

Description

Technical Field

[0001] The present disclosure is directed to a circuit for a hydraulic pump and, more particularly, to a circuit for bleeding air from the inlet to a hydraulic pump.

Background

[0002] Hydraulic pumps are commonly used for many purposes in many different applications. Vehicles, such as, for example, highway trucks and off-highway work machines, commonly include hydraulic pumps that are driven by an engine in the vehicle to generate a flow of pressurized fluid. The pressurized fluid may be used for any of a number of purposes during the operation of the vehicle. A highway truck, for example, uses pressurized fluid to operate a fuel injection system or a braking system. A work machine, for example, uses pressurized fluid to propel the machine around a work site or to move a work implement.

[0003] A hydraulic pump typically draws operating fluid, such as, for example, oil, from a reservoir and applies work to the fluid to increase the pressure of the fluid. The hydraulic pump directs the pressurized fluid into a fluid rail or another similar supply system for use during the operation of the vehicle. The hydraulic pump may be configured to vary the rate at which the pressurized fluid is directed into the fluid rail. This may be accomplished with a variable displacement pump or with a fixed displacement pump that has a variable flow.

[0004] A hydraulic pump usually includes a pumping element that applies the work to the fluid to increase the pressure of the fluid. The pumping element includes a sliding, rotating, or spinning part, such as, for example, a gear, gearotor, piston, vane, or swash plate. These moving parts are typically lubricated to prevent excessive wear due to friction.

[0005] The engine lubrication system in the vehicle may provide the operating fluid that is pressurized by the hydraulic pump and the lubricating fluid that is used to lubricate the moving parts of the hydraulic pump. The supply of fluid may, however, also include air that is drawn into the system. This is particularly a problem when the engine is starting after having been idle for a period of time. When the engine is not operating, the oil in the lubrication system may drain from the system and return to the reservoir. The draining oil is replaced by air pockets, which are purged from the lubrication system when the engine is started.

[0006] The inclusion of air in the flow of pressurized fluid generated by the hydraulic pump may impair or delay the operation of the system that uses the pressurized fluid. As shown in U.S. Patent No. 5,454,359 to Howell, an air bleed valve may be disposed in the outlet path of the pump. This type of valve can remove any air that is included in the flow of pressurized fluid. However, the

hydraulic pump must pressurize both the fluid and the air before the air is purged from the system through the air bleed valve. The additional work that is required to pressurize the air, which is subsequently released from the system, decreases the efficiency of the hydraulic pump.

[0007] The hydraulic pump circuit of the present disclosure solves one or more of the problems set forth above.

Summary of the Invention

[0008] According to one aspect, the present disclosure is directed to a circuit for a hydraulic pump. The circuit includes a supply of fluid. A pumping element is operable to increase the pressure of fluid received from the supply of fluid and to generate a flow of pressurized fluid. An inlet passageway connects the pumping element with the supply of fluid. A drain passageway is connected to the inlet passageway. A valve is disposed in the drain passageway. The valve is moveable between a first position where the valve prevents a flow of fluid relative to the drain passageway and a second position where the valve allows a flow of fluid relative to the drain passageway.

[0009] In another aspect, the present disclosure is directed to a method of removing air from a hydraulic pump. A flow of an operating fluid is supplied to an inlet passageway of the hydraulic pump. A pumping element is operated to increase the pressure of the flow of fluid supplied to the pump and to generate a flow of pressurized fluid. A valve is moved from a first position to a second position to allow fluid to flow from the inlet passageway to a drain passageway when the pressure of the fluid in inlet passageway is above a predetermined limit.

Brief Description of the Drawings

[0010]

Fig. 1 is a schematic and diagrammatic representation of a hydraulic circuit for a hydraulic pump in accordance with an exemplary embodiment of the present invention; and

Fig. 2 is a cross-sectional view of an exemplary embodiment of a valve for a hydraulic circuit in accordance with the present invention.

Detailed Description

[0011] As shown in Fig. 1, hydraulic circuit 10 includes a tank 12 that contains a supply of fluid. Tank 12 may be part of a lubrication system for the vehicle, such as an oil sump. The fluid within tank 12 may be a hydraulic fluid, such as, for example, a lubricating oil, although tank 12 may store other types of fluids.

[0012] As also shown, hydraulic circuit 10 may include

a supply pump 14. Supply pump 14 may be a relatively low pressure pump, such as, for example, a sump pump that may be commonly included in a lubrication system to distribute oil to various systems in an engine. Supply pump 14 may increase the pressure of the fluid to a relatively low pressure, such as about 70 Kpa. This relatively low pressurized fluid may then be directed into an inlet line 16.

[0013] Hydraulic circuit 10 may also include a high pressure pump, such as hydraulic pump 20, to further increase the pressure of the operating fluid. A high pressure fluid may be required to operate certain systems. For example, in a vehicle, the high pressure fluid may be used to operate a fuel injection system and/or a braking system. One skilled in the art will recognize that the high pressure fluid may be used to operate other types of systems as well.

[0014] In the illustrated exemplary embodiment, hydraulic pump 20 is depicted as a fixed displacement variable flow pump. It is contemplated, however, that hydraulic pump 20 may be another type of pump. For example, hydraulic pump 20 may be a constant displacement constant flow pump or a variable displacement pump.

[0015] Hydraulic pump 20 includes a housing 21 and an inlet 22. Inlet 22 may be connected to inlet line 16 to receive fluid from supply pump 14. Inlet 22 directs the low pressure operating fluid to a pumping element 26.

[0016] Pumping element 26 is operable to increase the pressure of the operating fluid provided through inlet 22. In the illustrated embodiment, pumping element 26 includes a series of pistons 32 that are driven by a swashplate 28. It should be understood that another type of pumping element 26 may also be used. For example, pumping element 26 may include a gear, gearotor, or vane pump.

[0017] As schematically illustrated in Fig. 1, an input shaft 52 is provided to drive pumping element 26. Input shaft 52 is mounted for rotating movement on a bearing 50. Input shaft 52 may be driven, for example, by an engine on the vehicle. Input shaft 52 may include a spline or keyed end that may be operatively engaged with the crankshaft or gear train of the engine. Input shaft 52 may be connected to the engine in any manner readily apparent to one skilled in the art.

[0018] As schematically illustrated, swashplate 28 has an angled driving surface that is engaged with pistons 32. The angle surface of swashplate 28 causes each piston 32 to reciprocate within a bore as swashplate 28 rotates. The reciprocating movement of each piston 32 pressurizes fluid contained within the bore and supplied through inlet 22. It should be noted that the angle of swashplate 28 may be varied to vary the displacement of each piston 32 within hydraulic pump 20.

[0019] A pivoting shoe 30 may be disposed between each piston 32 and the angled surface of swashplate 28. Each shoe 30 rides along the surface of swashplate 28 as swashplate 28 rotates. Each shoe 30 provides a pivoting motion to accommodate for the angled surface

of swashplate 28.

[0020] As further illustrated in Fig. 1, a check valve 36 may be disposed at the outlet of each bore. Each check valve 36 may be configured to open when the fluid within the bore reaches a predetermined level. When pumping element pressurizes the operating fluid to the predetermined pressure, check valve 36 will open to allow the pressurized fluid to flow from the bore.

[0021] Hydraulic pump 20 may include a collector 38. Pressurized fluid released from each bore may be directed to collector 38. Collector 38 stores a supply of pressurized fluid that is released by pistons 32.

[0022] Pump collector 38 is connected to an outlet 24, which may be further connected to an outlet line 18. Outlet line 18 may be connected to a fluid rail 19. Fluid rail 19 may be configured to distribute pressurized fluid to a system, such as, for example, a fuel injection system associated with the vehicle and/or engine.

[0023] As also schematically shown in Fig. 1, hydraulic pump 20 may include a control device 44 that is connected to outlet 24 through a control line 40. In the illustrated exemplary embodiment, control device 44 governs the flow rate of pressurized fluid produced by hydraulic pump 20 by controlling the position of a metering device 34. One skilled in the art may recognize, however that control device 44 may perform any controlling function that is common in a hydraulic pump, such as, for example, displacement control, flow rate control, output pressure control, torque or horsepower control, or load control.

[0024] The position of metering device 34 may control the flow rate of pressurized fluid produced by each piston 32. Metering device 34 may be, for example, a metering sleeve that is moveable between a first position and a second position. Movement of metering device 34 from the first position to the second position may act to decrease the flow rate of pressurized fluid generated by each piston 32.

[0025] As also schematically illustrated in Fig. 1, a drain passageway 46 may be connected to inlet 22. Drain passageway 46 may lead to bearing 50 of input shaft 52. It should be noted, however, that drain passageway 46 may lead to another bearing within hydraulic pump 20, another surface within hydraulic pump 20 that requires lubrication, directly to tank 12, or to some other desired location.

[0026] A valve 48 may be disposed in drain passageway 46. Valve 48 has a first, or closed, position, where valve 48 prevents fluid from flowing through drain passageway 46. Valve 48 also has a second, or open, position, where valve 48 allows fluid to flow through drain passageway 46. By controlling the position of valve 48, a fluid flow through drain passageway 46 may be selectively controlled. Valve 48 may be, for example, a check valve, a spool, valve, or any other type of valve operable to selectively allow a flow of fluid through a fluid passageway.

[0027] As illustrated in Fig. 2, valve 48 may be a check

valve. In this exemplary embodiment, valve 48 includes a body 60. Body 60 defines a valve inlet 62 and a valve outlet 64. A poppet 66 is slidably disposed within body 60. Poppet 66 is configured to engage a seat 70 that surrounds inlet 62. A spring 68 may be disposed in housing 60 to bias poppet 66 into engagement with seat 70. The engagement of poppet 66 with seat 70 prevents fluid from flowing from valve inlet 62 to valve outlet 64.

[0028] Valve 48 may be disposed in drain passageway 46 so that valve inlet 62 is exposed to fluid from inlet 22. Valve inlet 62 directs this fluid against poppet 66. When the force exerted by the fluid on poppet 66 exceeds the countering force exerted by spring 68, poppet 66 will disengage from seat 70 and allow fluid to flow from valve inlet 62 through valve outlet 64.

[0029] Spring 68 may be selected to allow poppet 66 to disengage seat 70 when poppet 66 is subject to a fluid having a predetermined pressure. For example, spring 68 may be configured to allow poppet 66 to disengage seat 70 when the fluid has a pressure of about 70 Kpa. One skilled in the art will recognize that valve 68 may be configured to open at other pressures.

Industrial Applicability

[0030] The operation of an exemplary embodiment of the described hydraulic circuit will now be described with reference to the figures. The described hydraulic circuit 10 may be included as part of a vehicle to provide pressurized fluid to a system in the vehicle. The vehicle may be, for example, a highway truck or an off-highway work machine.

[0031] When the vehicle, or engine, that includes hydraulic circuit 10 is not in operation, both supply pump 14 and hydraulic pump 20 will be idle. Accordingly, the oil in inlet line 16 and inlet 22 will be at a low pressure, so that valve 48 remains closed. In the closed position, valve 48 prevents oil from draining from inlet line 16 and inlet 22 through drain passageway 46. Valve 48 will thereby preventing the formation of air pockets in hydraulic circuit 10.

[0032] When the engine of the vehicle is started, both supply pump 14 and hydraulic pump 20 will also start operating. Supply pump 14 will provide a supply of relatively low pressure oil through inlet line 16 and inlet 22. Pumping element 26 of hydraulic pump 20 further increases the pressure of the oil. The high pressure oil is directed through outlet 24 to fluid rail 19 for use by another system in the vehicle.

[0033] Valve 48 may be configured to open when exposed to fluid having a pressure slightly lower than the standard output pressure of supply pump 14. Valve 48 will, therefore, open when supply pump 14 is operating normally and providing a stream of fluid at a typical output pressure. The opening of valve 48 will allow oil to flow from inlet 22 through drain passageway 46.

[0034] Drain passageway 46 may be connected with inlet 22 at the highest elevation in inlet 22. With this

placement, the force of gravity will act on the oil to cause the oil to continue to flow through inlet 22 and to pumping element 26. Any air that is mixed with the oil supplied to hydraulic pump 20 will tend to collect adjacent to or in drain passageway 46. When valve 48 opens in response to an increase in the pressure of the supply oil, the collected air, along with some of the oil will flow through drain passageway 46.

[0035] Drain passageway 46 may lead to bearing 50 that supports input shaft 52. The oil flowing through drain passageway 46 will lubricate bearing 50. The lubrication will prevent excessive wear on input shaft 52. Thus, the amount of maintenance necessary to keep hydraulic pump 20 operational may be reduced.

[0036] As will be apparent, the foregoing disclosure provides a hydraulic circuit 10 for a hydraulic pump 20 that allows for the removal of air at the inlet to the hydraulic pump 20 and may be used to lubricate the moving parts of the hydraulic pump 20. By removing the air before the air is pressurized by the pumping element 26, the efficiency of the hydraulic pump 20 may be increased. In addition, the described hydraulic circuit 10 may prevent the formation of air pockets in the flow of pressurized fluid that is used to operate an auxiliary system on the vehicle, such as, for example, a fuel injection system.

[0037] It will be apparent to those skilled in the art that various modifications and variations can be made in the described hydraulic circuit without departing from the scope of the invention. Other embodiments may be apparent to those skilled in the art from consideration of the specification and practice of the hydraulic circuit disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the present disclosure being indicated by the following claims and their equivalents.

Claims

1. A circuit (10) for a hydraulic pump (20), comprising:
 - a supply of fluid (12);
 - a pumping element (26) operable to increase the pressure of fluid received from the supply of fluid (12) and to generate a flow of pressurized fluid;
 - an inlet passageway (22) connecting the pumping element (26) with the supply of fluid (12);
 - a drain passageway (46) connected to the inlet passageway (22); and
 - a valve (48) disposed in the drain passageway (46), the valve (48) moveable between a first position where the valve (48) prevents a flow of fluid relative to the drain passageway (46) and a second position where the valve (48) allows a flow of fluid relative to the drain passageway (46).

2. The circuit of claim 1, further including a supply pump (14) disposed in the inlet passageway (22) and adapted to increase the pressure of the fluid supplied to the pumping element (26).
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3. The circuit of claim 1, wherein the valve (48) is a check valve configured to move to the second position when exposed to fluid having a predetermined pressure.
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4. The circuit of claim 1, further including an input shaft (52) supported by a bearing (50) and wherein the drain passageway (46) directs the flow of fluid from the inlet passageway (46) to the bearing (50).
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5. The circuit of claim 1, further including a fluid rail (19) and wherein the flow of pressurized fluid is directed into the fluid rail (19).
6. The circuit of claim 1, wherein the pumping element (26) includes a piston (32) slidably disposed in a bore and the piston (32) is driven by a swashplate (28).
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7. The circuit of claim 1, wherein the fluid is a lubricating oil and the valve (48) allows a mixture of air and lubricating oil to flow through the drain passageway (46).
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8. A hydraulic pump (20) having a hydraulic circuit (10) according to any one of claims 1 through 7.
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9. A method of removing air from a hydraulic pump (20), comprising:
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 - supplying a flow of an operating fluid to an inlet passageway (22) of the hydraulic pump (20);
 - operating a pumping element (26) to increase the pressure of the flow of fluid supplied to the hydraulic pump (20) and to generate a flow of pressurized fluid;
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 - moving a valve (48) from a first position to a second position to allow fluid to flow from the inlet passageway (22) to a drain passageway (46) when the pressure of the fluid in inlet passageway (22) is above a predetermined limit.
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10. The method of claim 9, further including lubricating a bearing (50) in the hydraulic pump (20) with at least a portion of the fluid flowing through the drain passageway (46).
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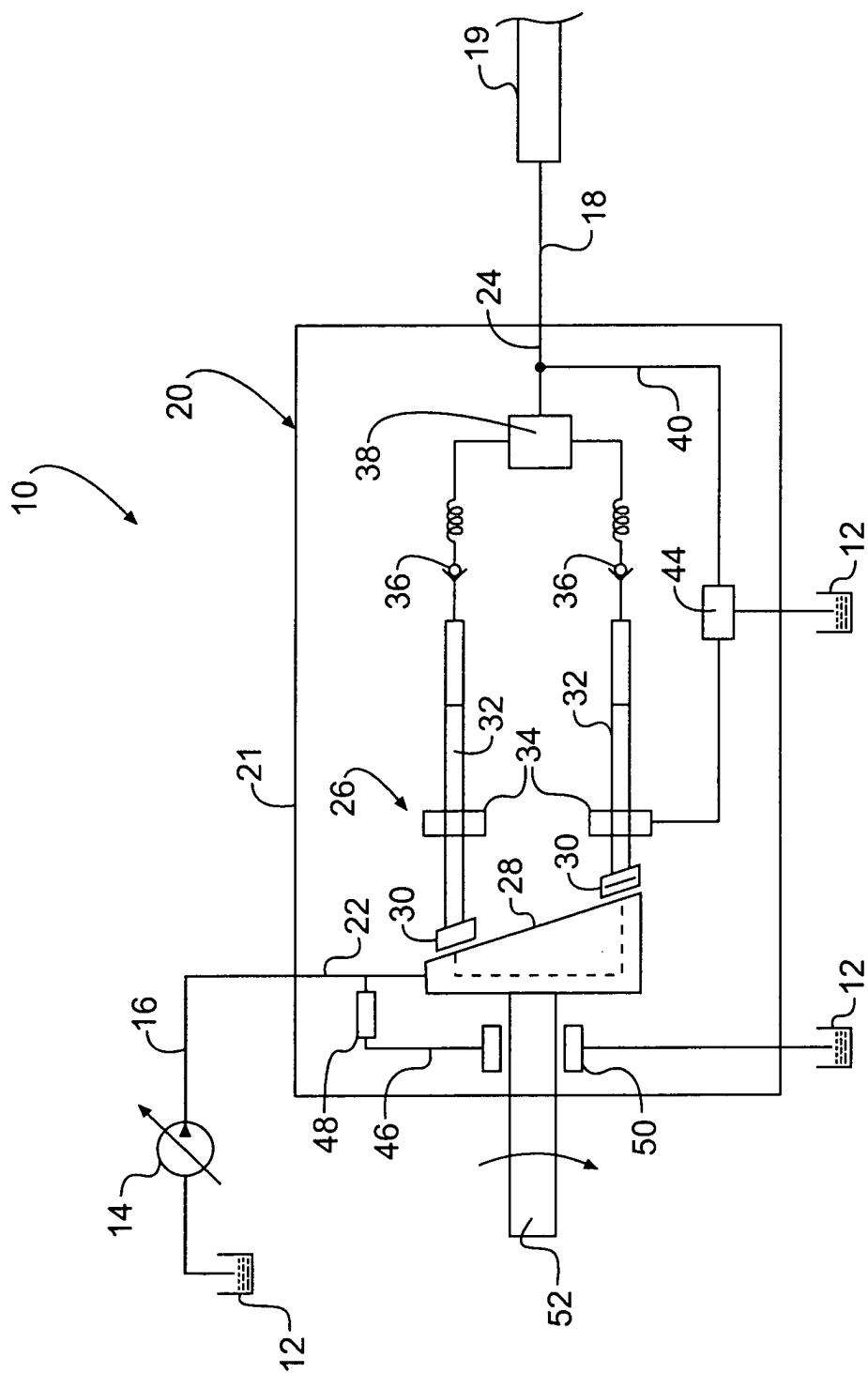


FIG. 1

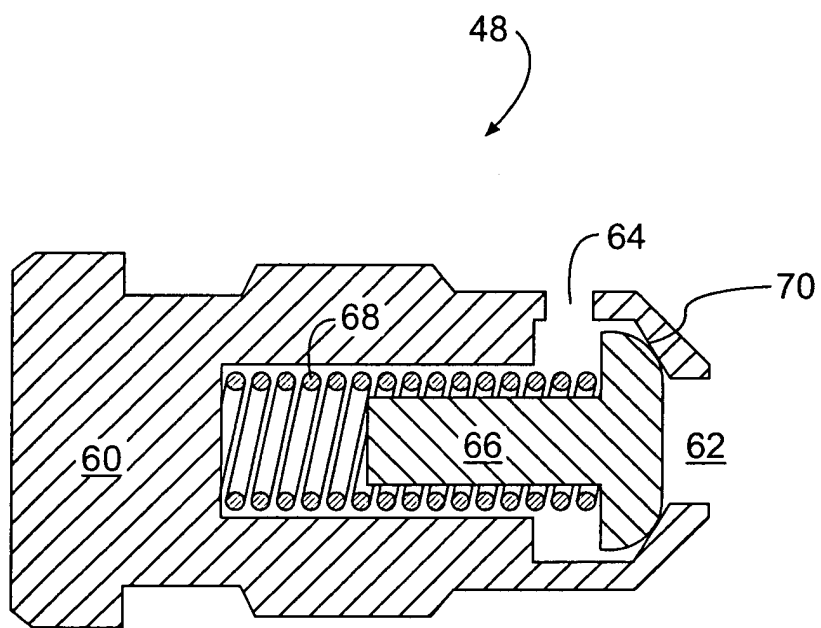


FIG.2



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EUROPEAN SEARCH REPORT

Application Number
EP 03 01 8897

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 3 December 2003	Examiner Busto, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03 82 (P04C01)



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EUROPEAN SEARCH REPORT

Application Number
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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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