HYDRAULIC PUMP WITH AIR VENT VALVE

Inventors: Siegfried Bornholt, Lohr, Main; Georg Schmitt, Tauberbischofsheim, both of Germany

Assignee: G. L. Rexroth GmbH, Lohr, Main, Germany

Filed: Apr. 24, 1974

Appl. No.: 463,781

Foreign Application Priority Data
June 1, 1973 Germany.......................... 2327814

U.S. Cl. .................. 417/299; 417/310; 417/435
Int. Cl. .................. F04B 49/08
Field of Search .................. 417/299, 310, 435

References Cited
UNITED STATES PATENTS
2,531,319 11/1950 Briggs.......................... 417/310 X

ABSTRACT
A hydraulic vane pump wherein the intake opening of an air vent valve communicates with the chambers which sweep past the pump outlet and the discharge opening of the valve communicates with a channel which is provided in the pump housing for leak fluid. The valve member of the valve is held in open position by a weak spring during priming of the pump but yields and enables the valve member to seal the intake opening from the discharge opening in response to increasing fluid pressure at the outlet when the priming is completed. The body of the valve is insertable into a compartment of the housing at that axial end of the rotor which is remote from the outlet.

9 Claims, 2 Drawing Figures
HYDRAULIC PUMP WITH AIR VENT VALVE

BACKGROUND OF THE INVENTION

The present invention relates to hydraulic machines in general, especially to hydraulic pumps, and more particularly to improvements in means for preventing a buildup of pressure at the outlet side of a hydraulic pump during priming.

It is already known to equip a vane pump with an air vent valve or relief valve which connects the outlet side of the pump with the atmosphere during priming, i.e., while the chambers between the vanes of the rotor are being filled with oil or another hydraulic fluid. The valve should close in immediate response to filling of the chambers with hydraulic fluid, i.e., as soon as the priming is completed, in order to enable the pump to convey pressurized hydraulic fluid to one or more consumers. In presently known hydraulic pumps, the air vent valve is likely to close prior to completion of priming, for example, if the conduit which connects the outlet side with a consumer contains an elbow or bend which stores a supply of hydraulic fluid. Such fluid can cause premature closing of the air vent valve whereby the priming is interrupted and the pump runs dry with attendant damage to moving parts and/or to the abutting surfaces between stationary and moving parts as a result of total absence of and/or insufficient lubrication.

SUMMARY OF THE INVENTION

An object of the invention is to provide a hydraulic pump, especially a vane pump, with an air vent valve which remains open during priming of the pump, even if the conduit which is connected to the outlet contains entrapped hydraulic fluid.

Another object of the invention is to provide an air vent valve which can be used in existing types of hydraulic pumps.

A further object of the invention is to provide an air vent valve which prevents damage to the pump during priming.

An additional object of the invention is to provide an air vent valve which occupies little room, which is of simple construction, and which contributes negligibly to the cost of a hydraulic pump.

The invention is embodied in a hydraulic machine, particularly in a hydraulic vane pump, which comprises a stator (this stator may include a housing and a valve plate) having inlet means for hydraulic fluid, outlet means for pressurized fluid and channel means for leak fluid, a rotor which is mounted in the stator to pressurize the fluid during transport from the inlet means to the outlet means, and an air vent valve which is installed in (the housing or valve plate of) the stator and has an intake opening communicating with the outlet means, a discharge opening communicating with the channel means for leak fluid, and a valve member (e.g., a sphere) which is arranged to seal the two openings from each other in response to increasing fluid pressure at the intake opening. Such pressure develops on completion of priming of the pump.

The air vent valve preferably constitutes a prefabricated unit, e.g., a cartridge whose body contains the valve member and is insertable into a compartment of the stator.

When the invention is embodied in a vane pump, the vanes of the rotor define with the stator a plurality of variable-volume chambers which sweep seriatim past the inlet and outlet means of the stator. The outlet means is preferably provided at one axial end of the rotor and the air vent valve is preferably installed in the stator at the other axial end of the rotor, and its intake opening is connected with the chambers containing pressurized fluid by a channel in the stator.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved pump itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a central longitudinal sectional view of a vane pump which embodies the improved air vent valve; and

FIG. 2 is a sectional view as seen in the direction of arrows from the line II—II of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawing illustrates a hydraulic vane pump including a stator having a pump housing and a valve plate 4, a rotor 3, an adjustable ring-shaped slide block 2 for the vanes 26 of the rotor 3, adjusting means for the slide block 2, and an air vent valve 12 which is installed in the stator. The housing of the stator includes a main portion 1 and a cover 7. The main portion 1 (hereinafter called cup for short) has a cylindrical recess 1a which receives the rotor 3 with vanes 26, the slide block 2, and the valve plate 4. The slide block 2 surrounds the rotor 3 and its eccentricity with respect to the rotor axis determines the throughput of the pump.

The inlet means of the pump includes a suction part 1b, 1c which is machined into the cup 1 at one axial end of the rotor 3 and is connected to a source of hydraulic fluid, e.g., an oil tank, and an arcuate slot 4b in the valve plate 4. The outlet means comprises a port 1d, 1e which is machined into the cup 1 and is connected to one or more consumers, and a slot 4c in the valve plate 4. The latter is adjacent to the inner surface 1f of the bottom wall of the cup 1. An axial bore 1g of this bottom wall receives a bearing sleeve 5 for the drive shaft 6 which is rotated by a motor, not shown. The cover 7 is affixed to the open end of the cup 1 and has a groove for a sealing ring 8 which prevents escape of fluid from the chambers 27 between the vanes 26. An axial bore 7a of the cover 7 receives a bearing sleeve 9 for the stub 10 of the drive shaft 6. The outer end of the bore 7a is sealed by a threaded plug 11.

The cover 7 is formed with a compartment 7b which extends radially of the bore 7a and receives a preassembled cartridge constituting the air vent valve 12. The body 12d of this valve has an intake opening 12a in communication with a bore or passage 13 which is machined into the cover 7 and communicates with successive chambers 27 sweeping past the outlet means 4a, 1d, 1e of the pump housing. It will be noted that the outlet means 4a, 1d, 1e is located at one axial end and the valve 12 is located at the other axial end of the rotor 3. Those chambers 27 wherein the fluid is pressurized when the rotor 3 is driven by the shaft 6 and
which communicate with the passage 13 are located in the portion D of the crescent-shaped space A between the slide block 2 and rotor 3.

The fluid discharging opening 12b of the body 12d of the valve 12 communicates with a smaller-diameter inner end portion 7c of the compartment 7b. The end portion 7c communicates with a radially extending channel 15 of the cover 7 by way of a groove 7d and a space 14 between the plug 11 and the end face 10a of the stub 10. The channel 15 serves for evacuation of leak fluid which flows into the space 14 from the space A along the internal and/or external surface of the bearing sleeve 9.

The body 12d of the valve 12 has an axial bore 12c which communicates the openings 12a, 12b and can be sealed by a spherical valve member 12e. The latter is biased away from its seat 12g in the body 12d by a weak helical valve spring 12f.

The space 14 communicates with a blind axial bore 16 of the drive shaft 6. The latter has a radial bore 17 which connects the axial bore 16 with an annular space 18 at the outer end of the bearing sleeve 5. The outer end of the space 18 is sealed by a packing 19.

The slide block 2 is shown in its leftmost position, as viewed in FIG. 2, so that the pump conveys hydraulic fluid at a maximum rate. The adjusting means for the slide block 2 comprises an externally threaded stop 20 in a tapped bore of the cup 1. By rotating the stop 20, the operator can move the slide block 2 or against the bias of a strong helical spring 21 bearing against the collar of a motion transmitting member 22 located diametrically opposite the stop 20 and having a pin-shaped projection received in a socket provided in the peripheral surface of the slide block 2. The bias of the spring 21 can be changed by a threaded retainer 23 which is in mesh with a radial extension 1A of the cup 1 and is normally concealed by a cap 23a. A similar cap 20a normally conceals a lock nut 20b on the shank of the stop 20.

The direction in which the rotor 3 is driven by the shaft 6 is indicated by an arrow 24. The vanes 26 are movable in radially extending slots 25 of the rotor 3 and are engaged by the internal surface of the slide block 2 under the action of centrifugal force when the shaft 6 rotates to drive the rotor 3.

When the motor for the shaft 6 is started and the shaft 6 drives the rotor 3, the volume of chambers 27 between neighboring vanes 26 increases gradually in the portion S of the crescent-shaped space A, namely, while a chamber 27 travels from the locus Sr toward the locus Sx (shown in FIG. 2). The chambers 27 then draw fluid via inlet means 1b, 1c, 4b. The volume of the chambers 27 begins to decrease during travel beyond the locus Sx and back toward the locus Sr. The displaced pressurized fluid flows through the outlet means 4a, 1e, 1d and on to one or more consumers, not shown. The pressure of fluid in the passage 13 and intake opening 12a of the valve body 12d is identical or nearly identical with that in the portion 1e of the outlet means. Such pressure is ample sufficient to overcome the resistance of the valve spring 12f and to maintain the spherical valve member 12e in engagement with the seat 12g of the valve body 12d so that the openings 12a, 12b are sealed from each other and the valve 12 prevents escape of pressurized fluid from the portion D of the space A into the channel 15 for leak fluid.

However, during priming of the pump, the bias of the spring 12f is sufficient to lift the valve member 12e off the seat 12g so that the chambers 27 which sweep past the outlet means 4a, 1e, 1d of the cup 1 can communicate with the channel 15 which is maintained at atmospheric pressure. This insures that the pressure in chambers 27 forming the portion D of the space A cannot rise during priming. The fluid (especially a viscous fluid, such as oil) immediately moves the valve member 12e against the seat 12g as soon as the priming is completed because the bias of the spring 12f is weak so that the openings 12a, 12b remain sealed from each other during normal operation of the pump. The higher the pressure of fluid in the portion D of the space A and in the passage 13, the greater is the force with which the valve member 12e is biased against the seat 12g. The spring 12f lifts the valve member 12e off the seat 12g when the shaft 6 is arrested and the pressure in the portion D of the space A decreases.

The improved pump is susceptible of many modifications without departing from the spirit of the invention. For example, the driven portion of the shaft 6 can be installed in the cover 7 and the air vent valve 12 can be installed in the cup 1 or in the valve plate 4.

An important advantage of the improved air vent valve is that its venting action is not dependent on the orientation and/or configuration of the conduit or conduits connecting the outlet means 4a, 1e, 1d with one or more consumers. This is due to the fact that the air vent valve 12 is mounted directly in the stator 1, 4, 7 of the pump so that its operation is not influenced by eventual accumulations of fluid in the bends, elbows or analogous portions of the aforementioned conduit or conduits.

The construction of the air vent valve in the form of a cartridge which can be inserted into or removed from a compartment or bore of the stator contributes to simplicity of installation, inspection and/or replacement.

The placing of the valve at the axial end of the rotor which is remote from the outlet means contributes to accessibility of the valve and renders it possible to connect the intake opening of the valve body with those chambers 27 which sweep past the outlet means by resorting to a relatively short passage in the stator.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a hydraulic pump, particularly a vane pump, a combination comprising a stator including housing means formed with an axial bore having a closed end and an open end, said stator having inlet means for admission of hydraulic fluid, and outlet means for pressurized fluid; a rotor in said stator; shaft means coaxial with and fixed to said rotor; said shaft means having a pair of coaxial portions respectively projecting to opposite sides of said rotor and being rotatably mounted in said axial bore, one of said portions projecting beyond the open end of said bore and the other of said portions ends short of said closed end of said bore so as to define
with said closed end a pocket for fluid leaking along said shaft means; channel means for evacuation of leak fluid from said pocket; and an air vent valve installed in said stator, said valve having an intake opening communicating with said outlet means, a discharge opening communicating with said pocket, and a valve member arranged to seal said openings from each other in response to increasing fluid pressure at said inlet opening such as develops on completion of priming of the pump.

2. The combination of claim 1, wherein said valve includes a body which is provided with said openings and contains said valve member, said stator having a compartment for said body and being provided with first and second passages respectively connecting said intake opening with said outlet means and said discharge opening with said pocket.

3. The combination of claim 1, wherein said channel means extends substantially radially of said rotor and is located substantially diametrically opposite said valve with respect to the axis of said rotor.

4. The combination as defined in claim 1, wherein said housing means comprises a main body in which said rotor is located and a cover, said inlet means and said outlet means being provided in said main body and said air vent valve being mounted in said cover.

5. The combination of claim 1, wherein said valve further comprises a seat between said openings and means for biasing said valve member away from said seat with a force which is overcome by said valve member in response to a predetermined rise of fluid pressure at said intake opening.

6. The combination of claim 5, wherein said valve member is a sphere.

7. The combination as defined in claim 1, wherein said outlet means is adjacent said one portion of said shaft means and said valve is installed in said stator adjacent to the other portion of said shaft means.

8. The combination of claim 7, wherein said stator and said rotor define a plurality of variable-volume chambers which sweep past said inlet and outlet means in response to rotation of said rotor and said intake opening communicates with successive chambers which sweep past said outlet means.

9. The combination of claim 8, wherein said stator has a passage which connects said intake opening with successive chambers sweeping past said outlet means.

* * * * *