

"Hydraulic cylinder assembly"

This invention relates to piston cylinder arrangements, such as dashpots, shock absorbers, hydraulic actuators and the like.

5 In the typical hydraulic actuator or damper a piston slides within a cylinder which is filled with a fluid. When such an arrangement is utilized, as a dashpot or shock absorber, for example, the piston may be fitted with small orifices or passages through which the fluid
10 flows so as to allow the piston to move within the cylinder at a controlled rate determined by the flow rate of the fluid through the orifices. In this way controlled motion or damping of an object connected to the piston through a piston rod is achieved. For
15 reliable operation the piston must be completely immersed in fluid at all times, and the fluid should be substantially free of any air bubbles, since they can alter the flow rate through the orifices and thus produce uneven piston movement and damping action. This
20 is also true for hydraulic actuators because any air in the fluid may decrease the maximum attainable fluid pressurization and thus decrease the actuator power output, mainly because air is compressible, whereas the fluid essentially is not.

25 In many hydraulic cylinder arrangements the fluid may gradually leak out of the cylinder, especially between the piston rod and the rod seals. The reason is that the seals sustain gradual wear and a small space, through which the fluid may leak, may develop between
30 the seals and the piston rod, as a result. If fluid does leak from the cylinder, the piston may not be completely immersed in fluid throughout its entire range of movement within the cylinder, and uneven operation may result.

One prior art effort to alleviate this problem focuses on the use of two tandem piston rod seals. These are disposed in a chamber to which the fluid is supplied from a separate external reservoir in order to keep the inner seal, which is closest to the piston, well lubricated at all times in order to reduce its wear. Should this inner seal leak, fluid may enter the cylinder from the reservoir on piston depressurization strokes or it may leak from the cylinder, into the reservoir, on pressurization strokes. The outer seal serves to prevent leakage from the reservoir to the outside, but if it leaks, the reservoir will empty ultimately, in which case air will enter the cylinder.

Thus while such approaches are successful for extending cylinder operating life, they do not ameliorate the basic problem of fluid loss. Furthermore, since there is a possibility that the reservoir may empty completely, maintenance is required to ensure that adequate fluid supply is maintained in the reservoir at all times.

An object of the present invention is to provide a self-refilling hydraulic cylinder arrangement. A preferred feature is to provide for automatic removal of any air in the cylinder arrangement. Other preferred features include preventing external fluid leakage from the cylinder and providing continuous piston seal lubrication.

In accordance with the present invention there is provided a hydraulic cylinder assembly comprising a fluid fillable cylinder having upper and lower partitions, an upper fluid reservoir disposed above the upper partition and a lower fluid reservoir disposed beneath the lower partition, a piston slidably disposed in said cylinder and having connected thereto an upper piston rod which passes through said upper partition and said upper reservoir and out of the assembly, said piston also having connected thereto a lower piston rod which

passes through said lower partition and terminates in the lower fluid reservoir, each partition being formed with an unvalved weep bore which fluidly communicates the cylinder with a conduit which is connected between the lower and upper fluid reservoirs to allow return of fluid to the chamber in the static condition.

In a preferred embodiment the upper piston rod passes out of the upper reservoir through an aperture in a wall thereof which is greater in size than the piston rod cross section whereby the upper reservoir is vented to ambient, so that any air bubbles in the fluid rise to the second reservoir, where they automatically vent to the atmosphere.

Movement of the piston is used to pump fluid between the lower reservoir and the upper reservoir to fill the low pressure side of the piston chamber as the piston moves; the chamber is thereby completely filled at all times. This is achieved by the lower piston rod variably extending into the lower reservoir in dependence on the position of the piston.

The piston rod extending into the lower reservoir pumps fluid into the upper reservoir when the rod displacement in the lower reservoir increases on downward piston movement; when the piston moves in the opposite direction, upward, there is a reduction in displacement in the lower reservoir and fluid flows from the upper reservoir into the lower reservoir. In this way, the lower reservoir is completely filled with fluid at all times and the seal between the lower reservoir and the chamber, like the seal between the upper reservoir and the chamber, is immersed in fluid at all times, thereby significantly reducing its wear and extending its usable life.

In order that the invention may be readily understood an embodiment thereof will now be described by way of example with reference to the accompanying drawing which shows a cross section of a shock absorber embodying the present invention.

5 A vertically oriented, self-refilling shock absorber or snubbing apparatus 10 embodying the present invention is illustrated in the drawing. In the apparatus 10 a piston 12 is slidably disposed in a cylinder 14. The piston is attached to a piston rod 16 and slides in a piston chamber 18. The chamber is completely filled with a fluid (i.e. hydraulic fluid). The cylinder contains a main fluid reservoir 22, which is located at its lowest point, and a secondary reservoir 24, which is located at the opposite end, the highest point. The main reservoir is completely filled with fluid while the secondary reservoir is partially filled. The secondary reservoir is vented to the ambient or atmosphere by means of a

small vent space 26 located around the piston rod 16.

The piston 12 includes a number of passages or orifices 28 and these accommodate fluid flow through the piston at a controlled rate in order to damp or snub a moving object (not shown) which may be connected to the rod. The size of the orifices determines the flow rate which determines the damping force applied to the object. In some instances the passages may contain a check valve for providing unidirectional piston movement in the chamber. Such an arrangement exists in shock absorbers-lifters, for example. In these devices the piston is powered in one direction, for lifting an object, but in the opposite direction fluid pressure is maintained on the piston, to hold the object in place. However, if this pressure exceeds a certain level, the check valves open to allow the fluid to flow through the piston, which then moves at a controlled rate in the cylinder, thereby providing shock absorption.

The end 30 of the piston rod 16 is located in the main fluid reservoir 22. As the piston 12 moves downward, the resultant fluid displacement produced by the movement of the end 30 in the main reservoir forces fluid to the secondary reservoir 24 through a fluid supply line 32, thus raising the fluid level in the secondary reservoir. At the same time fluid from the main reservoir is pumped through the line 32 to piston rod seals 34, 36 which are thereby lubricated. The upper seal 34 prevents any sediment in the secondary reservoir from reaching the lower seal 36; this minimizes wear on the lower seal, thereby significantly extending its life; it also lessens the possibility that the fluid supply system will become clogged, in whole or in part, by sediment in the secondary reservoir, whereas the lower seal 36 prevents leakage from the piston chamber 18. The fluid pressure in the upper section 37 of the chamber 18 may be quite

significant as the piston is pulled up; therefore, the fluid pressure on this seal may be substantial. Consequently, this seal is particularly conducive to leakage, and so it is important to maintain it in good operating conditions at all times in an effort to minimize the potential for leakage into the secondary reservoir from the central portion 18, since such leakage will decrease the fluid pressurization on an up stroke. However, even if such leakage occurs, the fluid simply flows into the fluid circulating system and, hence, is not lost.

Hence, any such leakage will simply produce a rise in the fluid level in the secondary reservoir. The reservoir and the chamber are connected through small weep holes 40, 42, which permit minute fluid flow between the reservoir and the chamber.

When the piston is not moving up or down, the head pressure in the secondary reservoir is greater than it is in any other portion of the circulating system; consequently, fluid may flow into the chamber through the weep holes. In this way any fluid that may have leaked out of the chamber, through the seals, during piston movement (chamber fluid pressurization) is replenished when the piston is at rest.

Any air bubbles in the upper section 37 of the chamber are vented through weep hole 40 into the secondary reservoir and from the secondary reservoir the air vents into the ambient through the space 26. Similarly, fluid flows into the central portion 18 through the weep hole 40 by gravity feed to purge out and replace the air. Thus the central portion or main chamber 18 is completely filled at all times.

The lower end of the rod also moves in a seal 46 which prevents leakage from the main portion into the main reservoir on down strokes. Significant fluid

pressure may also be exerted on this seal on down strokes and so it is also important that this seal does not leak. Nevertheless, any leakage simply enters the main reservoir 22 and produces a fluid level increase in the secondary reservoir. Thus, no external leakage from the cylinder, as a whole, can occur.

Thus, it will be observed that any leakage through the seals from the piston chamber 18 is restricted to a closed fluid supply or circulating system, consisting of the main fluid reservoir 22, the secondary reservoir 24 and the supply line 32. Except for vent path through space 26, the system is completely closed. Since no external leakage of fluid can take place, there is never a need to refill the cylinder; moreover, if there is any air in the fluid, it is vented out of the system and, as this happens, head pressure of the secondary reservoir replenishes the fluid in the piston chamber, which is thus kept completely filled and air free at all times.

The weep holes obviously should be small in order to avoid significant fluid leakage therethrough during piston movement in either direction (up or down) when significant fluid pressurization may occur in the chamber, since such leakage may deteriorate the operation of the damper.

The present invention has been described as embodied in one type actuator. In this actuator the piston rod extends from the piston chamber into the main reservoir which, as described, produces fluid displacement into the secondary reservoir and fluid return when the piston rod displacement is reduced in the main reservoir. In this way the upper seals 34, 36 and the lower seal 46 are always immersed in fluid.

The foregoing is a detailed description of an exemplary embodiment of the present invention and may suggest to one skilled in the art various modifications, omissions, additions, therein and thereto, embracing the true scope of the invention as indicated in the accompanying claims.



CLAIMS

1. A hydraulic cylinder assembly comprising a fluid fillable cylinder having upper and lower partitions, an upper fluid reservoir disposed above the upper partition and a lower fluid reservoir disposed beneath the lower partition, a piston slidably disposed in said cylinder and having connected thereto an upper piston rod which passes through said upper partition and said upper reservoir and out of the assembly, said piston also having connected thereto a lower piston rod which passes through said lower partition and terminates in the lower fluid reservoir, each partition being formed with an unvalved weep bore which fluidly communicates the cylinder with a conduit which is connected between the lower and upper fluid reservoirs to allow return of fluid to the chamber in the static condition.
2. An assembly according to claim 1 in which said conduit has a branch adapted to provide fluid to a seal in the upper partition for the piston rod extending therethrough.
3. An assembly according to claim 1 or 2 in which the upper piston rod passes out of the upper reservoir through an aperture in a wall thereof which is greater in size than the piston rod cross section whereby the upper reservoir is vented to ambient.
4. An assembly according to claim 1,2 or 3 in which the piston is formed with a plurality of bleed passages therethrough to enable the assembly to act as a shock absorber or dashpot.
5. An assembly according to claim 1,2 or 3 in which the piston is provided with a plurality of check valved bores therethrough to enable the assembly to act as an actuator.
6. A hydraulic cylinder assembly substantially as hereinbefore described with reference to the accompanying drawings.