spring means to said inlet chamber of the cylinder so as to be engaged by the displaceable member at the end of its return strokes.

8. The motor according to any one of Claims 1-7, wherein said valve member is disposed on the inlet chamber side of said displaceable member and is biased to its open position with respect to said valve

opening but is movable by the inlet pressure to its closed position during the forward strokes.

9. The motor according to any one of Claims 1-7, wherein said valve member is disposed on the outlet chamber side of said displaceable member and is moved by its weight to its closed position with respect to the valve opening during the forward strokes.

10. The motor according to any one of Claims 1-9, wherein said displaceable member is a piston movable within said cylinder.

11. A fluid driven reciprocating motor substantially as described with reference to and as illustrated in the accompanying drawings.

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FIG. 1

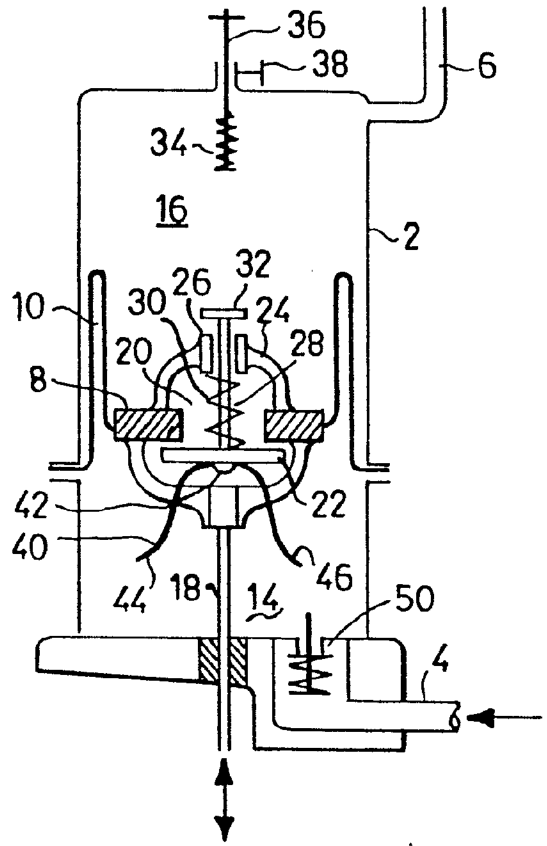


FIG 1a

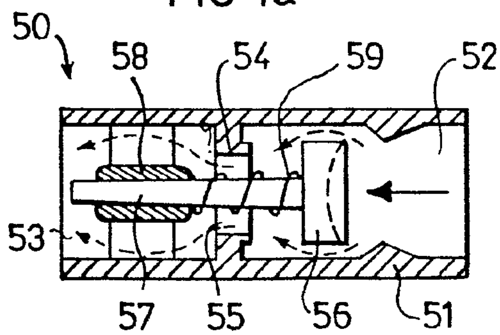


FIG. 2

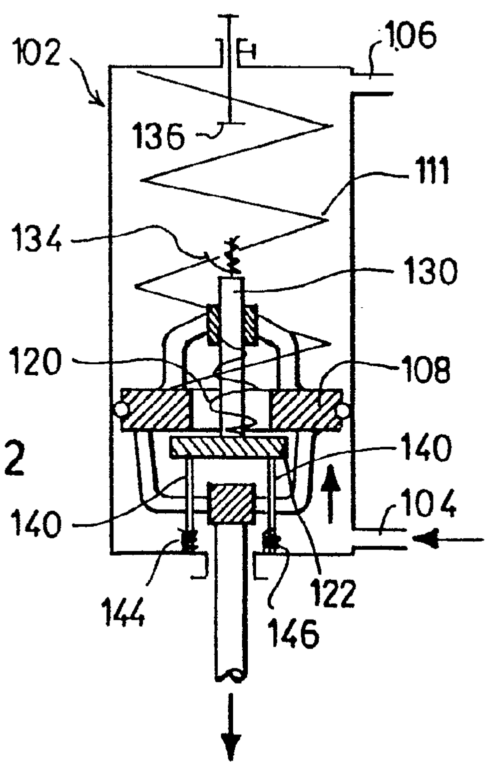

FIG. 3

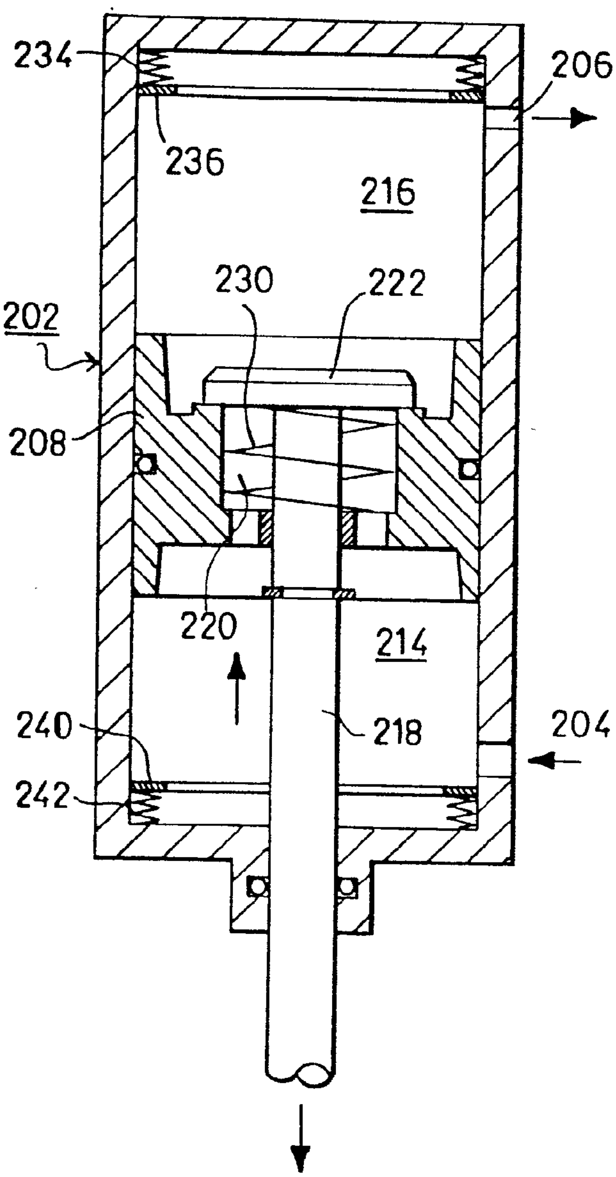
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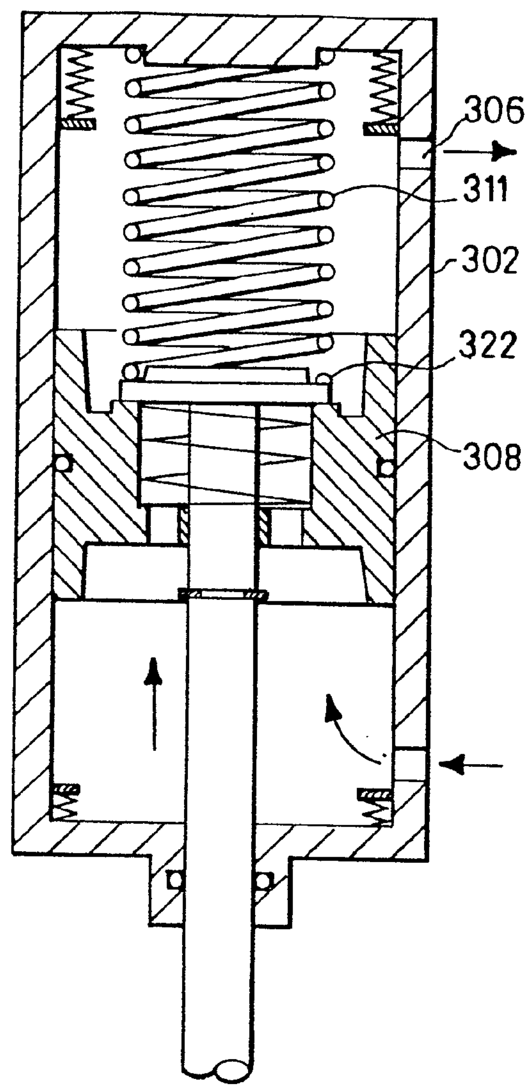
FIG. 4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