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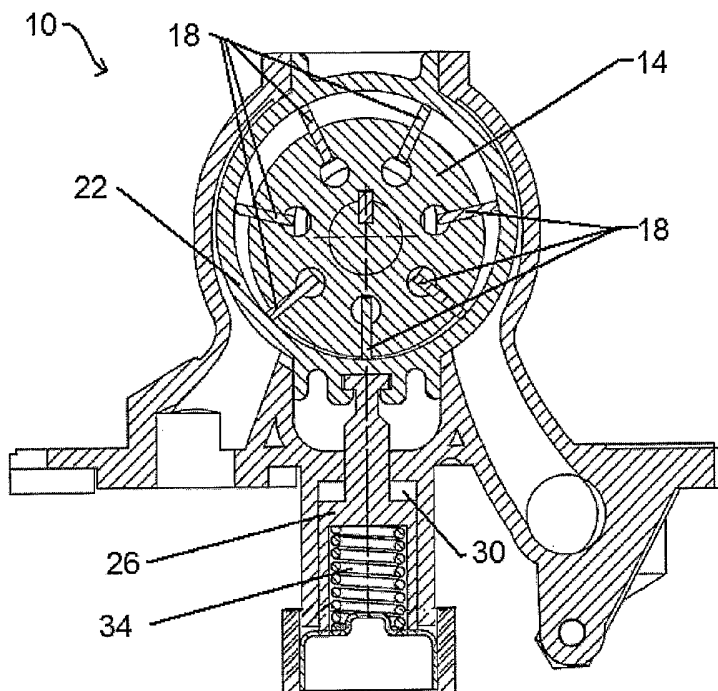
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(54) Title: VARIABLE CAPACITY VANE PUMP WITH OUT-OF-PLANE CONTROL



(prior art)

element, such as a control spring, is located either above or below the rotor plane.

(57) Abstract: Variable capacity vane pumps are provided which require less radial volume about the pump by placing the pump control mechanism out of the plane of the pump rotor. In one embodiment, the control mechanism is placed on one side of the rotor plane and is connected to the capacity adjusting element by a pin, or other suitable mechanism. In another embodiment, the control mechanism is split above and below the plane of the pump rotor, with one element of the control mechanism, such as a control spring, being located on one side of the rotor plane and another element of the control mechanism, such as a control piston, being located on the other side of the rotor plane. In yet another embodiment, two control mechanisms are provided, one on each side of the rotor plane, to provide different equilibrium operating pressures for the pump. In yet another embodiment, the element of the control mechanism which moves the capacity adjusting element to increase capacity is a chamber supplied with pressurized working fluid to urge the capacity adjusting element to reduce capacity. In this embodiment, a biasing



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Variable Capacity Vane Pump With Out-Of-Plane Control

FIELD OF THE INVENTION

[0001] The present invention relates to a variable capacity vane pump. More specifically, the present invention relates to a variable capacity vane pump wherein the control mechanism controlling the capacity adjusting ring is located out of the plane of the pump rotor to reduce the diameter of the pump.

BACKGROUND OF THE INVENTION

[0002] Variable capacity vane pumps are well known and feature a capacity adjusting element in the form of a pump capacity adjusting ring, or slide, that can be moved to alter the rotor eccentricity of the pump and hence alter the volumetric capacity of the pump. Typically, the ring is mounted within the pump body by a pivot pin or linear slide and an appropriate control system, usually an output pressure-driven piston acting against a spring, is provided to move the ring about the pivot or linear guide to obtain the desired equilibrium pressure from the pump.

[0003] While such pumps operate very well, they do suffer from disadvantages in that they require a relatively large radial volume, compared to some other types of pumps, and it can be difficult or impossible to provide the required radial volume in many applications, such as automotive engines and/or transmissions.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a novel variable capacity vane pump which obviates or mitigates at least one disadvantage of the prior art.

[0005] According to a first aspect of the present invention, there is provided a variable capacity vane pump comprising: a pump housing; a rotor being rotatably mounted with the pump housing; a capacity adjusting element surrounding the rotor and being moveable with respect to the axis of rotation of the rotor to alter the capacity of the pump; and a control mechanism connected to the capacity

adjusting element to move the capacity adjusting element to adjust the capacity of the pump, the control element being located out of the plane which the rotor rotates in.

[0006] Preferably, the control mechanism includes a control spring and a control piston, the control spring biasing the capacity adjusting element to increase the capacity of the pump and the control piston being urged by pressurized working fluid from the pump or from an engine lubrication system or from any other suitable source to move the capacity adjusting element to reduce the capacity of the pump. In another preferred aspect, the control spring is located in one of a position above or below the plane and the control piston is located in the other of a position above or below the plane. In yet another preferred aspect, the control mechanism includes a control spring and a control chamber, the control spring biasing the capacity adjusting element to increase the capacity of the pump and the control chamber being supplied with pressurized working fluid to urge the capacity adjusting element to reduce the capacity of the pump.

[0007] The present invention provides variable capacity vane pumps which require less radial volume about the pump by placing the pump control mechanism out of the plane of the pump rotor. In one embodiment, the control mechanism is placed on one side of the rotor plane and is connected to the capacity adjusting element by a pin, or other suitable mechanism. In another embodiment, the control mechanism is split above and below the plane of the pump rotor, with one element of the control mechanism, such as a control spring, being located on one side of the rotor plane and another element of the control mechanism, such as a control piston, being located on the other side of the rotor plane. In yet another embodiment, two control mechanisms are provided, one on each side of the rotor plane, to provide different equilibrium operating pressures for the pump to provide a variable displacement variable pressure pump. In yet another embodiment, the element of the control mechanism which moves the capacity adjusting element to increase capacity is a chamber supplied with pressurized working fluid to urge the capacity adjusting element to reduce capacity. In this embodiment, a biasing element, such as a control spring, is

located either above or below the rotor plane to act against the force created by the pressurized fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Preferred embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

Figure 1 shows a cross section through the front of a prior art variable capacity vane pump;

Figure 2 shows a cross section through the front of a variable capacity vane pump in accordance with the present invention;

Figure 3 shows a side view of the pump of Figure 2;

Figure 4 shows a cross section through the front of another variable capacity vane pump in accordance with the present invention;

Figure 5 shows a side view of the pump of Figure 4;

Figure 6 shows a top and side perspective view of a variable capacity and variable pressure vane pump in accordance with the present invention;

Figure 7 shows a side view of the pump of Figure 6;

Figure 8 shows a top and side perspective view of another variable capacity and variable pressure vane pump in accordance with the present invention; and

Figure 9 shows a side view of the pump of Figure 8.

DETAILED DESCRIPTION OF THE INVENTION

[0009] A prior art variable capacity vane pump is indicated at 10 in Figure 1. As shown, pump 10 includes a pump rotor 14 with moveable vanes 18 and pump rotor 14 rotates with a moveable capacity adjusting ring 22. As ring 22 is moved with respect to rotor 14, about a pivot pin 24, the eccentricity of rotor 14 with respect to ring 22 is altered, varying the volumetric capacity of pump 10.

[0010] In pump 10, ring 22 is controlled by a control piston 26 which is connected to ring 22 and which has a volume 30 into which pressurized working fluid is supplied to rotate slide ring 22 counterclockwise, in the illustrated orientation, about pivot pin 24 to reduce the volumetric capacity of pump 10. A

control spring 34 acts against control piston 26 to bias ring 26 clockwise, in the illustrated orientation, about pivot pin 24 to increase the capacity of pump 10. By correctly sizing control piston 26 and control spring 34, pump 10 can be operated with a desired equilibrium pressure.

[0011] However, as shown, the control mechanism, namely control piston 26 and control spring 34, requires a significant radial volume about rotor 14. In environments wherein the available radial space about a pump is limited, it can be problematic or impossible to employ prior art pump 10, or other known variable vane pumps including such pumps wherein the adjusting ring slides rather than pivots.

[0012] A variable capacity vane pump in accordance with an embodiment of the present invention is indicated generally at 100 in Figures 2 and 3. As shown, pump 100 includes a rotor 104 with moveable vanes 108, the rotor 104 and vanes 108 rotating within a capacity adjusting ring 112. Ring 112 is mounted the pump housing 116 via a pivot pin 120.

[0013] Ring 112 of pump 100 is controlled via a control mechanism 124, which in this embodiment comprises a control spring 128 which acts against a control piston 132 (shown in solid line in Figure 3 and in ghosted line in Figure 2).

[0014] Control piston 132 is attached to ring 112 via a control pin 136, or any other suitable mechanism, which is received in a suitably shaped aperture 140 in control piston 132. Aperture 140 allows ring 112 to pivot about pin 120 as control piston 132 moves left to right (in the orientation shown in the Figures).

[0015] Control mechanism 132 is received in a gallery (not shown), or the like, or the engine or other device to which pump 100 is mounted. One end of control spring 128 abuts a stop, or plug, in the gallery which serves as a reaction surface against which control spring 128 can act. The other end of control spring 128 abuts and/or is received in control piston 132 and biases control piston 132 away from the reaction surface (towards the right in the illustrated orientation).

[0016] Control piston 132 is sealed within and is slidable within the gallery and pressurized working fluid from the outlet of pump 100 or from another suitable supply is provided to a volume on the right hand (in the illustrated orientation) side of control piston 132 such that the working fluid exerts force on

control piston 132 to move it towards control spring 128. As control piston 132 moves towards or away from control spring 128, control pin 136 moves with control piston 136 to move ring 112 and to thus alter the volumetric capacity of pump 100 appropriately.

[0017] As will be apparent, control mechanism 124 is located out of the plane of rotor 104 and pump housing 116 and thus pump 100 requires less radial volume than would otherwise be the case. It is contemplated that this will advantageously allow pump 100 to be employed in a variety of environments and circumstances where a conventional variable capacity vane pump could not be employed.

[0018] As will also be apparent, the present invention is not limited to the use of control pin 136 to interconnect ring 112 and control piston 132 and any other suitable means, as will occur to those of skill in the art, of interconnecting control mechanism 124 and ring 112 can be employed. As will also be apparent, control mechanism 124 is not limited to the illustrated spring and piston configuration and any other specific suitable control mechanism, as will occur to those of skill in the art, can be employed.

[0019] A variable capacity vane pump 200 in accordance with another embodiment of the present invention is illustrated generally at 200 in Figures 4 and 5, where like components to those of pump 100 are indicated with like reference numerals.

[0020] In pump 200, control spring 204 and control piston 208 are located on opposite sides of the plane of rotor 104. Specifically, as shown in the illustrations, control spring 204 is below the plane of rotor 104 while control piston 208 is located above the plane of rotor 104. Control spring 204 acts between a stop 212 and a control pin 216 connected to ring 112 and control piston 208 is located in a gallery (not illustrated) and acts against a second control pin 220 connected to ring 112. Control piston 208 has force exerted on it, by pressurized working fluid in the gallery, to move control pin 220, and thus ring 112, to reduce the volumetric capacity of pump 200 while control spring 204 acts against stop 212 to bias control pin 216, and thus ring 112, to increase the volumetric capacity of pump 200.

[0021] As will be apparent, by locating the control mechanism above and below the plane of rotor 104 and pump housing 116 pump 200 requires less radial volume than would otherwise be the case. It is contemplated that this will advantageously allow pump 200 to be employed in a variety of environments and circumstances where a conventional variable capacity vane pump could not be employed.

[0022] As will also be apparent, the present invention is not limited to the use of two control pins 216 and 220 to interconnect ring 112 and the control mechanism and any other suitable means, as will occur to those of skill in the art, of interconnecting control spring 204, control piston 208 and ring 112 can be employed. As will also be apparent, pump 200 is not limited to using the illustrated control mechanism comprising a control spring and control piston and any other specific suitable control mechanism, as will occur to those of skill in the art, can be employed.

[0023] It is also contemplated that the present invention can provide advantages if it is desired to provide two different control mechanisms for a variable capacity vane pump to, for example, provide two or more selectable equilibrium pressures for such a pump. Figures 6 and 7 show a first embodiment of such a variable displacement variable pressure pump 300, in accordance with the present invention, where like components to those of pump 100 are indicated with like reference numerals.

[0024] As shown, pump 300 includes two control mechanisms 124a, 124b each of which comprise a respective control spring 128a, 128b which acts against a respective control piston 132a, 132b. In this embodiment, control spring 128a of control mechanism 124a has a first spring force constant and has a control piston 132a having a first size, and control mechanism 124a is located on one side of the rotor plane. A second control mechanism 124b, having a control spring 128b with either the same or a different spring force constant and having a control piston 132b with either the same size or a different size, is located on the opposite side of the rotor plane. In this case the supply of pressurized working fluid can be selectively applied to one or both of control mechanisms 124a, 124b to select one of up to three different equilibrium

operating pressures for pump 300. The supply of pressurized working fluid to control pistons 132a and 132b can be controlled in a variety of manners as will occur to those of skill in the art, including via an electric solenoid operated valve, or a mechanical valve.

[0025] By selecting which (or both) of the control mechanisms to be supplied with pressurized working fluid, the equilibrium operating pressure of the pump can be selected. By varying the design of the spring force or the size of the control piston, or both, the performance of the pump can be optimized for up to three different equilibrium operating pressures to suit a desired set of requirements for a given application. Within reason, further control mechanisms can be added to provide additional equilibrium operating pressures, if required. With such configurations, the advantage of the reduction in the required radial volume about the pump is still obtained.

[0026] It is also contemplated that the control springs for both control mechanisms can be located on one side of the rotor plane and the control pistons (or other mechanisms) for both control mechanisms can both be located on the opposite side of the rotor plane.

[0027] It is also contemplated that both control mechanisms can be located on the same side of the rotor plane and this embodiment is illustrated in Figures 8 and 9. In Figures 8 and 9, another embodiment of a variable displacement variable pressure pump 400 is illustrated, where like components to those of pump 100 are indicated with like reference numerals. In pump 400, control mechanisms 124a and 124b are both attached to control pin 136 on one side of the rotor plane.

[0028] In another embodiment of the invention, if instead of a control piston, a control chamber supplied with pressurized working fluid, such as that taught in U.S. Patent 4,342,545, is employed, and only the biasing means which acts to move the ring to minimum capacity position, such as a control spring, need be located above or below the rotor plane.

[0029] The present invention allows variable capacity vane pumps and/or variable capacity variable pressure to be constructed which require less radial volume about the pump by placing the pump control mechanism out of the plane

of the pump rotor. In one embodiment, the control mechanism is placed on one side of the rotor plane and is connected to the capacity adjusting ring by a pin, or other suitable mechanism. In another embodiment, the control mechanism is split above and below the plane of the pump rotor, with one element of the control mechanism, such as a control spring, being located on one side of the rotor and another element of the control mechanism, such as a control piston, being located on the other side of the rotor plane. In yet another embodiment, two control mechanisms are provided, one on each side of the rotor plane, to provide different equilibrium operating pressures for the pump. In yet another embodiment, the element of the control mechanism which moves the capacity adjusting element to increase capacity is a chamber supplied with pressurized working fluid to urge the capacity adjusting ring to reduce capacity. In this embodiment, a biasing element, such as a control spring, is located either above or below the rotor plane.

[0030] The above-described embodiments of the invention are intended to be examples of the present invention and alterations and modifications may be effected thereto, by those of skill in the art, without departing from the scope of the invention which is defined solely by the claims appended hereto.

We claim:

1. A variable capacity vane pump comprising:
 - a pump housing;
 - a rotor being rotatably mounted with the pump housing;
 - a capacity adjusting element surrounding the rotor and being moveable with respect to the axis of rotation of the rotor to alter the capacity of the pump; and
 - a control mechanism connected to the capacity adjusting element to move the capacity adjusting element to adjust the capacity of the pump, the control mechanism being located out of the plane which the rotor rotates in.
2. The variable capacity vane pump of claim 1 wherein the control mechanism includes a control spring and a control piston, the control spring biasing the capacity adjusting element to increase the capacity of the pump and the control piston being urged by pressurized working fluid from the pump to move the capacity adjusting element to reduce the capacity of the pump.
3. The variable capacity vane pump of claim 2 wherein the control spring is located in one of a position above and below the plane and the control piston is located in the other of a position above and below the plane.
4. The variable capacity vane pump of claim 1 wherein the control mechanism includes a control spring and a control chamber, the control spring biasing the capacity adjusting element to increase the capacity of the pump and the control chamber being supplied with pressurized working fluid from the pump to urge the capacity adjusting element to reduce the capacity of the pump.
5. The variable capacity vane pump of claim 1 further including a second

control mechanism connected to the capacity adjusting element to obtain a variable capacity variable pressure vane pump, the second control mechanism also being located out of the plane which the rotor rotates in.

6. The variable capacity vane pump of claim 5 wherein the control mechanism and the second control mechanism are respectively located on opposite sides of the plane in which the rotor rotates in.

7. The variable capacity vane pump of claim 5 wherein the control mechanism and the second control mechanism are located on the same side of the plane which the rotor rotates in.

8. The variable capacity vane pump according to claim 5 wherein pressurized working fluid can selectively be applied to either or both of the control mechanism and the second control mechanism to alter the equilibrium pressure of the pump.

9. The variable capacity vane pump according to claim 8 wherein one of at least three equilibrium pressures can be selected for the pump.

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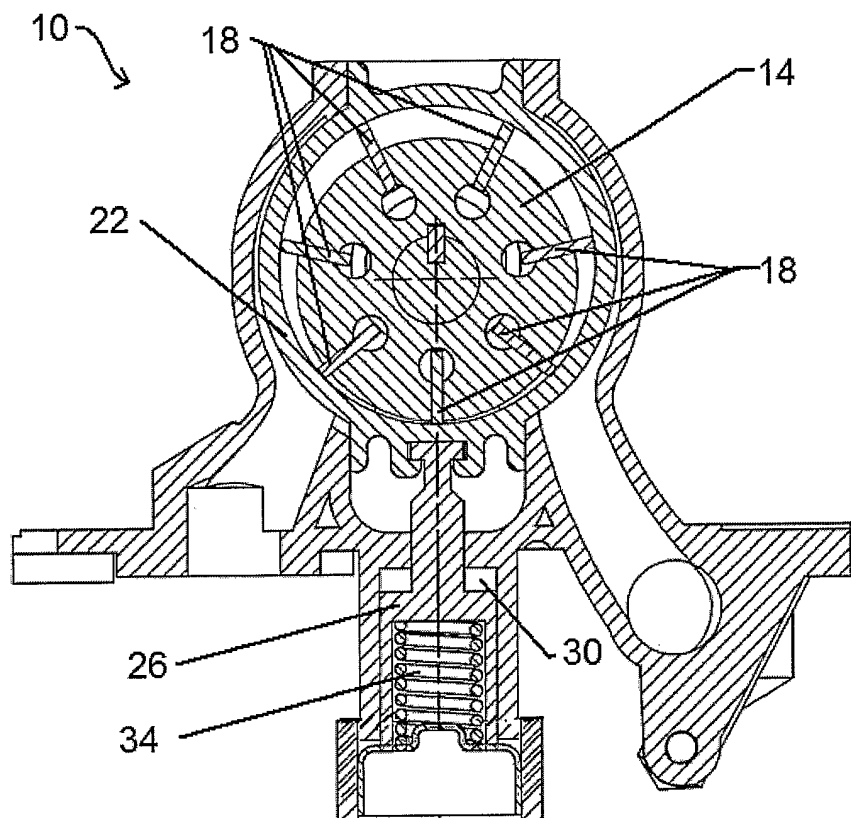
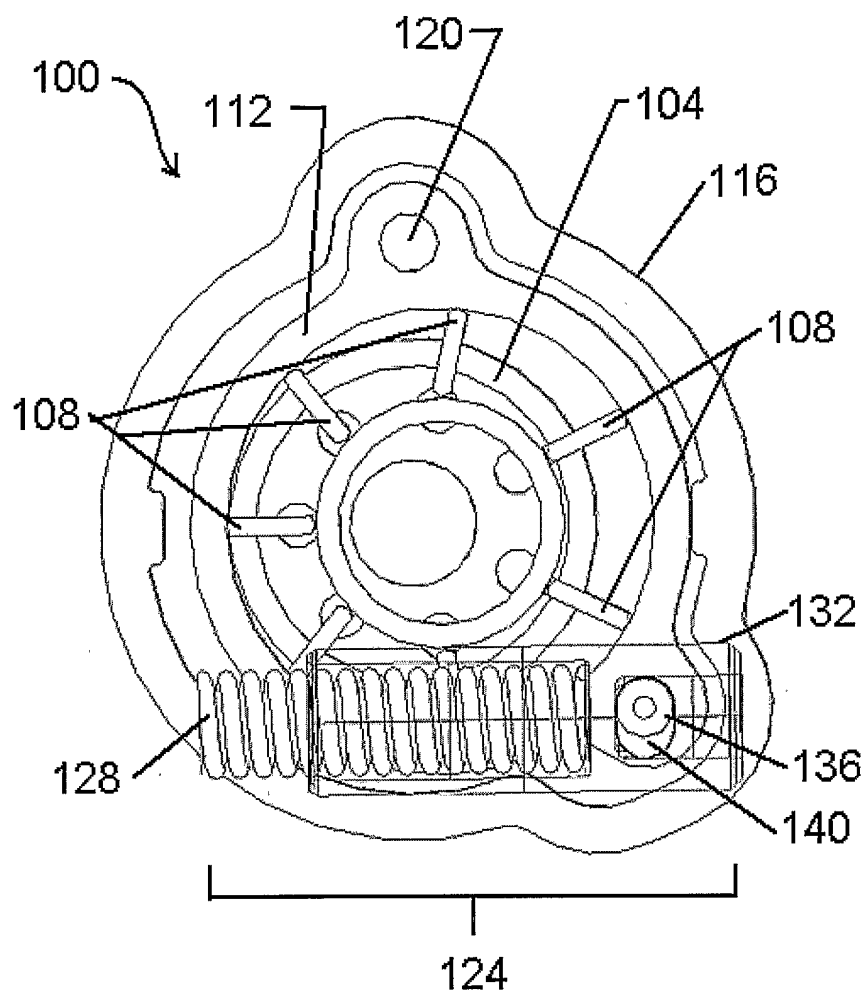
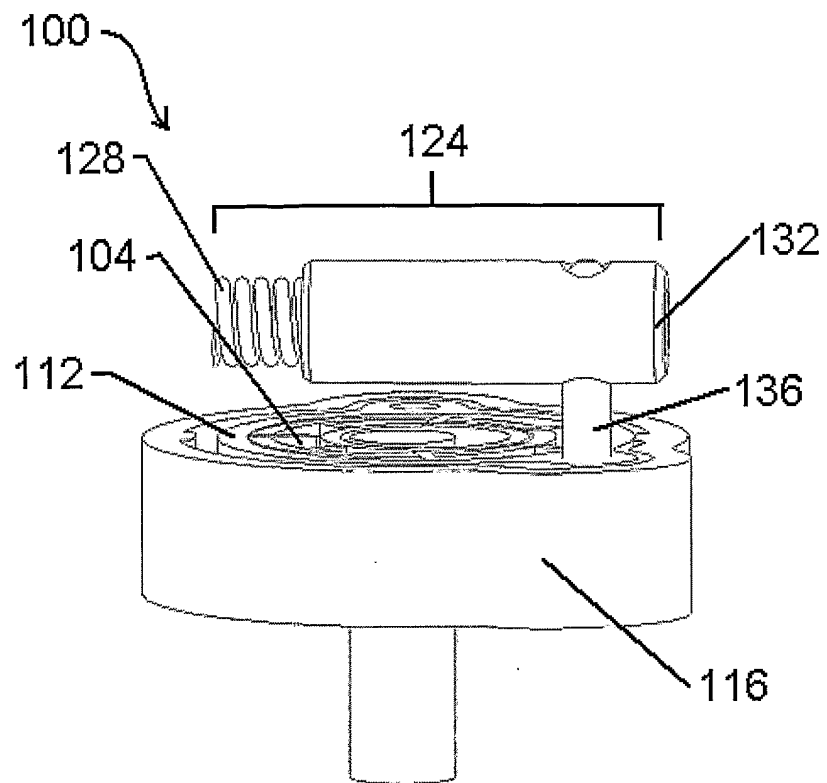


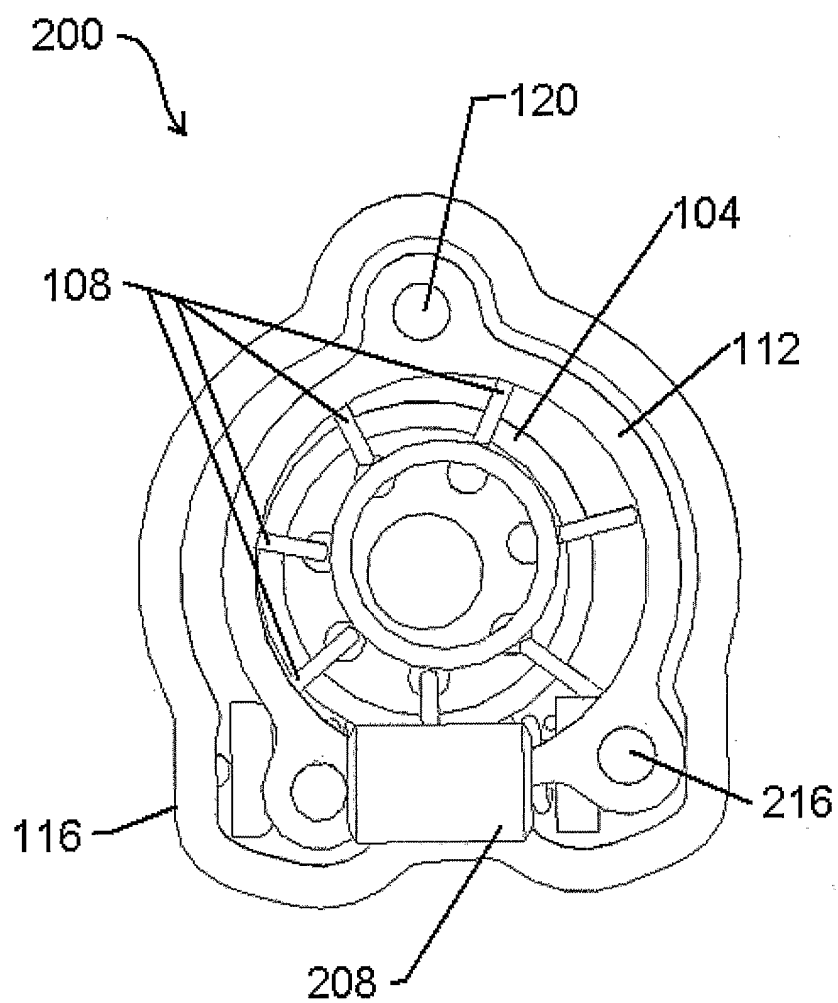
Fig.1
(prior art)

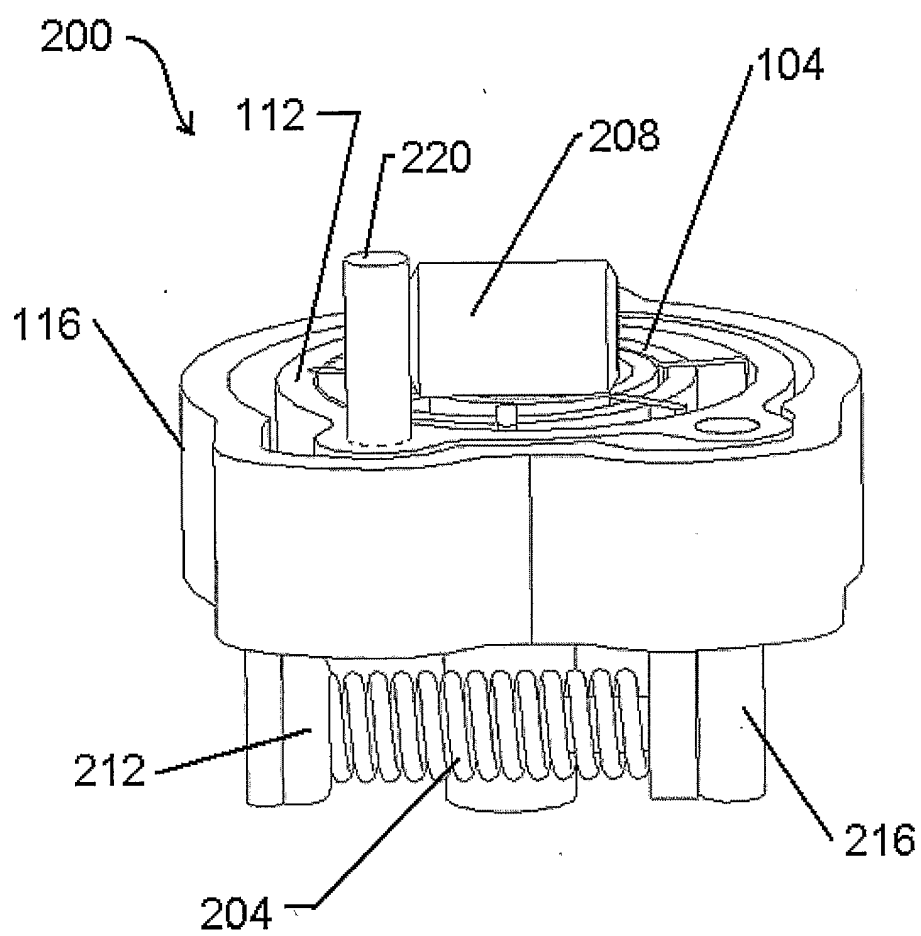
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**Fig. 2**

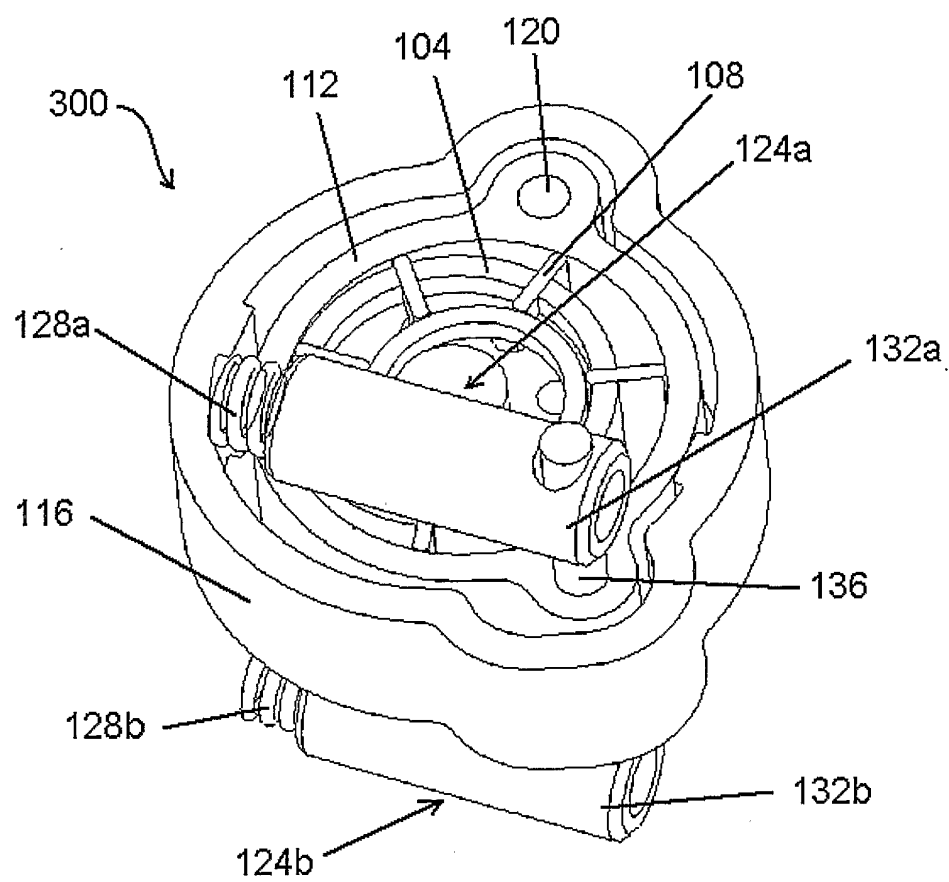
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**Fig. 3**

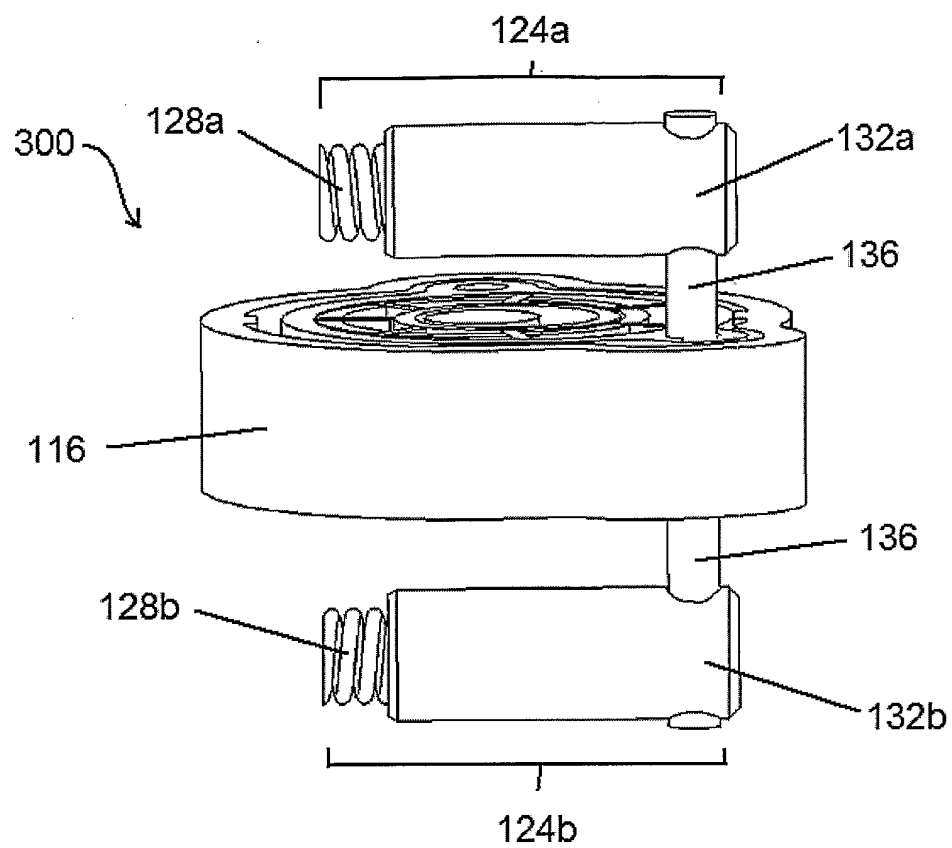
**Fig. 4**

**Fig. 5**

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**Fig. 6**

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**Fig. 7**

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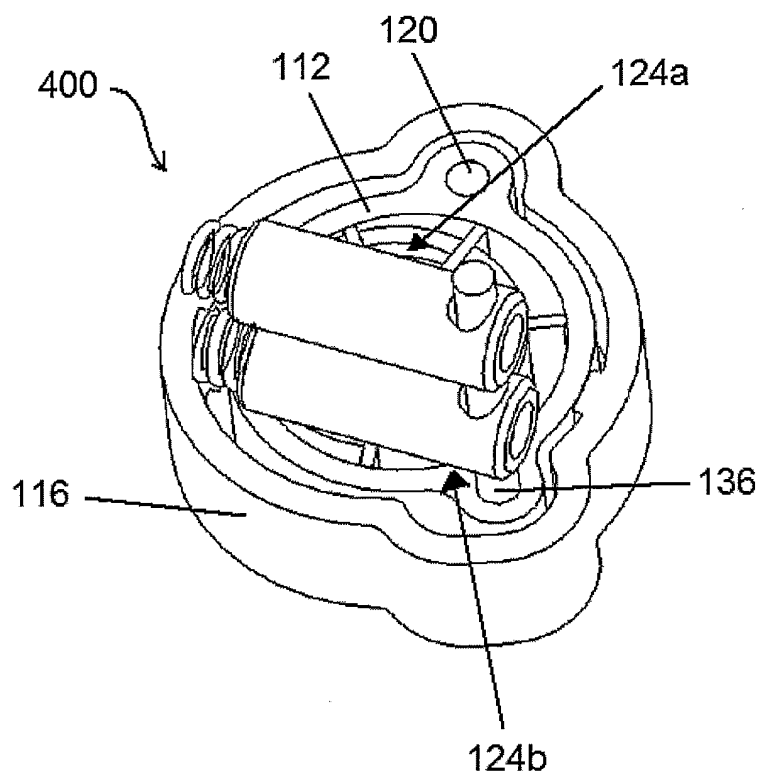
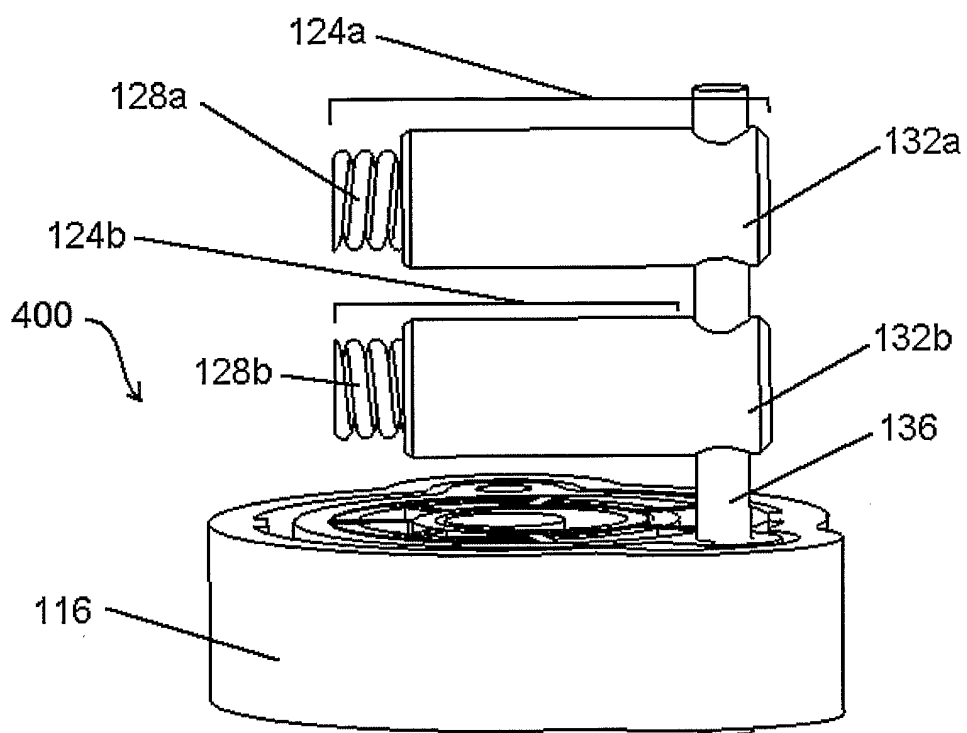


Fig. 8

**Fig. 9**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/001636

A. CLASSIFICATION OF SUBJECT MATTER
IPC: *F04C 28/22* (2006.01), *F04C 27/00* (2006.01), *F04C 29/12* (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(7): F04C USPC: 418 CPD: 230, 103

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
WEST, USPTO, Delphion, Espacenet
Search terms: variable, capacity, vane, pump, ring, pivot, spring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5490770 A (OOGUSHI, N.) 13 February 1996 (13-02-1996) * Abstract; Col. 3, lines 55-62; Figure 1 *	1,2
Y	* Whole document *	4-9
X	US 4634349 A (ABE, T. et al.) 6 January 1987 (06-01-1987) * Abstract; Col. 2, lines 20-28; Col. 2, line 60 - Col. 3, line 2; Col. 3, lines 60-66; Fig. 2 and 3 *	1-3
Y	* Whole document *	4-9
Y	US 3415058 A (UNDERWOOD, H. N. et al.) 10 December 1968 (10-12-1968) * Abstract; Figures *	4-9
A	US 5690479 A (LEHMANN, U. et al.) 25 November 1997 (25-11-1997) * Abstract; Figures *	1
A	US 4259039 A (ARNOLD, D.) 31 March 1981 (31-03-1981) * Abstract; Figures *	1

[] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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Patent Document Cited in Search Report.	Publication Date	Patent Family Member(s)	Publication Date
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