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(54) **VARIABLE DISPLACEMENT SLIDING VANE PUMP**

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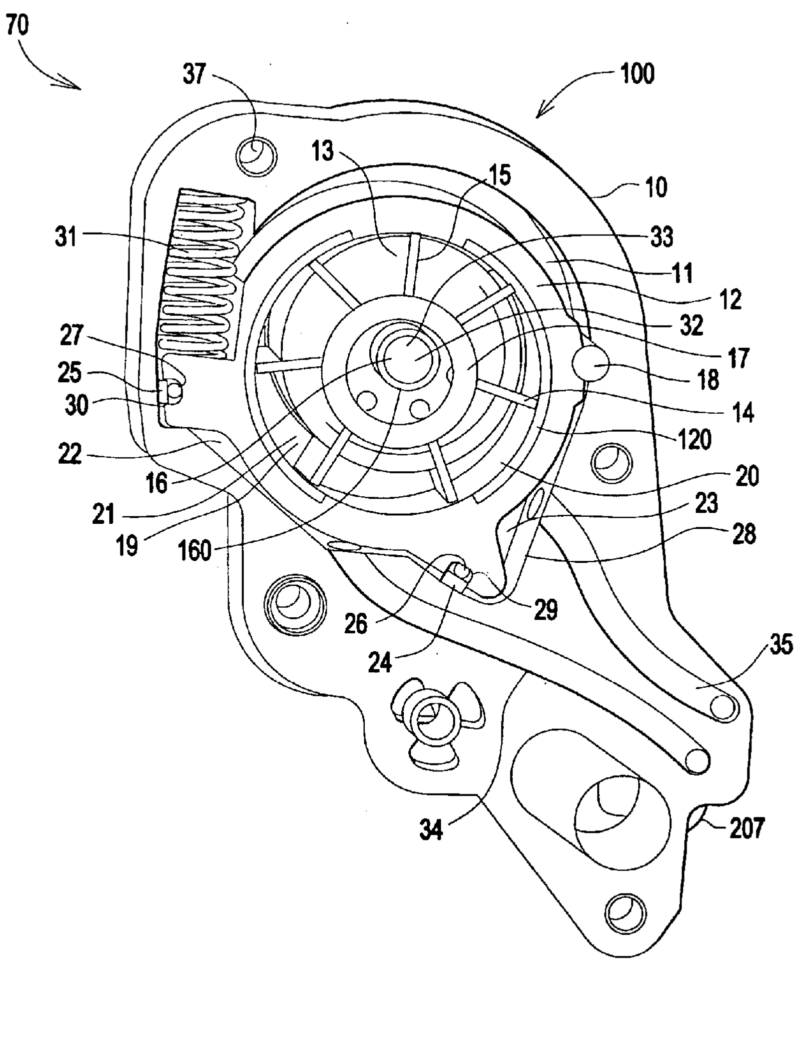
(52) **U.S. Cl.** **418/26**; 418/30; 418/106; 418/113

(57) **ABSTRACT**

A variable displacement sliding vane pump comprising a pump body, inlet and outlet ports formed in said pump body, a drive shaft rotatably mounted in said pump body, a rotor driven by said drive shaft and co-axially aligned therewith, a plurality of radially extending vanes slidably disposed in said rotor, a pivot disposed in said pump body, a slide pivotally disposed on said pivot in said pump body and having a central axis eccentric to the axis of said rotor, a plurality of fluid chambers defined by said rotor, said vanes, and said slide that are successively connected to said inlet and outlet ports, a spring acting on said slide to urge said slide in one direction, a first chamber and a second chamber, each suitable for receiving a fluid pressure and each disposed between said pump body and an outer surface of said slide, the first chamber in fluid communication with a pump outlet discharge pressure, and a valve operable to selectively pressurize and depressurize the second chamber.



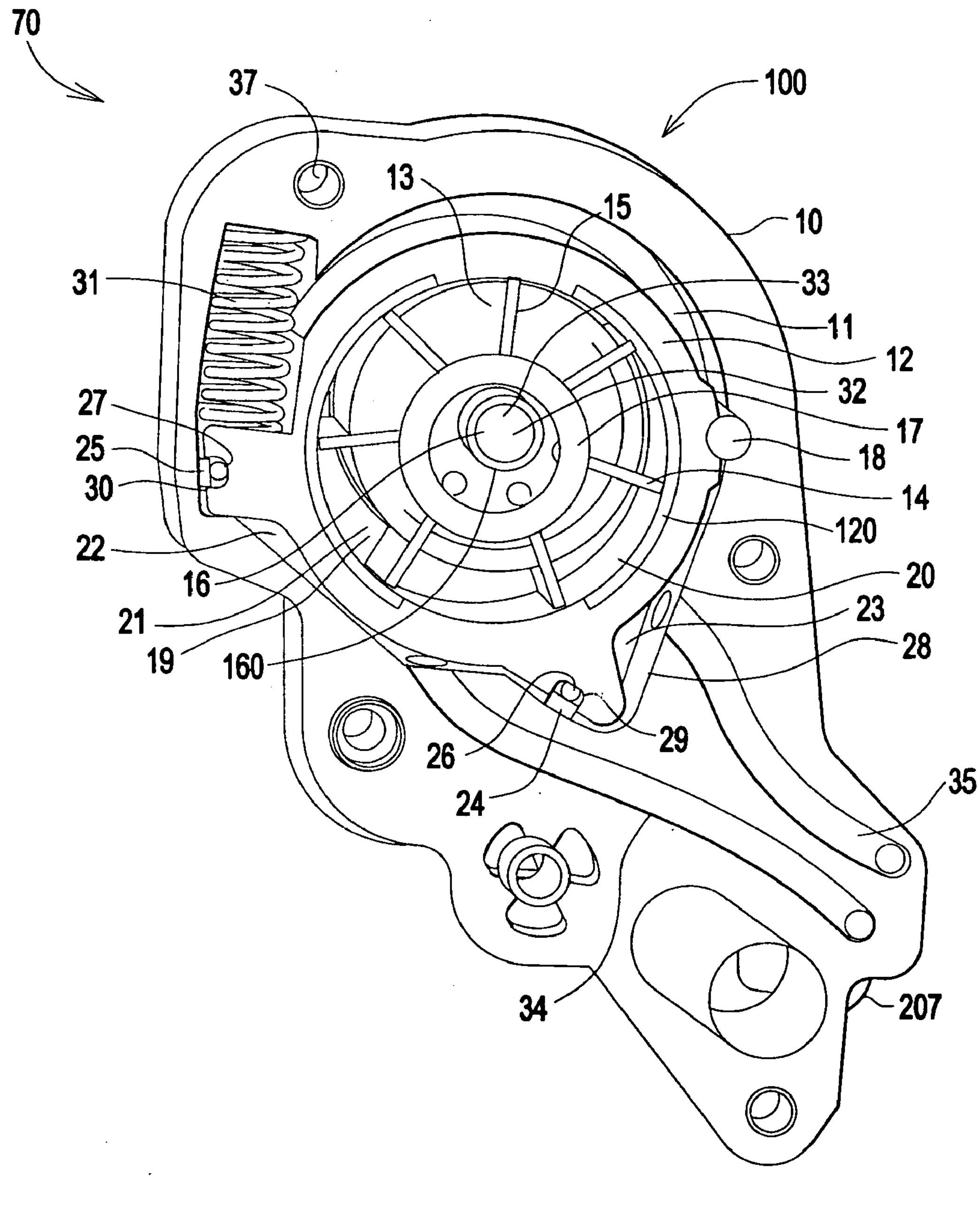

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FIG.1

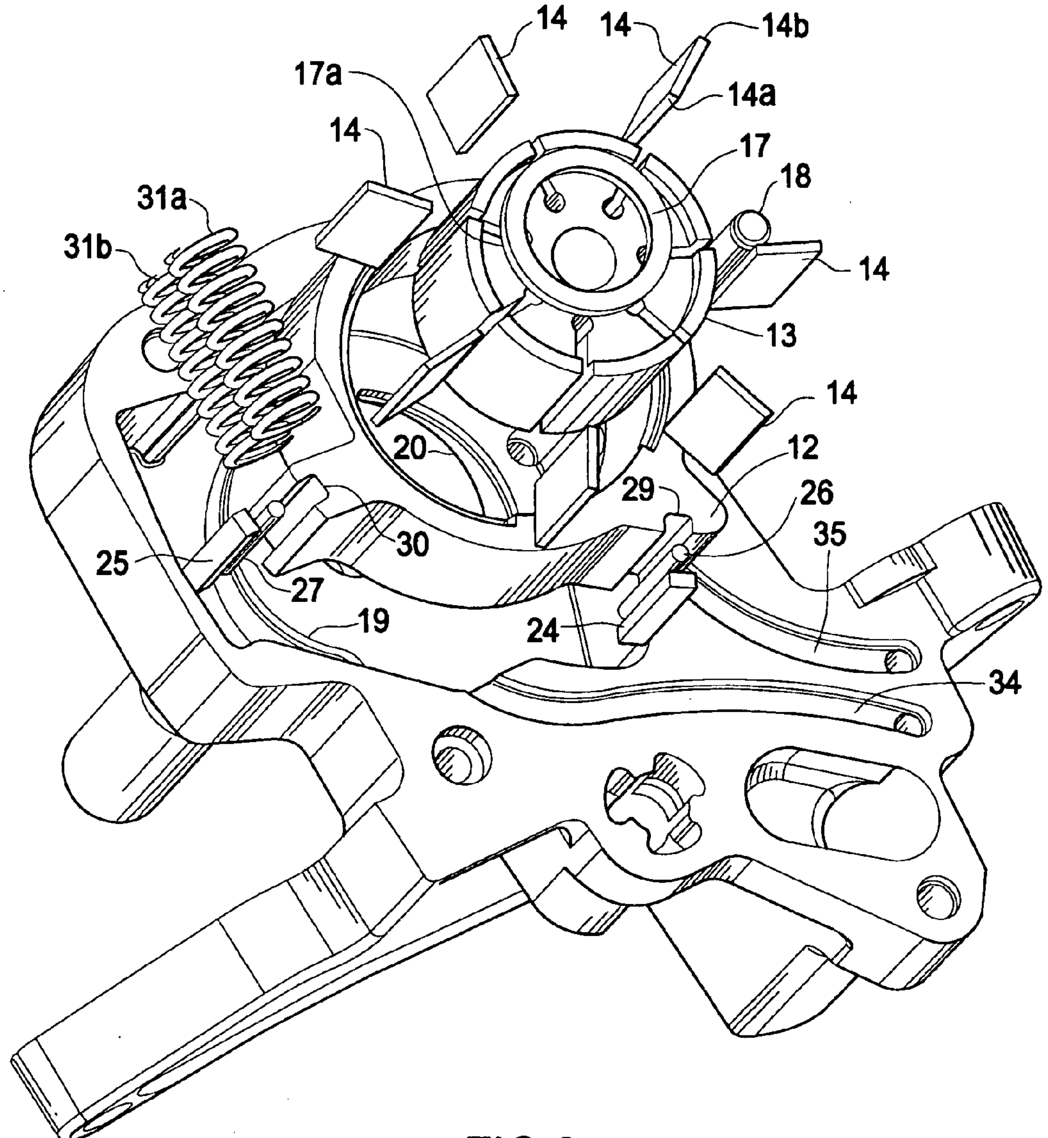
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FIG.2

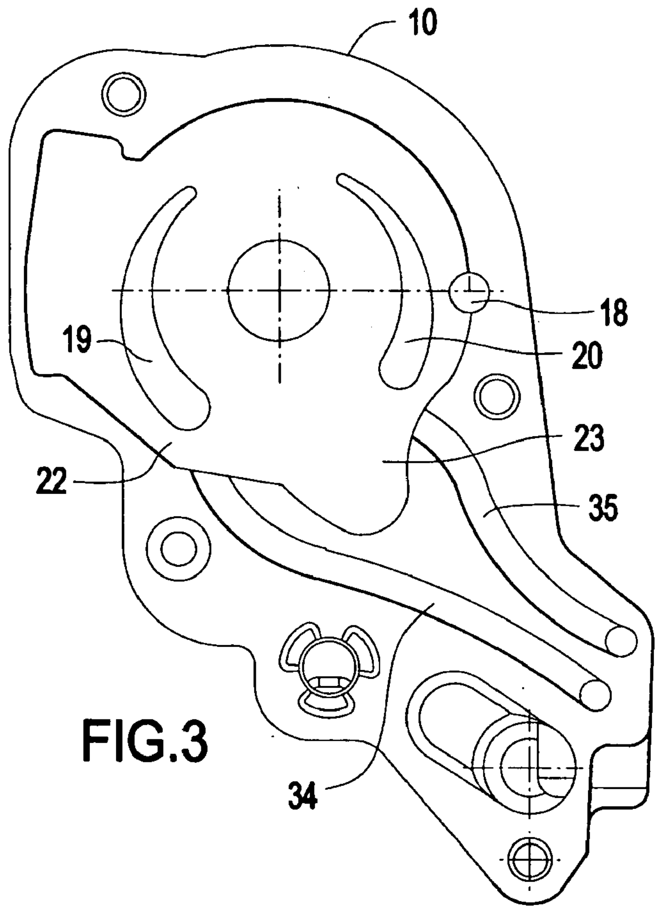


FIG.3

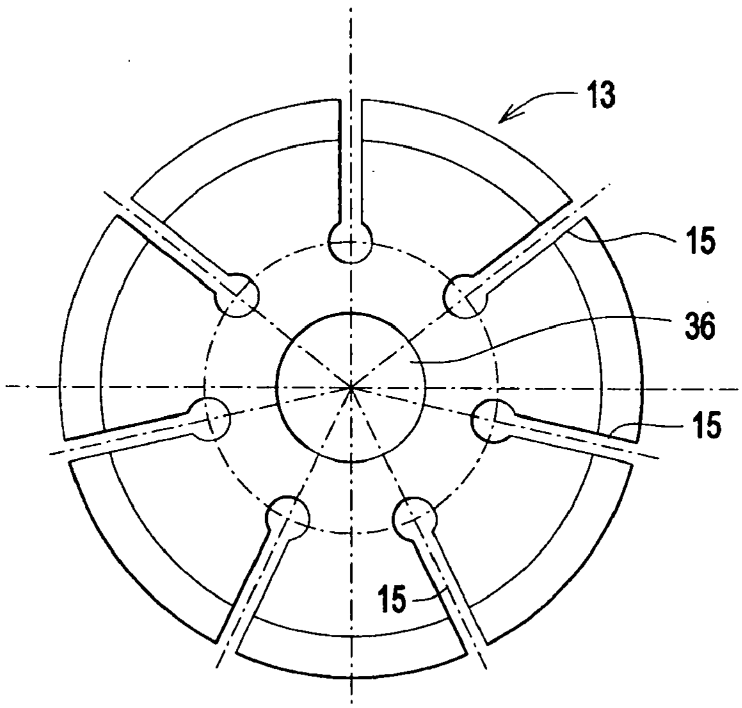


FIG.4

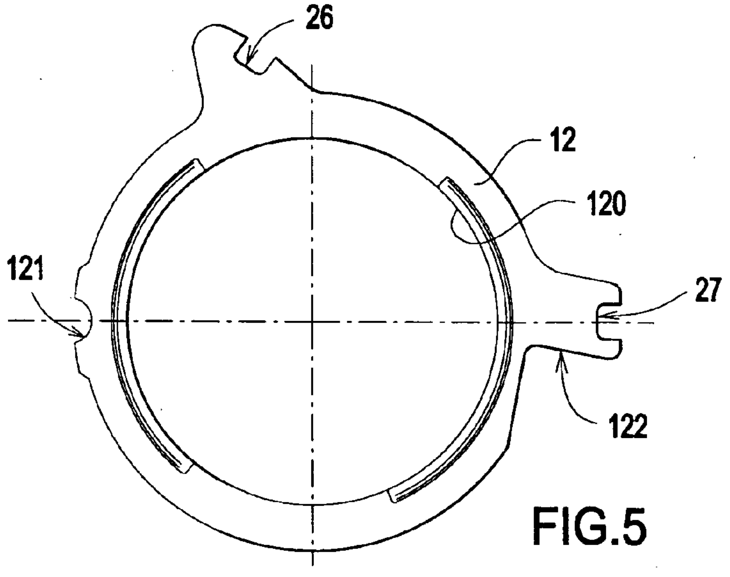


FIG.5

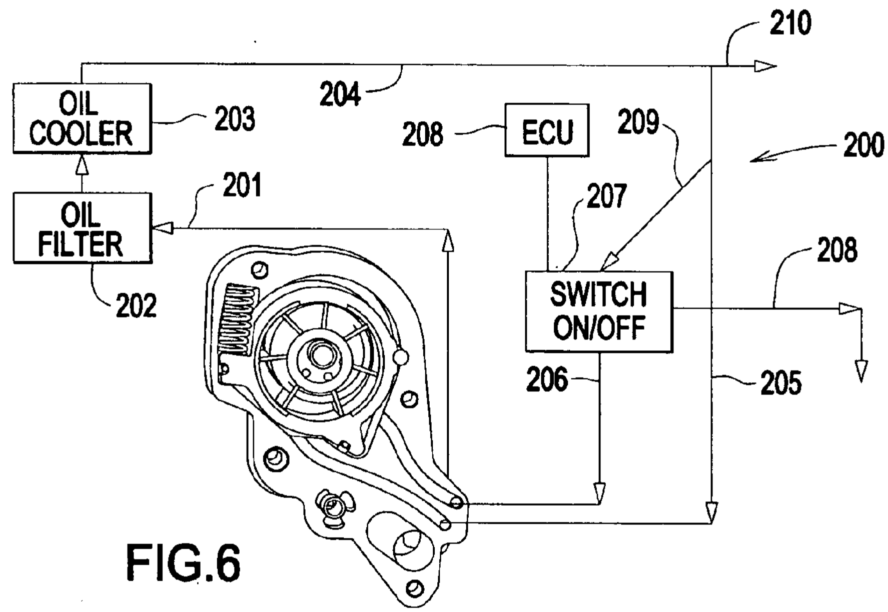


FIG.6

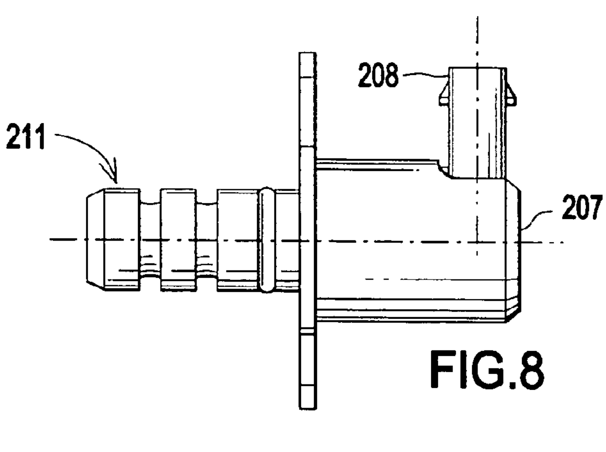


FIG.8

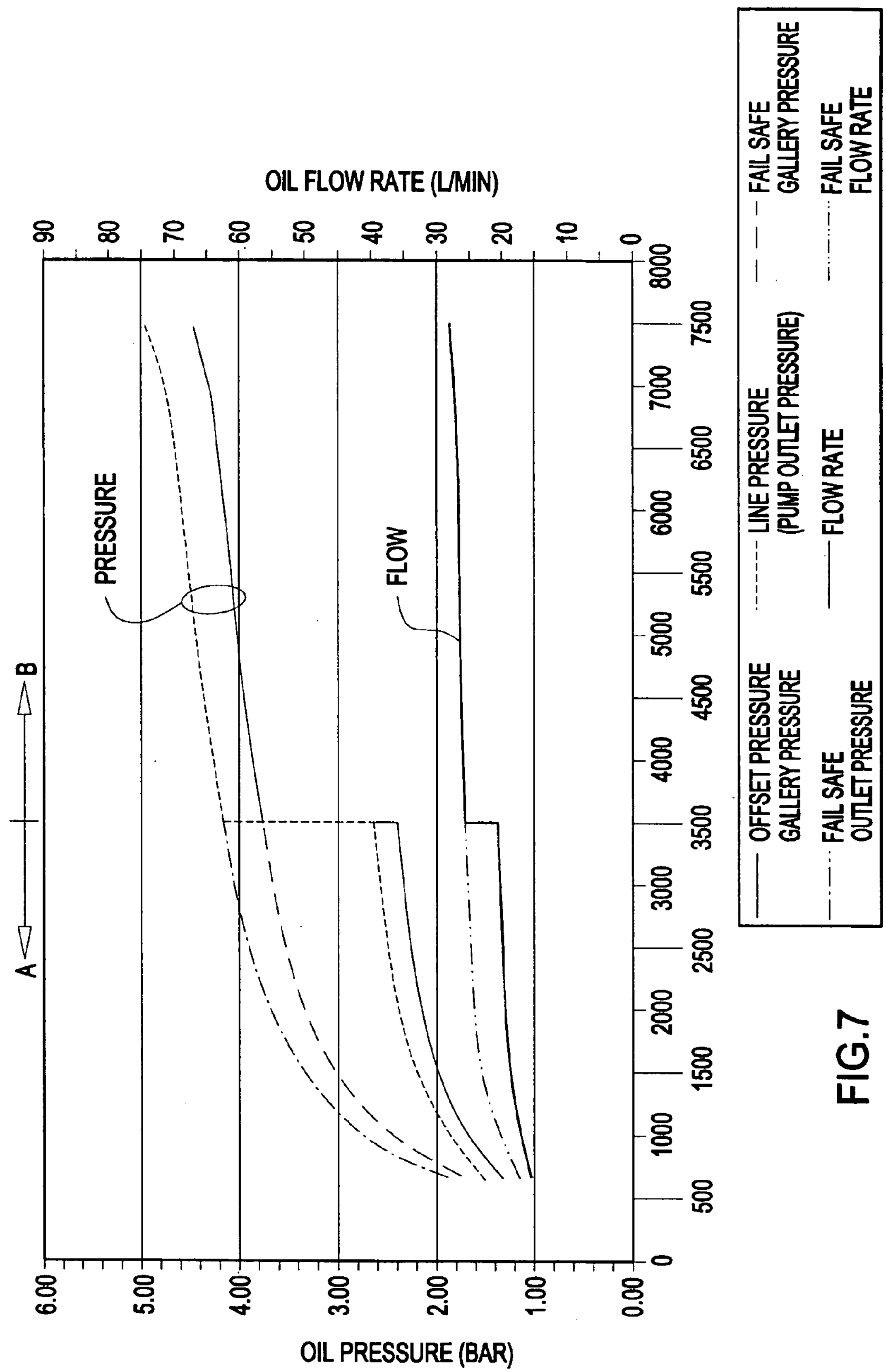
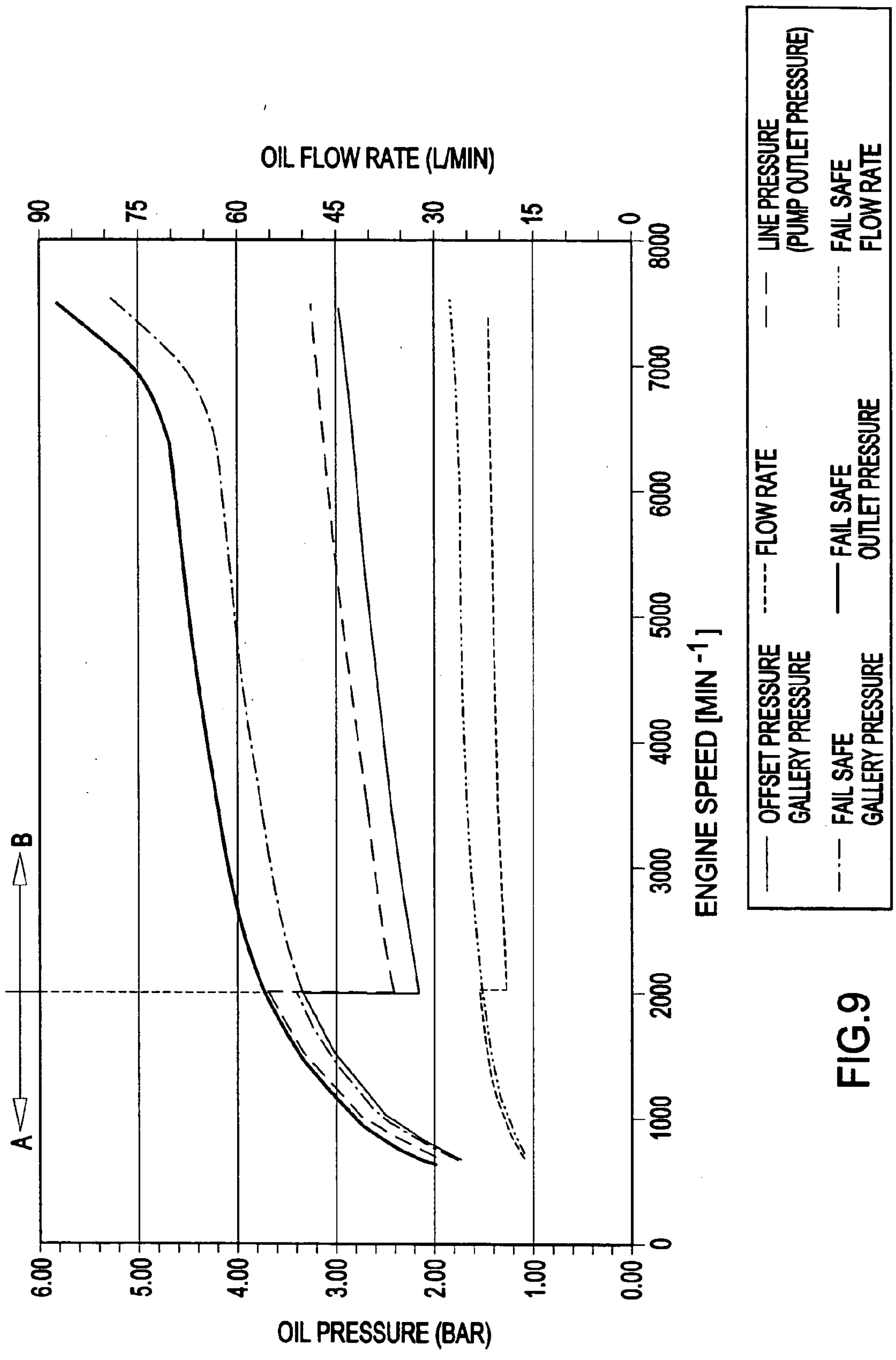

OIL FLOW RATE (L/MIN)
90
80
70
60
50
40
30
20
10
0
OIL PRESSURE (BAR)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
A
B
PRESSURE
FLOW
OFFSET PRESSURE GALLERY PRESSURE
FAIL SAFE OUTLET PRESSURE
LINE PRESSURE (PUMP OUTLET PRESSURE)
FLOW RATE
FAIL SAFE GALLERY PRESSURE
FAIL SAFE FLOW RATE

FIG.7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90
75
60
45
30
15
0
OIL PRESSURE (BAR)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ENGINE SPEED [MIN -1]
0
1000
2000
3000
4000
5000
6000
7000
8000
A
B
OFFSET PRESSURE GALLERY PRESSURE
FLOW RATE
LINE PRESSURE (PUMP OUTLET PRESSURE)
FAIL SAFE GALLERY PRESSURE
FAIL SAFE OUTLET PRESSURE
FAIL SAFE FLOW RATE

FIG.9

VARIABLE DISPLACEMENT SLIDING VANE PUMP

FIELD OF THE INVENTION

[0001] The invention relates to a variable displacement sliding vane pump having a slide whose position is controlled by a differential pressure between a constant pressure source and a variable pressure source, the differential pressure equilibrating a spring force applied to the slide to establish a desired flow rate and pressure.

BACKGROUND OF THE INVENTION

[0002] A lubrication system for an engine pressurizes and distributes lubrication fluid to the engine lubrication circuits. It employs a rotor and a slide with multiple vanes and cavities which can vary the volume of fluid delivered to the oil circuits.

[0003] The slide is eccentrically offset from the rotor to create fluid chambers defined by the vanes, rotor, and inner surface of the slide. A compression spring positions the slide to create large fluid chambers as the default. When the engine requires less volume of fluid or less oil pressure by the pump, a pressure regulator directs fluid from the pump output line to a regulating chamber in the pump. Pressure in the regulating chamber pivots the slide against the force of the spring to more closely align the centers of the rotor and slide, thereby reducing the size of the fluid chambers. This reduces the amount of fluid drawn into the pump from the fluid reservoir and likewise, the amount of fluid output by the pump and thereby reduces the oil pressure as well.

[0004] There are two ways to control pump output. The first way is to direct line pressure to the regulating chamber via the pressure regulator to decrease pump output. The second way is to remove pressure from the regulating chamber via the pressure regulator by exhausting fluid to increase pump output.

[0005] Representative of the art is U.S. Pat. No. 4,342,545 (1982) to Schuster discloses a variable displacement vane type pump having a pivotally mounted ring member controllable to vary the eccentricity between the rotor and the ring thus controlling the pump displacement. The ring is positioned on the pivot such that the center thereof is always located in one quadrant relative to axes through the pivot point and the center of the pump rotor to continually maintain the net ring reaction force, due to internal pressure, directed to one side of the pivot connection in opposition to the displacement control pressure, which is impressed on a portion of the outer surface of the ring, whereby control stability throughout the displacement range is improved.

[0006] What is needed is a variable displacement sliding vane pump having a slide whose position is controlled by a differential pressure between a constant pressure source and a variable pressure source, the differential pressure equilibrating a spring force applied to the slide to establish a desired flow rate and pressure. The present invention meets this need.

SUMMARY OF THE INVENTION

[0007] The primary aspect of the invention is to provide a variable displacement sliding vane pump having a slide whose position is controlled by a differential pressure between a constant pressure source and a variable pressure source, the differential pressure equilibrating a spring force applied to the slide to establish a desired flow rate and pressure.

[0008] Other aspects of the invention will be pointed out or made obvious by the following description of the invention and the accompanying drawings.

[0009] The invention comprises a variable displacement sliding vane pump comprising a pump body, inlet and outlet ports formed in said pump body, a drive shaft rotatably mounted in said pump body, a rotor driven by said drive shaft and co-axially aligned therewith, a plurality of radially extending vanes slidably disposed in said rotor, a pivot disposed in said pump body, a slide pivotally disposed on said pivot in said pump body and having a central axis eccentric to the axis of said rotor, a plurality of fluid chambers defined by said rotor, said vanes, and said slide that are successively connected to said inlet and outlet ports, a spring acting on said slide to urge said slide in one direction, a first chamber and a second chamber, each suitable for receiving a fluid pressure and each disposed between said pump body and an outer surface of said slide, the first chamber in fluid communication with a pump outlet discharge pressure, and a valve operable to selectively pressurize and depressurize the second chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings, which are incorporated in and form a part of the specification, illustrate preferred embodiments of the present invention, and together with a description, serve to explain the principles of the invention.

[0011] FIG. **1** is a front view of the pump with outer cover removed.

[0012] FIG. **2** is an exploded view of the pump.

[0013] FIG. **3** is a front view of the pump body without the outer cover, slide, rotor and vanes.

[0014] FIG. **4** is a top/plan view of the pump rotor.

[0015] FIG. **5** is a plan view of the pump slide.

[0016] FIG. **6** is a schematic diagram of the pump fluid circuit.

[0017] FIG. **7** is a graph depicting the pump performance including pump flow rate and pressure.

[0018] FIG. **8** is a side view of an electric valve.

[0019] FIG. **9** is a graph depicting the pump performance including pump flow rate and pressure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] FIG. **1** is a front view of the pump with outer cover removed. The inventive pump **100** comprises body **10**. Body **10** defines a cavity **11** within which is disposed slide **12** and rotor **13**. A plurality of sliding vanes **14** are radially disposed about rotor **13**. Each vane **14** extends radially from a slot **15** in rotor **13**. Each vane **14** is moveable within each slot **15**.

[0021] Pump shaft **16** is rotatably mounted in body **10**. A splined end **160** of pump shaft **16** engages rotor **13**. As rotor

13 rotates vanes **14** are urged outwardly by a pair of vane control rings **17** and centripetal force into a sliding engagement with inner surface **120** of slide **12**.

[**0022**] Slide **12** is pivotally engaged with the body at a pivot member **18**. Slide **12** pivots at pivot member **18** within cavity **11** thereby describing an arc which defines the operating range of motion of slide **12**.

[**0023**] The position of each vane **14** is a function of the position of slide **12** with respect to ring **17**. Ring **17** occupies a space determined by the ends of vanes **14**. Ring **17** is substantially concentric with inner surface **120**.

[**0024**] The position of ring **17** with respect to rotor **13** determines the radial position of each vane **14** in each slot **15**, which in turn, determines a given slide **12** position as compared to the position of the axis of rotation of rotor **13**. This relationship determines the volume of each of the chambers **21** between the inlet port **19** and the outlet port **20** for a given engine speed and hence a given slide **12** position.

[**0025**] Body **12** defines a pair of kidney shaped ports **19**, **20** which comprise an inlet port and an outlet port, respectively, for the pump **100**. A plurality of chambers **21** are formed by the vanes **14**, rotor **13** and inner surface **120**. Chambers **21** rotate with rotor **13** and expand and contract during rotation, as is well-known in vane type pumps.

[**0026**] Inlet port **19** accepts fluid from a source or reservoir such as an engine oil system, not shown, and passes the fluid to the chambers **21** in turn as rotor **13** rotates. Vanes **14** move the fluid in chambers **21** from the inlet port **19** to the outlet port **20**. As can be seen in FIG. **1**, if the pump rotor **13** is rotating in a counterclockwise direction, chambers **21** are continually expanding thereby creating a low pressure region which causes an inflow of fluid in the area of inlet port **19** and are contracting thereby increasing fluid pressure which causes an outflow of fluid in the area of the outlet port **20**.

[**0027**] The position of slide **12** is established by the combined effect of the control pressure in each for two chambers, namely, chamber **22** and chamber **23** acting in balance with the spring force from spring **31**. Chamber **22** extends about a portion of the outer circumference of slide **12** from seal member **24** disposed in a groove **26** to seal member **25** disposed in a groove **27**, each formed in slide **12**. Each seal member **24** and **25** is urged outwardly against surface **28** by a resilient backing member **29**, **30** respectively. Chamber **23** extends about a portion of the outer circumference of slide **12** from seal member **24** to pivot member **18**.

[**0028**] Spring **31** acts in opposition to the sum of the fluid pressures in chambers **22** and **23** such that as the total pressure in chambers **22** and **23** increases, and therefore the torque of the slide around the pivot member increases, the pump slide **12** will move clockwise about pivot member **18**. The combined torque caused by the pressure in chamber **22**, **23** is balanced by the spring force of spring **31**.

[**0029**] The fluid pressure in chamber **22** is supplied by fluid in ultimate communication with the outlet port **20** of pump **100** and is therefore subject to the outlet pressure of pump **100** or from a feedback channel to the engine gallery, see FIG. **5**. The fluid pressure in chamber **23** is supplied by fluid communication with a second pressure source also connected to the outlet port **20** of pump **100**. The fluid pressure in chamber **22** is proportional to the outlet pressure of pump **100**. The fluid pressure in chamber **23** is dependent upon the speed of the pump **100**, namely, for certain operating regimes below a predetermined pump speed the pressure in chamber **23** is automatically vented to ambient, for example, an oil storage reservoir. Above a predetermined speed the pressure in chamber **23** is equivalent to the pressure in chamber **22**. This is also referred to as the "switching point" and can be set at any speed depending upon the application. The sum of the pressures, and therefore torque, in chambers **22** and **23** determine the position of slide **12**. The position of slide **12** determines the outlet pressure and flow rate of the pump.

[**0030**] Under most operating conditions, the axis of slide **12**, and therefore of inner surface **120**, moves between position **32** during low engine speed conditions to position **33** during high engine speed conditions. As vanes **14** are rotated from the inlet port **19** to outlet port **20** a pressure transition takes place with the chambers **21**.

[**0031**] Since the inner surface **120** is subjected to the internal pressure generation in chambers **21**, slide **12** is inherently unbalanced during operation. The net resultant reaction force due to the internal pressure generation passes through the central axis of inner surface **120**. It will be appreciated that the reaction forces always provides a counterclockwise moment about axis **18** which is in opposition to the clockwise moment generated by the control pressure in chambers **22** and **23**.

[**0032**] The pressures in chamber **22**, **23** are balanced against the force of spring **31** so that the displacement of the pump, and as a result the flow, may be adjusted by varying the chamber pressures. The inventive pump controls both displacement and oil flow for two or more outlet pressure levels based upon the pump outlet pressure or the engine gallery pressure.

[**0033**] Typically the desirable pressure level in the pump for each chamber is the pressure level required to produce the proper oil flow and pressure for all engine speeds and load conditions. In some cases, at lower rpm's the engine does not require a high oil pressure level, therefore a somewhat lower pressure is acceptable, and therefore the flow is reduced as well. The lower operating pressure and flow is achieved by pressurizing chamber **23**.

[**0034**] The required magnitude of the lower oil pressure depends upon different engine parameters, including whether it is a gas or diesel engine, the engine complexity, engine speed and load.

[**0035**] The inventive pump provides two levels of control. The first is pressure control over a given speed range due to the variable vane pump function. The second is based upon the ability of the pump to change between two (or more) pressure levels by use of two (or more) pressure chambers **22**, **23**, controlling the position of slide **12**.

[**0036**] A cover **70** is secured to the housing **10** by a plurality of fasteners **37**. Leakage from the chambers **21** radially outwardly past the cover **70** is prevented by surface to surface contact.

[**0037**] FIG. **2** is an exploded view of the pump. The position of ring **17** with respect to rotor **13** determines the radial position of each vane **14** in each slot **15**, which in turn, determines a slide **12** position as compared to the position of the axis of rotation of rotor **13**. An inner edge **14***a* of each vane **14** bears upon the outer surface **17***a* of ring **17**. An outer edge **14***b* of each vane **14** also bears upon and slides upon inner surface **120** of slide **12**. The pump may use a single spring **31**, or it may use for example, two springs **31***a* and **31***b*.

[**0038**] FIG. **3** is a front view of the pump body without the outer cover, slide, rotor and vanes. Inlet port **19** and outlet port **20** are disposed in body **10**. Conduit **34** transmits pressure from the main oil gallery **204** to chamber **22**, see FIG. **5**. Conduit **35** transmits pressure from the main oil gallery **204** to chamber **23**, see FIG. **5**. Conduit **34** is exposed to pump outlet pressure or engine gallery oil pressure during all pump operating conditions. The fluid pressure in conduit **35** is determined by the position of valve **207**, see FIG. **1**.

[**0039**] FIG. **4** is a top plan view of the pump rotor. Rotor **13** comprises slots **15** which are oriented radially about the outer circumference. A vane **14** is slidingly engaged in each slot **15**. Drive shaft **16** engages rotor **13** through splined hole **36**. Drive shaft **16** may also be press fit in hole **36**. Each slot **15** comprises a radial length sufficient to accommodate the entire range of movement of each vane **14**. During operation of the pump each vane **14** moves radially a predetermined distance which distance is dependent upon the position of rings **17** with respect to rotor **13**.

[**0040**] FIG. **5** is a plan view of the pump slide. Slide **12** comprises inner surface **120**. An outer edge of each vane **14** slidingly engages inner surface **120**. Inner surface **120** is cylindrical, but the shape of the surface can be slightly distorted to accommodate design geometries, for example to an oval or egg-shaped form. Pivot **18** engages detent **121**. Groove **26** and groove **27** each receive seal members **24**, **25** respectively, for sealing a fluid pressure within each chamber **23**, **22** respectively. Spring **31** bears upon surface **122**. Seal members **24**, **25** may comprise any material having a suitable compatibility with the pump fluid, for example, synthetic and/or natural rubbers.

[**0041**] FIG. **6** is an example schematic diagram of the pump fluid circuit **200**. Fluid conduit **201** connects pump outlet port **20** to an oil filter **202**, oil cooler **203** and to a main oil gallery **204**. The main oil gallery **204** is exposed to the outlet pressure of pump **100**, subject to friction losses normal to any fluid system. Main oil gallery **204** is also connected to the engine oil system **210**. This system is offered only as an example and does not depict the varieties of engine oil systems to which the inventive pump and system may be applied.

[**0042**] Connected to the main oil gallery **204** is conduit **205** which connects to chamber **22** through conduit **34**, see FIG. **1**. Connected to conduit **205** is conduit **209**. Conduit **209** is connected to electric valve **207**, see FIG. **7**. Valve **207** is used to selectively connect or disconnect conduit **209** through conduit **206** to conduit **35** and chamber **23** in FIG. **1**, with the fluid pressure in conduit **205**. Valve **207** is preferably contained within body **10**. Valve **207** is shown in FIG. **5** schematically separate from pump **100** for ease of illustration. However, valve **207** may also be separated from pump body **100** as schematically shown in FIG. **5** in order to accommodate variable physical constraints as required by system space requirements. Valve **207** may also comprise a mechanical valve known in the art, for example, a valve which regulates a downstream pressure based upon an upstream pressure commonly known as a pressure regulating valve.

[**0043**] The total force exerted against spring **31** by slide **12** is the sum of the torques created by the fluid pressure in chamber **22** plus the fluid pressure in chamber **23**, both acting about pivot member **18**.

[**0044**] At or less than a first operating speed, valve **207** is OPEN thereby allowing the engine gallery pressure to enter chamber **23**. The pressure in chamber **23** and combined with the pressure in chamber **22** causes slide **12** to pivot about pivot member **18** an arcuate distance to a position where the torque caused by the combined pressures in chambers **22**, **23** is balanced by the spring force of spring **31**. The pump characteristics with slide **12** in this position are shown by portion "A" of FIG. **7**. The pressure in chamber **22** and **23** is proportional to the pump speed. As the engine speed, and thereby pump speed, increase so does the pressure in the chambers **22**, **23**. In this operating condition the pump output is a flow and pressure that is less than the flow and pressure of the pump with the valve **207** closed (chamber **23** depressurized) at the same engine speed. In portion "A" the position of slide **12**, and thereby of the pump output flow and pressure, is a function of the pressure in both chambers **22**, **23**.

[**0045**] At an operating condition greater than the first operating speed, valve **207** is closed thereby venting chamber **23** to ambient pressure (approximately 1 bar). The pressure in chamber **22** causes slide **12** to pivot about pivot member **18** an arcuate distance to an equilibrium position where the torque caused by the pressure in chamber **22** is balanced by the spring force of spring **31**. Slide **12** pivots because as the pump speed increases, the pressure in chamber **22** also increases, thereby increasing the force exerted against spring **31**. The pump characteristics with slide **12** in this position are shown by portion B of FIG. **7**. The operating regime in portion B can also be characterized as a passive mode since chamber **23** is vented to atmospheric pressure and the entire pivot movement and position of slide **12** is determined by the level of pressurization of chamber **22**.

[**0046**] In an alternate embodiment valve **207** may be opened to a partial position thereby causing slide **12** to move to a position that is intermediate position A and position B, causing an intermediate outlet pressure and flow. Placing valve **207** in any position between fully open and fully closed allows the pressure in chamber **23** to be variable, thereby providing a range of slide positions for a given pump outlet pressure.

[**0047**] In the case of a failure of valve **207**, the pump will continue to operate in a passive mode (chamber **23** depressurized) while meeting all oil requirements of the engine. The passive operating mode is still more efficient that a fixed displacement pump. With valve **207** in operation the instant invention provides incremental horsepower reduction over the passive design.

[**0048**] FIG. **7** is an example graph depicting the pump performance including pump flow rate and pressure. A range of engine speeds is represented on the x-axis and a range of pump outlet pressures is represented on the y-axis. A range of pump flow rates is also represented on the second y-axis in liters per minute.

[0049] The engine speed range is from 0 RPM to 8000 RPM. The outlet pressure range is from 0 bar to 6.00 bar. The pump flow rate range is from 0 liters/minute to 90.00 liters/minute.

[0050] For the purposes of illustration an engine speed of ~3,500 RPM is selected to demonstrate the characteristics of the inventive pump. The transition between operating conditions "A" and "B" is depicted as the "switching point" in the center of the curves in the graph.

[0051] For engine speeds less than ~3,500 RPM the maximum pump outlet pressure is approximately 2.6 bar. The maximum flow rate is approximately 20.0 liters/minute.

[0052] For engine speeds greater than ~3,500 RPM the pump outlet pressure quickly transitions up to a minimum outlet pressure of approximately 4.9 bar at 7,500 RPM. The flow rate transitions to a maximum of approximately 28.0 liters/minute at 7,500 RPM.

[0053] At the transition point the step change in pressure is approximately 1.6 bar. The step change in flow is approximately 5 l/min.

[0054] The performance transition is caused by slide **12** pivoting about pivot **18** caused by deactivation of valve **207** venting chamber **23** to ambient atmospheric conditions. Valve **207** is controlled by an electric signal transmitted by an engine ECU, for example. Upon reaching the predetermined engine speed, in this case ~3,5.00 RPM, ECU **208** (see FIG. **6**) signals valve **207** to close, thereby pressurizing chamber **23** with fluid pressure equal to that in the main oil gallery **204**.

[0055] As described previously, the pressures in chambers **22**, **23** create a torque and hence force which is greater than the combination of the force of the spring **31** and the fluid force in chambers **21**, thereby causing spring **31** to compress. This causes slide **12** to pivot. By pivoting in the clockwise direction the flow rate and outlet pressure are each substantially decreased at the predetermined engine speed because pump displacement is reduced.

[0056] For the purposes of comparison, the dashed lines in portion A of FIG. **7** below ~3,500 RPM depict the behavior of the outlet pressure and flow rate of a pump in the case where the position of slide **12** is only controlled by a single pressure chamber. In the single chamber case, at relatively low engine speeds, say only slightly greater than idle (~1, 500 RPM), the pump would operate at a comparatively elevated outlet pressure and flow rate not otherwise required by the engine. This is inefficient. The inventive pump provides only the required amount of flow and pressure for efficient operation at reduced engine speeds. This equates to considerable energy savings in the system. However, at elevated engine speeds the pump can quickly and precisely transition to higher flow rates and outlet pressures necessary to meet engine demands.

[0057] FIG. **8** is a side view of an electric valve. Valve **207** is engaged with the body **10** of the pump. Valve **207** is connected to the electrical harness of the engine or vehicle (not shown). An electrical connector (not shown) engages the valve **207** at socket **208**. When valve **207** is de-activated, pressure is vented from chamber **23**, thereby causing the pump to operate in region "A". When valve **207** is activated fluid pressure is admitted to chamber **23** from nozzle **211**, thereby causing the pump to operate in region "B". In order to avoid engine failure caused by inadequate fluid pressure at high speed, the valve must be electrically de-activated to vent pressure from chamber **23**. This results in the fail safe situation at high speed, namely, chamber **23** is vented upon electrical failure of valve **207**.

[0058] FIG. **9** is a graph depicting the pump performance including pump flow rate and pressure. A range of engine speeds is represented on the x-axis and a range of pump outlet pressures is represented on the y-axis. A range of pump flow rates is also represented on the second y-axis.

[0059] The engine speed range is from 0 RPM to 8000 RPM. The outlet pressure range is from 0 bar to 6.00 bar. The pump flow rate range is from 0 liters/minute to 90 liters/minute.

[0060] For the purposes of illustration an engine speed of ~2,000 RPM is selected to demonstrate the characteristics of the inventive pump. The transition between operating conditions "A" and "B" is depicted as the "switching point" at approximately 2,000 RPM.

[0061] In this example, valve **207** is OFF at start up and for engine speeds less than 2,000 RPM, namely, chamber **23** is unpressurized and vented to ambient. For engine speeds less than approximately 2,000 RPM the maximum pump outlet pressure (Line Pressure) is approximately 3.6 bar. The maximum flow rate (Flow Rate) is approximately 25.0 liters/minute.

[0062] For engine speeds greater than approximately 2,000 RPM the pump outlet pressure (Line Pressure) quickly transitions down to a minimum outlet pressure of approximately 2.4 bar at 2,000 RPM up to 3.2 bar at approximately 7,500 RPM. The flow rate (Flow Rate) transitions to a maximum of approximately 23.0 liters/minute at 7,500 RPM.

[0063] At the transition point the step change in pressure is approximately 1.4 bar. The step change in flow is approximately 5 l/min.

[0064] The performance transition in this example is caused by slide **12** pivoting about pivot **18** caused by activation of valve **207** thereby pressuring chamber **23**. Valve **207** is controlled by an electric signal transmitted by an engine ECU, for example. Upon reaching the predetermined engine speed, in this case approximately 2,000 RPM, ECU **208** (see FIG. **6**) signals valve **207** to close, thereby pressurizing chamber **23** with fluid pressure equal to that in the main oil gallery **204**. In the event of a failure of valve **207** chamber **23** would depressurize thereby putting the pump in high discharge pressure mode.

[0065] Although a form of the invention has been described herein, it will be obvious to those skilled in the art that variations may be made in the construction and relation of parts without departing from the spirit and scope of the invention described herein.

We claim:

1. A variable displacement sliding vane pump comprising:

a pump body;

inlet and outlet ports in said pump body;

a drive shaft rotatably mounted in said pump body;

a rotor driven by said drive shaft;

a plurality of radially extending vanes slidably disposed in said rotor;

a pivot disposed in said pump body;

a slide pivotally disposed on said pivot and having a central axis eccentric to the axis of said rotor;

a plurality of fluid chambers defined by said rotor, said vanes, and said slide that are successively connected to said inlet and outlet ports;

a spring acting on said slide to urge said slide in one direction;

a first chamber and a second chamber, each for receiving a fluid pressure and each disposed between said pump body and an outer surface of said slide;

the first chamber connected to a pump outlet discharge pressure; and

a valve operable to selectively pressurize the second chamber to a fluid pressure greater than an atmospheric ambient pressure condition.

2. The variable displacement pump as in claim 1 further comprising a second spring acting in parallel with the spring.

3. The variable displacement sliding vane pump as in claim 1, wherein the valve is electric and controlled by an engine ECU.

4. The variable displacement sliding vane pump as in claim 1, wherein the pump outlet discharge flow rate decreases upon depressurization of the second chamber.

5. The variable displacement sliding vane pump as in claim 1, wherein the second chamber is pressurized to a pressure greater than atmospheric ambient pressure for engine speeds less than a predetermined engine speed and is depressurized to an atmospheric ambient pressure for engine speeds greater than said predetermined engine speed.

6. The variable displacement sliding vane pump as in claim 1, wherein the first chamber and the second chamber are both in fluid communication with a pump output discharge pressure.

7. A variable displacement sliding vane pump comprising:

a pump body;

inlet and outlet ports in said pump body;

a drive shaft rotatably mounted in said pump body;

a rotor driven by said drive shaft and co-axially aligned therewith;

a plurality of radially extending vanes slidably disposed in said rotor;

a pivot disposed in said pump body;

a slide pivotally disposed on said pivot in said pump body and having a central axis eccentric to the axis of said rotor;

a plurality of fluid chambers defined by said rotor, said vanes, and said slide that are successively connected to said inlet and outlet ports;

a spring acting on said slide to urge said slide in one direction;

a first chamber and a second chamber, each in fluid communication with a pump discharge oil pressure and each disposed between the pump body and an outer surface of said slide; and

a valve operable at a predetermined pump speed wherein the second chamber is selectively switched between an ambient atmospheric pressure and an pump discharge oil pressure.

8. A variable displacement sliding vane pump comprising:

a pump body;

inlet and outlet ports formed in said pump body;

a drive shaft rotatably mounted in said pump body;

a rotor driven by said drive shaft and co-axially aligned therewith;

a plurality of radially extending vanes slidably disposed in said rotor;

a pivot disposed in said pump body;

a slide pivotally disposed on said pivot in said pump body and having a central axis eccentric to the axis of said rotor;

a plurality of fluid chambers defined by said rotor, said vanes, and said slide that are successively connected to said inlet and outlet ports;

a spring acting on said slide to urge said slide in one direction;

a first chamber and a second chamber, each suitable for receiving a fluid pressure and each disposed between said pump body and an outer surface of said slide;

the first chamber in fluid communication with a pump outlet discharge pressure; and

a valve operable to selectively pressurize and depressurize the second chamber.

9. The variable displacement sliding vane pump as in claim 8, wherein the second chamber is pressurized to a pressure greater than atmospheric ambient pressure for engine speeds less than a predetermined engine speed and is depressurizeable to an atmospheric ambient pressure for engine speeds greater than said predetermined engine speed.

10. The variable displacement sliding vane pump as in claim 8, wherein the second chamber is pressurizeable up to approximately a pump outlet discharge pressure.

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