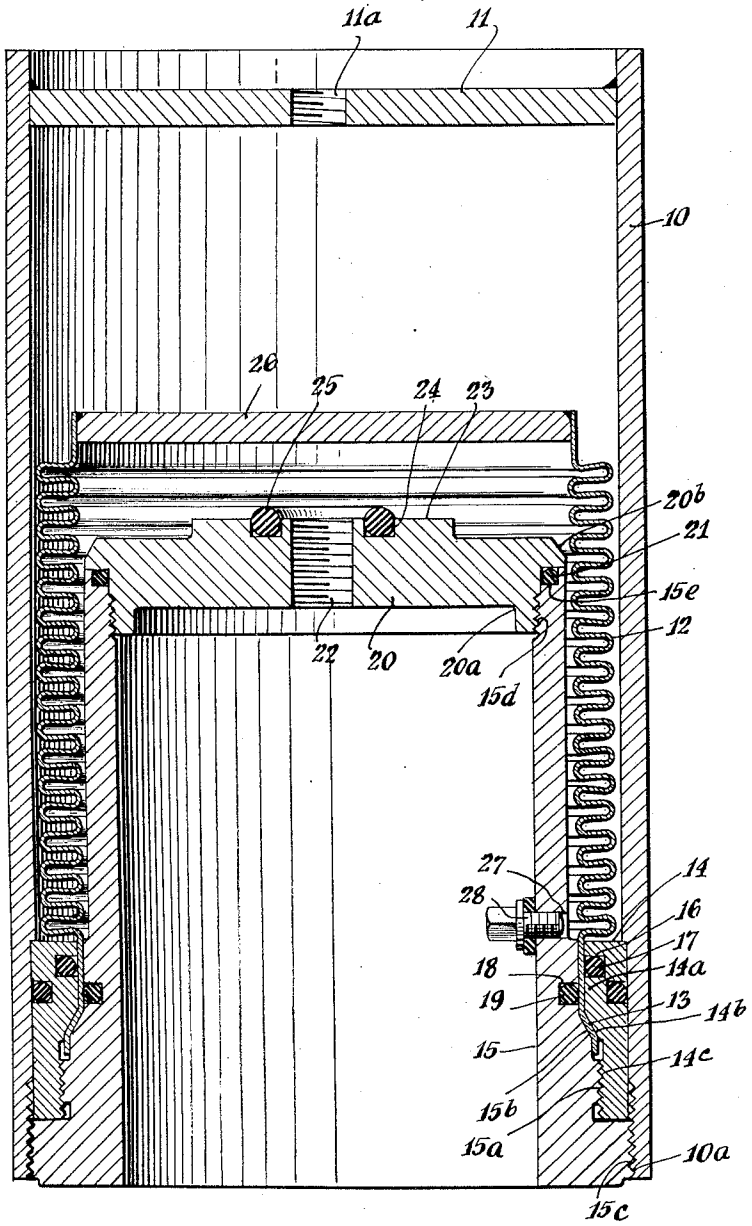
Dec. 26, 1944. B. N. ASHTON 2,365,994

ACCUMULATOR

Filed March 22, 1944



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Patented Dec. 26, 1944 2,365,994

UNITED STATES PATENT OFFICE

2,365,994

ACCUMULATOR

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Application March 22, 1944, Serial No. 527,657

1 Claim. (Cl. 138—31)

This invention relates to devices for absorbing hydraulic shock and for storing liquid under pressure. It relates particularly to improvements in accumulators of the type commonly used in the hydraulic systems of aircraft, for example, for receiving liquid under pressure to store energy for aiding in actuating the retractable landing gear, wing flaps, wing folding mechanisms and the like.

The most commonly used type of accumulator includes a receptacle having a flexible, rubberized diaphragm that divides the receptacle into two chambers. One side of the diaphragm is subjected to air under pressure in one of the chambers, while the other side of the diaphragm is subjected to the pressure of liquid in the other chamber which is connected to the hydraulic system.

As the pressure in the hydraulic system is increased by operation of a pump in the system, the diaphragm is displaced, thereby compressing the air on one side of the diaphragm and permitting the accumulation of a supply of liquid under pressure in the receptacle.

When the pressure in the system falls, as by operation of hydraulic equipment in the system, the excess liquid in the accumulator and the air under pressure supply additional energy for the actuation of the equipment. The accumulator may have a sufficiently large capacity to store energy sufficient to insure actuation of some of the hydraulic equipment even if the pump associated with the system fails.

Because of the fluctuations in pressure in the system, the diaphragm is flexed back and forth with the result that it will become weakened and may fail in service. The diaphragm may also be torn or punctured when the liquid in the system is lost, as by puncturing of a conduit, inasmuch as the diaphragm is subjected normally to high pressures, sometimes as high as 1000 pounds per square inch. Ordinarily, of course, this pressure is counter-balanced by an equal liquid pressure on the opposite side of the diaphragm.

Shock absorbing devices, operating on somewhat different principles, have been provided heretofore with metallic bellows which can expand and contract in response to variation in pressure thereon. Such bellows are quite satisfactory so long as the pressure on opposite sides thereof remain substantially the same. However, if the pressures on opposite sides of the bellows vary excessively, the bellows may be crushed or permanently distorted.

An object of the present invention is to provide an accumulator having a metallic bellows therein that permits accumulation of liquid under pressure and is so arranged that a decrease in liquid pressure will not damage the bellows.

Another object of the invention is to provide a metallic bellows accumulator in which liquid can be trapped in order to oppose the pressure exerted on the diaphragm by air so as to avoid crushing of the bellows upon abnormal decrease in pressure in an associated hydraulic system.

Other objects of the invention will become apparent from the following description of a typical form of device embodying the present invention.

In accordance with the present invention, I have provided an accumulator including a cylinder provided with a corrugated flexible metal bellows that is subjected on one side to air under pressure in the cylinder and on the other side to liquid under pressure. The bellows can expand or contract as the result of unequal pressures on opposite sides thereof. The bellows is provided with one element of a valve device which cooperates with another valve element in the cylinder to trap liquid within the bellows when the pressure in the hydraulic system has dropped sufficiently for the two valve elements to come into contact. The trapped liquid, being substantially incompressible, supports the bellows against the air pressure and prevents the bellows from being crushed or distorted. Even when the liquid pressure in the hydraulic system drops to zero or thereabouts and the air pressure in the accumulator is as high as 1000 pounds, no damage to the bellows can result.

For a better understanding of the present invention, reference may be had to the accompanying drawing in which the single figure is a view in vertical section of a typical form of device embodying the present invention.

The form of accumulator chosen for purposes of illustration includes a cylindrical receptacle 10 having one end closed by means of a disc-like plate 11 which is welded to the cylinder 10. If desired, the end plate 11 may be formed integrally with the cylinder 10.

The end plate 11 is provided with an internally threaded aperture 11*a* for receiving an air check valve, for example, or a sealing plug, not shown.

An assembly including a corrugated expansible metal bellows 12 is mounted within the cylinder 10 in the following manner. The bellows 12 has a cylindrical and flared lower edge portion 13 which is received between a ring member 14 and an inner cylindrical sleeve 15 that extends axially of the cylinder 10 in spaced relation to the cylinder. The ring member 14 has an upper thickened portion 14*a*, an intermediate outwardly tapered inner face 14*b* which engages the flared portion of the bellows and a lower threaded portion 14*c*. The threaded portion engages a threaded portion 15*a* on the exterior of the sleeve 15, and the tapered portion 14*b* of the ring 14 opposes a com-

plementally tapered portion 15b on the sleeve member 15. Thus, when the sleeve member 15 and the ring member are threaded together, the flared portion 13 of the bellows is clamped tightly therebetween so that it cannot be displaced.

In order to provide a liquid-tight seal between the ring 14 and the bellows 12, the ring 14 may be provided with an annular internal groove 16 for receiving a toroidal ring formed of rubber or similar material 17 which acts to prevent leakage of fluid. The sleeve 15 may also be provided with an external peripheral groove 18 for receiving a similar rubber ring acting to prevent leakage between the bellows and the sleeve 15.

When these elements have been assembled, they can be inserted in the lower end of the cylinder 10 and retained therein by means of the threaded portions 10a and 15c on the cylinder 10 and the sleeve 15, respectively. A sealing ring or gasket may be interposed between the ring 14 and the cylinder 10 to prevent escape of air from the cylinder 10.

The upper end of the sleeve 15 is provided with internal threads 15d for receiving the externally threaded base 20a on a disc-like member 20. The member 20 has a peripheral flange 20b that overlies the end of the sleeve 15 and engages a sealing ring 21 that is mounted in a groove 15e in the end of the sleeve 15, thereby providing a fluid-tight seal between these elements.

The disc-like member 20 is provided with a central internally threaded aperture 22 forming a valve port through which liquid can enter the space between the sleeve 15, the disc-like member 20 and the bellows 12.

The upper face of the member 20 is provided with a plane surface portion 23 forming a valve seat and having therein an annular groove 24 for receiving a rubbery ring 25 that projects slightly above the seat portion 23. The rubbery ring 25 and the seat 24 cooperate with a rigid disc member 26 that is secured to the upper end of the bellows 12 to form a check valve that prevents flow of liquid from within the bellows into the sleeve 15 when the above-described valve elements are in engagement. Thus, when the liquid pressure in the sleeve 15 drops, the compressed air above and around the bellows will force the member 26 against the valve seat 23, and the pressure on the rubber ring will force the ring into tight sealing engagement with both the member 26 and the seat 23.

The bellows 12 may be arranged, and preferably is arranged, so that the plate 26 normally is spaced slightly from the valve seat 23 and the ring 25. However, the bellows 12 is compressible without permanent distortion sufficiently to permit the plate 26 to engage the valve seat 23. Also, the bellows 12 can be expanded so that the plate 26 will come into contact with the end plate 11, or nearly so, thereby providing a relatively large capacity for the reception of liquid under pressure.

Inasmuch as the accumulator may sometimes be replaced or taken out for repair, it is sometimes desirable to drain the oil from within the bellows. In order to permit this, the cylinder 10 may be provided with a drainage opening 27 which is normally closed by set screw 28. Upon removal of the set screw 28, all of the oil trapped in the bellows can be readily drained therefrom.

It will be understood that the accumulator may be connected directly to the hydraulic system, in any desired way. Preferably the aperture or valve port 22 receives the threaded end of a conduit (not shown) that is connected to the hydraulic system.

In operation, and with the bellows full of hydraulic fluid, air under pressure is introduced through the valved opening 11a into the space between the cylinder 10 and the bellows 12. The air pressure may be of any suitable order, for example, 300 to 600 pounds per square inch, so that when the air is compressed by expansion of the bellows, it will attain a pressure substantially equal to the desired maximum pressure in the hydraulic system.

As the hydraulic pressure builds up in the system, the liquid will flow through the aperture 22 and will expand the bellows against the air pressure in the chamber. In this way, energy as well as hydraulic fluid is stored in the accumulator for use in operation of the hydraulic system. At the same time, the compressed air will act to absorb sudden shock in the hydraulic system so that damage to the system by such hydraulic shock is minimized.

When the pressure in the hydraulic system drops, as by operation of some of the equipment or because of leakage of the fluid, the air pressure will cause compression of the bellows and discharge of the fluid from within the bellows. If the pressure in the system drops appreciably below the air pressure in the cylinder 10, the plate 26 will be forced downwardly against the valve seat 23 and the ring 25, thereby trapping the oil that remains within the bellows and preventing collapse of the bellows by the external air pressure.

The above-described accumulator has the advantage of permitting the use of a sturdy metal bellows which is not easily damaged or punctured and which cannot be crushed or distorted by air pressure upon loss of pressure in the hydraulic system. The accumulator, therefore, is more durable and requires less servicing than prior types of accumulators, while at the same time may be substituted readily in hydraulic systems for the prior types of accumulators.

While the preferred form of accumulator has been described above, it will be understood that it can be modified considerably without departing from the invention. Changes in the type of trapping valve, size and shape of the parts can be made within the scope of the invention. Therefore, the form of device described above should be considered as illustrative, only, and not as limiting the scope of the following claims.

I claim:

An accumulator for an hydraulic system comprising a hollow receptacle having an open and a closed end, a sleeve within said receptacle secured adjacent to said open end and otherwise spaced from said receptacle, a hollow, cylindrical metallic bellows interposed between said receptacle and said sleeve, a valve seat member secured to the inner end of said sleeve, said member having an aperture therethrough and an annular groove in its inner surface, a rubbery ring mounted in said groove, and a disk member mounted in the inner end of and sealing said bellows and movable with said bellows into and out of engagement with said valve seat member and said rubbery ring.

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