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UNIT AREA RATIO ACCUMULATOR WITH FAIL-SAFE MEANS

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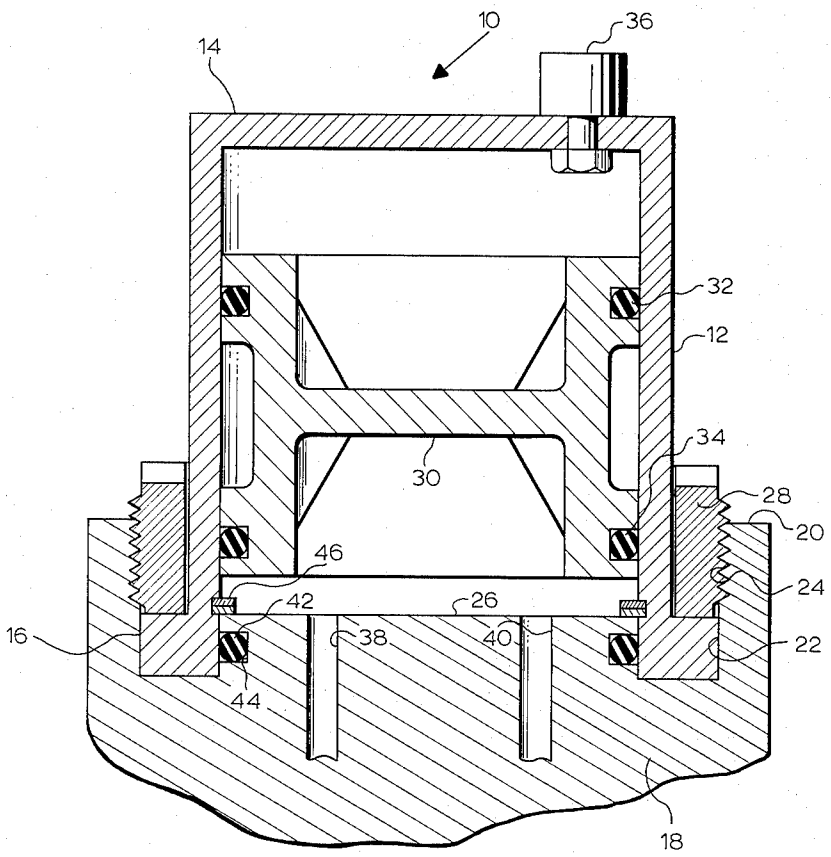

FIG. 1

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UNIT AREA RATIO ACCUMULATOR WITH FAIL-SAFE MEANS

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The present invention relates to accumulators for hydraulic systems and more particularly to an accumulator adapted to be mounted directly on a hydraulic unit to form a complete hydraulic package.

Accumulators have been used extensively as fluid power storage sources. They generally have a free-floating piston with the fluid to be pressurized on one side thereof and some medium, such as a precharged gas, on the other side thereof to pressurize the fluid. Therefore, the pressure of the fluid is that of the gas which is, in turn, a function of initial precharge pressure, temperature and the displaced position of the piston in steady state conditions. The accumulator provides a supply of oil under pressure for short duration high discharge system requirements where it is not advisable to employ larger equivalent pumps because of the duty cycle involved and the cost and weight factors. The accumulator can be charged during the low demand portion of the cycle so that it is able to maintain system pressure during peak demands which cannot be satisfied by the pump alone. A secondary usage of accumulators is to attenuate surges caused by pump pulsations and high load system dynamic effects, the pressurized gas on the one side of the piston acting as a pulsation absorber.

Recently accumulators have been incorporated as an integral component of hydraulic packages rather than as separate plumbed elements in order to save cost and to reduce size and vulnerability to external leaks. In such an arrangement, the O-ring seal which prevents pressurized fluid from leaking from the accumulator is positioned about the external surface of the accumulator. This results in an increase in the effective area loading on the flange attaching the accumulator to the hydraulic package above that of the effective area of the floating piston operating within the accumulator. Consequently, the stress level in the flange is increased and the safety factor is reduced. High safety factors and fail-safe protection are very important for many accumulator applications because the high energy stored in the precharged gas has explosive characteristics.

Accordingly, it is one object of the present invention to reduce the stress level imposed on attachment flanges by accumulators and thus increase the safety factor.

It is another object of the invention to provide a fail-safe protection device for accumulators to prevent their being blown off of hydraulic packages to which they are attached in the event of failure of mechanical connections therebetween.

It is a further object of the invention to provide an accumulator having a free-floating piston operating therein and a primary pressure drain seal with substantially the same effective area as the free-floating piston whereby a higher safety factor is obtained as compared to prior art accumulators in which the effective area of the primary pressure drain seal is significantly greater than the effective area of the piston.

It is a still further object of the invention to provide a fail-safe protection device for accumulators of the type described which positively blocks the free-floating pistons against being blown out of the accumulators in the event of failure to prevent acceleration of the accumulators off of the hydraulic packages in a dangerous manner.

In accordance with one embodiment of the present invention the foregoing objects are accomplished by providing a cylindrical accumulator having a closed end and an open end with a free-floating piston slidably sealed therein. The open end of the accumulator is slidably positioned over a boss projecting from the surface of a hydraulic unit to which the accumulator is to be attached. The boss has substantially the same effective area as the floating piston and an O-ring is seated in a groove in the cylindrical surface of the boss in position to slidably seal against the cylinder wall of the accumulator. A radially projecting attachment flange is also provided about the open end to facilitate clamping the accumulator to the hydraulic unit. Since the O-ring which provides the primary drain seal and the free-floating piston engage the same cylinder wall, the effective area determining the loading on the attachment flange is substantially the same as the effective area of the piston itself. This provides a unit ratio as opposed to the multiple ratio of prior accumulators in which the O-ring seals against the outer cylindrical surface of the accumulator.

A precharged gas is contained between the closed end of the accumulator and the piston to exert the necessary pressure on the piston. Therefore in the event of failure of the mechanical connection between the accumulator and the hydraulic unit, the accumulator will tend to be blown off of the hydraulic unit by the pressurized gas because of its explosive characteristics. In accordance with another important feature of the present invention the acceleration of the accumulator from the hydraulic unit in the event of such a failure is quickly dampened by a locking ring fixed to and projecting radially inwardly from the cylindrical wall of the accumulator on the fluid side of the piston. Should the accumulator be pulled off of the hydraulic unit, the free-floating piston will be accelerated against the locking ring by the pressurized gas at which point it is positively blocked and a balanced condition prevails to prevent further acceleration of the accumulator.

Other objects and features of novelty of the present invention will be specifically pointed out or will otherwise become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawing, wherein:

FIG. 1 is a fragmentary sectional view of a hydraulic unit having an accumulator embodying features of the present invention attached thereto.

Referring to FIG. 1, an accumulator **10** is shown which illustrates one embodiment of the invention. It comprises a cylinder **12** having an end wall **14** closing off one end thereof. A radially projecting attachment flange **16** is provided about the open end of the cylinder to facilitate the attachment thereof to a conventional hydraulic unit **18** to form a hydraulic package. A surface **20** of the hydraulic unit is provided with a cylindrical recess **22** having the same diameter as the outside diameter of the attachment flange **16** and an internally threaded portion **24** at the upper end thereof. A boss **26** having the same external diameter as the internal diameter of the cylinder **12** projects upwardly into the recess **22**. An externally threaded clamping ring **28** threadably engages the internally threaded portion **24** of the recess to positively clamp the attachment flange **16** against the hydraulic unit **18**. A free-floating piston **30** is slidably sealed within the cylinder **12** by a pair of axially-spaced O-rings **32** and **34** which slidably seal against the inner surface of the cylinder. A suitable fitting **36** is provided in the end wall **14** to enable pressurized gas to be introduced into the closed end of the cylinder to continuously urge the piston toward the hydraulic unit.

Fluid is introduced under pressure into the chamber on the other side of the piston through a passageway **38**

in the hydraulic unit communicating with the end of the boss, and the pressurized fluid is delivered from the accumulator chamber through an outlet passageway **40** which also communicates with the end of the boss **26**. A suitable relief valve (not shown) may be provided in the hydraulic unit to connect the outlet passageway **40** to tank when the pressure of the fluid exceeds a predetermined value.

In order to prevent the pressurized fluid escaping from the accumulator chamber an O-ring **42** is seated within an annular groove **44** in the cylindrical surface of the boss **26** in position to slidably seal against the inner cylindrical surface of the cylinder **12**. Consequently the net force attempting to pull the accumulator off of the manifold is equal to the pressure of the hydraulic fluid multiplied by the effective area at the primary pressure drain seal provided by the O-ring **42**. Since this effective area is basically the same as the piston area itself, the net force tending to shear the threaded connection between the clamping ring **28** and the threaded portion **24** has a unit ratio with respect to the force on the piston. This is in direct contrast to prior accumulators having the primary pressure drain seal located on the outer surface of the accumulator so that pressurized fluid acts on the underside of the attachment flange. Consequently the effective area determining the force on the attachment flange is greater than the basic piston area. This necessitated heavier restraining means and the yield and burst safety factors were generally marginal.

The pressurized gas stored within the accumulator **10** generally has explosive characteristics. Therefore if the threaded connection between the clamping ring **28** and hydraulic unit **18** fails, the cylinder **12** will be blown off of the hydraulic unit by the rapidly expanding gas which drives the cylinder away from the hydraulic unit and the piston toward the hydraulic unit. This explosive pressure is applied at a high level until the piston comes out of the cylinder to release the pressure, or conversely, until the cylinder **12** comes off of the end of the piston. In prior accumulators this high duration impulse effectively accelerates the accumulator to a very high velocity since there are no restraining forces against separation of the cylinder from the piston other than the drag provided by the O-rings which slidably seal the piston to the cylinder wall. Because of this there have been instances in the past where lives have actually been lost and much property destroyed as a result of accumulator explosions.

In accordance with the present invention this explosion danger is prevented by seating a locking ring **46** in an annular groove in the inner cylindrical surface of the cylinder **12** near the open end thereof. The locking ring projects radially inward to positively block the piston **30** against removal from the cylinder **12**. Consequently in the event of failure the pressurized gas will start to drive the cylinder **12** off of the hydraulic unit, but at the same time the piston **30** will be driven toward the hydraulic unit until it strikes the locking ring **46**. In this position the piston reaction against the ring creates a balanced condition and further acceleration of the cylinder off of the hydraulic unit is not possible. By making the piston of lighter material than the cylinder it will have a lower inertia than the cylinder and therefore can be made to move quickly against the locking ring **46**.

While it will be apparent that the embodiment of the invention herein disclosed is well calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In combination, a hydraulic unit having a cylindrical recess in one surface thereof with a cylindrical boss of reduced diameter projecting upwardly into said recess, an accumulator comprising a cylindrical housing having a closed end and an open end with an attachment flange about said open end, the outside diameter of said boss being substantially the same as the inside diameter of the housing, said open end of the housing being slidably positioned over said boss, a clamping ring fitted within said recess about said housing and abutting against said attachment flange, said clamping ring threadably engaging the wall of said recess to positively prevent the disengagement of the housing from the boss, a free-floating piston slidably sealed within said housing, said hydraulic unit having inlet and outlet passageways communicating with the end face of said boss to direct pressurized fluid into and out of a chamber on one side of the piston, said piston being maintained against the fluid by a pressurized gas in a chamber on the other side of the piston, and an O-ring seated in an annular groove in the cylindrical wall of said boss and slidably sealing against the inner cylindrical surface of said housing.

2. The invention as defined in claim **1** including a locking ring fixed within an annular groove in the inner cylindrical surface of the accumulator on said one side of the piston and projecting radially inward to positively block the piston against being blown out of the accumulator in the event of failure of the threaded connection between the clamping ring and the wall of said recess.

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