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(54) PRESSURIZATION SYSTEM

(71) We, SUNDSTRAND CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 4751 Harrison Avenue, Rockford, Illinois 61101, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates generally to a system for pressurizing a housing so that liquid may be more readily withdrawn from a source, such as a sump of the housing, and supplied to drive assembly components within the housing for lubrication and control purposes. Aircraft drive assemblies, such as gear boxes and constant speed drives, often employ a scavenge pump in the housing to withdraw liquid from the sump. An example of such a mechanism is Gantzer U.S. Patent No. 3,365,981, entitled "Combined fluid and Mechanical Drive", assigned to us. These devices do not scavenge well at high altitudes unless the pressure in the drive housing or case is above the ambient pressure. Baits *et al* U.S. Patent No. 3,600,106, entitled "Self-Pressurizing Scheme", also assigned to us, shows a means for pressurizing the housing or case when the ambient pressure exceeds the case pressure by a predetermined amount. In that system air-entrained liquid is transmitted to the sump by employing an injector and a differential pressure valve. One problem encountered with this type of scheme is that the system has a tendency to become "air bound" at very high altitudes, i.e. low atmospheric pressures, due to bubbles coming out of the driving fluid.

One method of suitably pressurizing the case would be to employ a displacement pump for supplying air thereto. However, the pump cannot be allowed to run dry without lubrication, and provision must be made to avoid overpressurization of the case, preferably without blowing anything overboard.

The present invention provides a pressurization system comprising a sealed housing having parts to be lubricated, a pump having an outlet connected to the housing, a first conduit for delivering ambient air to the pump inlet, a check valve in the first conduit biased to interrupt the delivery of ambient air, a second conduit for delivering lubricating oil to the sump inlet, and a pressure-actuable valve in the second conduit actuable to regulate but not to interrupt fluid communication between a source of lubricating oil, such as a sump of the housing, and the pump inlet in response to a predetermined difference between a reference pressure such as the pump inlet pressure and the pressure in the housing. For example regulation of the fluid communication between the source and the pump inlet may be by a bypass passage providing restricted fluid communication between the source and the pump inlet when the pressure-actuable valve is closed. In such a system, the pump having its discharge port connected to the housing is employed to pressurize the housing with ambient air drawn through the first conduit communicating with the atmosphere. The pressure-responsive valve is responsive to a pressure differential between the housing and the reference pressure, and regulates the amount of lubricating oil delivered to the intake port of the pump. The check valve interrupts the supply of ambient air to the pump when the reference pressure rises, which occurs when a substantial amount of oil is delivered to the pump through the pressure-actuable valve being open. As a result, there is positive exclusion when the desired pressure in the housing is reached. When the pressure differential is low, the pressure-actuable valve is closed but a small amount of oil is delivered for example through the by-pass passage, to provide constant lubrication to the pump and wet the clearances of the pump for efficient operation and thereby permit air to be drawn into the system.

In such a system, a positive constant displacement pump may be used without over-

pressurizing the housing and having over-board flow.

The invention is hereinafter particularly described, by way of example only, with reference to the drawing which is a schematic illustration of a hydraulic circuit permitting self-pressurization of a housing.

An example of an environment in which this circuit may generally be employed is shown in U.S. Patent No. 3,600,106, cited earlier. Therein, the drive assembly has a housing, drive means in the housing including input and output shafts, a sump in the housing, and pump means operatively associated with the drive means for withdrawing liquid, such as oil, from the sump and supplying oil to a reservoir. As will become apparent, the self-pressurization system herein described may be substituted for the injector and the differential pressure valve utilized therein. The details of the drive assembly form no part of the invention disclosed herein.

Referring to the drawing, a self-pressurization system for a drive assembly housing 10 such as shown in U.S. Patent No. 3,600,106 includes a valve 12, a positive constant displacement pump 14, a restricted orifice 16, and a check valve 18. These components may be disposed within the housing 10 which is airtight.

The valve 12 has an inlet 20, outlets 22 and 24, and pilot ports 26 and 28. The inlet 20 is connected by a conduit 32 to a source of oil 30 which may be a reservoir in the housing 10. The source of oil 30 may be the lube pressure in the return conduit which delivers make-up, lubricating and control fluid for the system. This could be a connection to line 83 of the above U.S. Patent. The pilot port 26 communicates with the housing 10 including the sump via a conduit 34 so that pressure in the housing 10 is transmitted to the valve 12. The pilot port 28 is connected to an air intake conduit 36 by a conduit 38.

The check valve 18 is in the conduit 36 between the end open to the atmosphere and the conduit 38. The check valve 18 has a valve ball 42 which is biased to a closed position by a small centring spring 44. The force provided by the spring 44 is relatively low and acts only to return the valve ball 42 to its seat when the conduit 36 is sealed from the atmosphere.

The valve 12 includes a spool 46 slidable within a bore 48 and is biased towards the pilot port 26 by a spring 50 to the force of which establishes a reference pressure. A typical reference pressure would be 5 p.s.i. The reference pressure is augmented by atmospheric pressure delivered through conduit 38 from the air intake conduit 36. An aneroid reference could be used to

regulate to an absolute pressure, but this is usually not necessary.

The spool 46 is selectively movable between first and second positions. In the first position, shown in the drawing, the inlet 20 communicates with the outlet 22 and thence with a conduit 52. In the second position (not illustrated) this connection is closed. The orifice 16 is in the conduit 54 always to provide a small flow of oil into the pump 14. Whenever the valve 12 is moved to its second position, air is pumped into the housing 10 and, at the same time, the pump 14 is lubed and the clearance gaps wet.

The pump 14 is a positive constant displacement pump having an intake suction port 56 connected to a conduit 58 which communicates with the conduits 36, 52 and 54 at a junction 60. The pump has a discharge port 62 communicating with the housing 10 through a conduit 64. The pump acts to reduce the pressure in its suction chamber whereby pressure is reduced at its intake port so that external pressure (herein, the pressure normally acting on the oil source 30) pushes oil into the pump.

The amount of ambient air the pump 14 will draw in is regulated by controlling the amount of oil supplied to the pump 14. If sufficient oil is provided to the pump 14, its suction port pressure will rise above ambient and no air will be drawn in. The supply of oil to the pump 14, and hence to the housing 10, is in turn controlled by the valve 12.

When the housing pressure is less than 5 p.s.i. above ambient atmospheric pressure (minus minor loss in the check valve 18) the valve spool 46 is moved to its second position to starve the pump 14 so that air flowing from the conduit 36 to the pump 14 is drawn into the system to pressurize the housing 10. The restricted orifice 16 provides for lubrication flow for the pump 14 at all times the unit is operated.

When housing pressure is more than 5 p.s.i. above ambient atmospheric pressure, the housing pressure acts through the conduit 34 against the spring 50 and shifts the valve spool 46 upwardly, as shown in the drawing, whereby oil flows into the conduit 52. As a result, the pump intake port 56 is pressurized, which along with the back pressure from the valve 12 acts against the valve member 42 to pressurize the check valve 18, close it and block off the air supply. Thereafter, air is prevented from being drawn into the housing 10 and only oil is circulated in the system to terminate continued pressurization of the housing 10. When the relative pressure differential between the housing and atmosphere is lowered, atmosphere pressure opens the check valve 18 and acts through conduits 36 and 38 to shift the valve 12 to its second position once again.

WHAT WE CLAIM IS:—

1. A pressurization system comprising a sealed housing having parts to be lubricated, a pump having an outlet connected to the housing, a first conduit for delivering ambient air to the pump inlet, a check valve in the first conduit biased to interrupt the delivery of ambient air, a second conduit for delivering lubricating oil to the pump inlet, and a pressure-actuable valve in the second conduit actuable to regulate but not to interrupt fluid communication between a source of lubricating oil and the pump inlet in response to a predetermined difference between a reference pressure and the pressure in the housing.
2. A system according to claim 1, wherein the source of lubricating oil is a sump of the housing.
3. A system according to claim 1 or claim 2, wherein the reference pressure is the pump inlet pressure.
4. A system according to any preceding claim, wherein the pressure-actuable valve is a spool valve.
5. A system according to any preceding claim wherein the pressure-actuable valve has a first pilot pressure port for utilizing housing pressure to bias the pressure-actuable valve to an open condition, a second pilot pressure port for utilizing the reference pressure to bias the pressure-actuable valve to its closed condition and means for apply-

ing a further continuous bias on the pressure-actuable valve to its closed condition.

6. A system according to claim 5, wherein the continuous bias on the pressure-actuable valve is of a constant amount.

7. A system according to claim 6, wherein the continuous bias on the pressure-actuable valve is applied by a spring.

8. A system according to any preceding claim, wherein regulation of the fluid communication between the source of lubricating oil and the pump inlet when the pressure-actuable valve is closed is by means of a by-pass passage from an auxiliary outlet of the pressure-actuable valve past a restricted orifice to the pump inlet.

9. A system according to claim 8, wherein lubricating oil passing through the pressure-actuable valve is supplied to the auxiliary outlet in both the open and closed conditions of the valve.

10. A system according to any preceding claim, wherein the pump is a positive constant displacement pump.

11. A pressurization system comprising a sealed housing having parts to be lubricated and a sump to collect the lubricating oil, substantially as particularly described herein with reference to the drawing.

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