June 19, 1945. W. C. TRAUTMAN 2,378,517

ACCUMULATOR

Filed Aug. 16, 1943 2 Sheets-Sheet 1

FIG 1

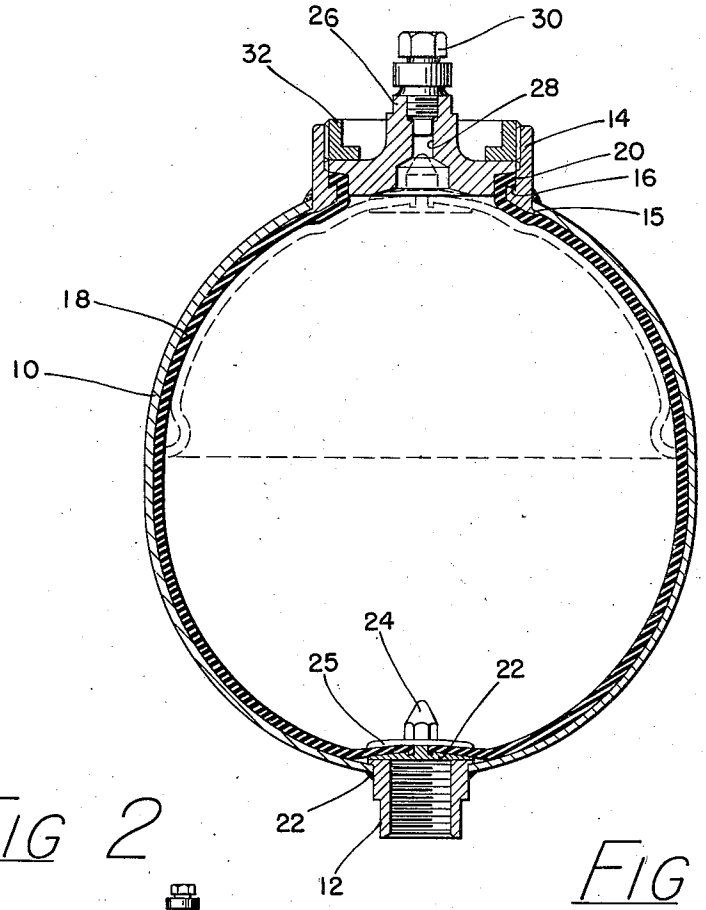

FIG 2

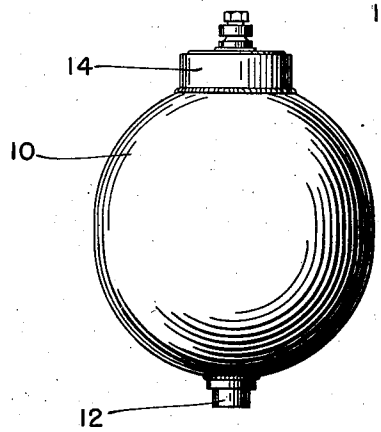

FIG 3

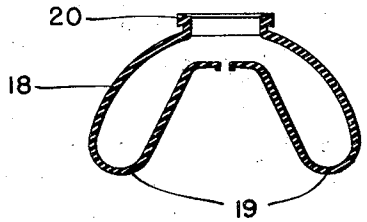

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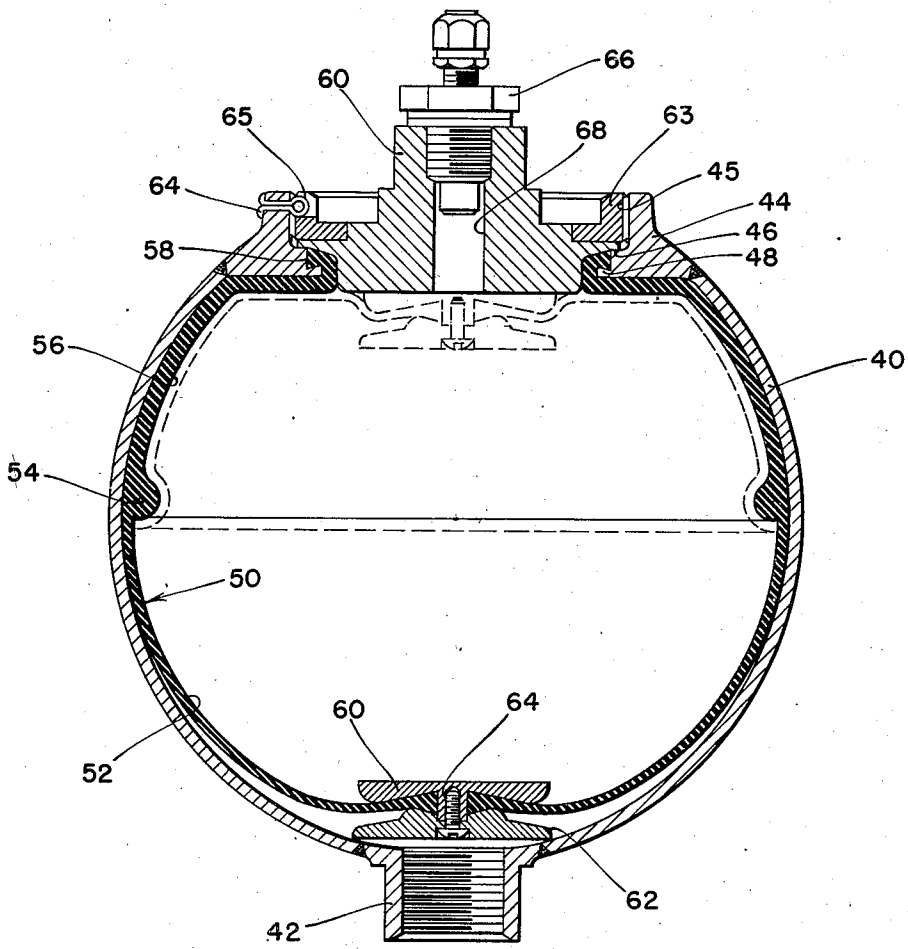
FIG 4



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2,378,517

ACCUMULATOR

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Application August 16, 1943, Serial No. 498,807

10 Claims. (Cl. 138—30)

This invention relates to accumulators, and more particularly to an accumulator having a one-piece shell and a bladder for separating a compressible fluid from a relatively incompressible liquid. This application is a continuation in part of my application Serial No. 422,714, filed December 12, 1941.

Accumulators are devices for storing liquid under operating pressures. They are necessary because the liquid demand of a hydraulic system may be greater at any one instant than the capacity of the pump which supplies the liquid under pressure. When such a condition exists, the accumulator supplies the deficiency and is in turn recharged with liquid when the demands of the system are less than the capacity of the pump. Such an arrangement permits the use of a small pump for a relatively large hydraulic system.

Accumulators in general are chambers wherein incompressible liquid may act upon a compressible medium which maintains the liquid under pressure. Air is preferred to springs as the compressible medium since it is lighter. When air is used, it must be carefully isolated from the liquid since it would dissolve into liquid under pressure and come out of solution when the pressure is relieved, creating troublesome air pockets and bubbles. For this reason a flexible partition is provided between air and liquid. This partition may be in the form of a diaphragm or a bladder. The present invention relates to bladder type accumulators.

Bladder type accumulators are more desirable than the usual pair of half shells clamping a flexible diaphragm between them because they can be made lighter. When two half shells are used, strong flanges must be provided to accommodate the securing bolts, whereas in a one-piece shell construction the weight of the flanges may be eliminated.

The present invention employs a substantially spherical shell having an opening in one end through which a bladder may be inserted into the shell, and the open end of the bladder secured to the accumulator shell. A hydraulic opening is provided in the other end of the shell. The bottom of the bladder is provided with a metal button to seal the hydraulic outlet when the hydraulic fluid is completely exhausted and to seal the air inlet when the air is completely exhausted. If the metal button were not provided the soft material of the bladder, which may be a rubber-like material, may be extruded through the hydraulic or air opening, permanently damaging the bladder. The aviation standards which accumulators must meet include the requirement that the bladder must not be damaged when all hydraulic fluid is exhausted, or in the other extreme condition when all air is exhausted.

It is therefore an object of the invention to provide an accumulator of the bladder type having a one-piece shell construction.

Another object is to provide an accumulator of the bladder type having diametrically opposite hydraulic and air openings and having a bladder with a metal insert to cover said openings.

Another object is to provide an accumulator having a bladder with a lip formed on the opening thereof and means to secure said lip to the shell of the accumulator for operation.

Another object is to provide a bladder for an accumulator which bladder is preformed to roll along the inner side of the shell without trapping hydraulic fluid.

Still another object is to provide an accumulator having maximum capacity with minimum weight.

In the drawings forming a part of this specification:

Figure 1 is a view in vertical section of an accumulator made according to the invention showing the shape of the bladder in full lines when all liquid is exhausted and showing the shape of the bladder in dotted lines when the air is exhausted;

Figure 2 is a view in elevation showing the outline of the accumulator of Figure 1 on reduced scale;

Figure 3 is a view in vertical section of one preformed shape of the bladder of Figure 1; and

Figure 4 is an elevation view in full section of a modification of the invention.

The accumulator is shown in Figure 1. A substantially spherical steel shell 10 has welded or brazed to the bottom thereof a hydraulic outlet fitting 12 which may be connected to the hydraulic system of an airplane. Welded or brazed to the top of shell 10 is an annular collar 14 having an internal lip 16. It will be noted that an external flange 15 of the collar is of a greater diameter than the opening in which the collar 14 is placed, and the collar 14 must accordingly be inserted within the shell 10 before the final forming of the upper part of the shell, which may be by spinning or pressing.

Placed within the shell 10 is a bladder 18 made of neoprene or other rubber-like oil resisting material, having an external lip 20 around the mouth thereof. Secured to the bottom of bladder 10 is a disc 22 held thereto by a point headed bolt 24 pressing against a washer 25. When the bladder

is extended as shown in Figure 1, the disc 22 covers the hydraulic outlet 12 as shown. When the air is exhausted from the accumulator, the bladder takes a shape shown by the dotted lines of Figure 1, the washer 25 covering the air inlet.

The bladder 18 is held in the shell 10 by its external lip 20 resting upon the internal lip 16 of collar 14. The bladder lip is secured in place by a stopper 26 which not only covers the top of bladder lip 20, but fits against the mouth of the bladder 18. Formed in the center of stopper 26 is a hole 28 in which is screwed an air valve unit 30 through which air is admitted to the bladder 18. The stopper 26 is held in collar 14 by an annular nut 32 screwed inside collar 14.

An external view of the accumulator is shown in Figure 2 wherein the collar 14 and the hydraulic outlet 12 are shown welded to the shell 10.

The preformed shape of the bladder 18 is shown in Figure 3. It will be noted that the mouth of the bladder is relatively wide as compared to the total width. This wide-mouthed construction permits the utmost in accuracy in the mold cores used to form the bladder in that a fewer number of parts may be used in the cores. It will also be noted that in its free shape, the bottom of the bladder is in close proximity to the mouth, insuring that the pointed bolt 24 (Figure 1) will center itself in the hole 28 in the stopper 26. This results in positive contact of the washer 25 over the hole 28 when the air is exhausted, making certain that the bladder material will not cover the hole 28 and thus be injured by high pressure fluid. The general preformed shape of the bladder may be referred to as connected telescoping hemispherical shells.

As shown in Figure 1, the bladder is preformed to fit exactly the upper half of the shell 10. This close fit insures that no liquid will get between the bladder and the upper half of the shell 10. As the liquid leaves the accumulator, the bladder 18 rolls downwardly along the lower walls of the shell 10. This rolling action is accomplished by making the walls at the bend relatively thin as shown at 19 in Figure 3. The bladder rolls along the walls to a point near the hydraulic outlet 12 and thereafter the center portion becomes flat and seats over the hydraulic outlet 14 at the final stage which condition slightly stretches the bladder 18. This rolling action along the wall 10 insures that little or no liquid is trapped. Actual tests have demonstrated that when the accumulator is filled to capacity with liquid that very little liquid is trapped and there is about a 97% return of the liquid. This high volumetric efficiency is one of the features of the invention.

The shell 10 is preferably made of steel to facilitate welding and to obtain a favorable weight to strength ratio. Hydraulic pressures for aircraft are normally in excess of one thousand pounds per square inch and the accumulator must therefore be strong. The accumulator has a normal burst test rating of about six thousand pounds per square inch, and the shell 10 is preferably made of one piece of stock material to give the greatest strength for unit weight. Two hemispherical shells have been welded together with good results, and the danger of a rough internal surface which might puncture the bladder 18 can be remedied by grinding. As stated above, in the collar construction of Figures 1 and 2, the collar must be inserted in the shell before the final closure operation.

The large size of the opening in collar 14 permits easy insertion and removal of the bladder 18 for assembly and repairs. This feature is in contrast to many accumulator constructions wherein a small opening only is provided for the bladder, limiting the thickness of the bladder wall, and preventing removal of the bladder unit intact. The large opening also permits the use of a large stopper 26 wherein the washer 25 may seat without the possibility of damaging any part of the bladder.

The operation of the accumulator is as follows. Air is pumped into the bladder 18 through the air valve 30 until a pressure of several hundred pounds is reached. This distends the bladder from its preformed shape of Figure 3 to the shape shown in Figure 1. Thereafter liquid is admitted through opening 12 and the bladder will assume, normally, a position intermediate that between the solid and dotted lines of Figure 1, depending upon the amount of liquid.

During normal operation the liquid demand may be so great that the liquid will run completely out of the accumulator and the disc 22, connected to the bottom of bladder 18, will seal outlet 12 as shown in Figure 1. This prevents injury to the bladder by extrusion through outlet 12 by air pressure. If the air valve 30 should be damaged so that the air escapes, the bladder 18 will tend to assume its preformed shape shown in Figure 3. Thereafter hydraulic pressure will force the inner half upwardly until the washer 25 covers the air inlet 28 as shown by dotted lines in Figure 1. This sealing action prevents injury to bladder 18 by extrusion.

Shown in Figure 4 is a modification of the invention using a different bladder shape and a different collar construction. A generally spherical shell 40 has a hydraulic fitting 42 secured to the bottom and a collar 44 secured to the top. Collar 44 has internal threads 45, an internal annular shoulder 46, and an internal flange 48.

Placed within shell 40 is a bladder 50 having a free shape which is generally spherical. The bladder has a thin lower part 52, an internal bead 54 at the mid-section, and an upper thick part 56 having an external flange 58. It will be noted that thin portion 52 is tapered from bead 54 to the bottom. Secured to the bottom of bladder 50 are discs 60 and 62, held on opposite sides of the bladder by a screw 64. The bladder 50 is held in shell 40 by flange 58 hooking over collar flange 48. A plug member 60 rests on shoulder 46 and fits the bladder mouth closely, locking the flanges together. An annular nut 63 holds plug 60 in place and is in turn locked in place by a cotter pin 64 which fits in a notch 65 in the nut. An airvalve 66 is screwed into a hole 68 in plug 60.

Since the upper part 56 of bladder 50 is thick, it retains its position against shell 40, preventing bulges which would trap oil. The plug 60 holds the bladder in place and shoulder 46 prevents any shear stress on the bladder. The lower half 52 is considerably thinner and flexes easily under liquid displacement. The discs 60 and 62 give the lower part of the bladder an upward bulge which aids in initiating the flexing of the bladder. As the accumulator fills with liquid, the thinner lower parts of section 52 yield first, permitting an orderly collapse or telescoping of the lower half into the upper half. The result is a rolling action similar to that of the bladder of Figure 1. The rolling action, both on collapse and expansion of the bladder, prevents trapping of oil. This rolling action is aided by the taper in wall thickness and by the initial bulge given by discs 60 and 62.

The bead 54 prevents sharp folds in the bladder when all air is exhausted.

The operation of the accumulator of Figure 4 is similar to that of Figure 1.

Although the invention has been described with reference to particular embodiments thereof, it is not limited to these specific embodiments, nor otherwise, except by the terms of the following claims.

I claim:

1. An accumulator comprising a shell having a liquid opening, a bladder secured in said shell having a flexible part and a stationary part into which the flexible part is adapted to telescope, means to apply a gas under pressure to one side of said bladder, the opposite side being exposed to liquid which may enter through the liquid opening, said bladder being adapted to telescope and expand with a rolling action and having the flexible portion adjoining the stationary portion made in a thinner section to aid in the rolling action.

2. In an accumulator, a shell having a gas inlet and a liquid outlet coaxial with an axis about which the shell is symmetrical, a flexible bladder in said shell having a preformed shape of inner and outer concave walls, the inner wall being disposed within the outer wall, and secured to said shell symmetrically with respect to said axis, said bladder being thinned at the juncture of the two walls to promote a rolling action as the bladder expands, and substantially rigid elements on said bladder, one on the inside and one on the outside adapted to cover said inlet when the bladder is collapsed, and to cover said outlet when the bladder is extended, to prevent extrusion of said bladder when under fluid pressure.

3. An accumulator comprising a shell having a liquid opening, a bladder secured therein having a stationary portion and a flexible portion adapted to telescope into said stationary portion, said flexible portion having a much thinner wall than the stationary portion so that the flexible portion will flex and the stationary portion will remain fixed under liquid volume changes, and means to apply a gas under compression to one side of said bladder, the opposite side being exposed to liquid admitted through the liquid opening.

4. An accumulator comprising a shell having oppositely disposed gas and hydraulic openings, a bladder secured at one end to said shell around one of said openings, metal discs on either side of said bladder at a point remote from the secured end, the portion near the secured end being thick so as to maintain its shape and position at all times and the portion near the discs being relatively thin so that it may telescope into the thick portion, said thin portion having walls which taper in thickness from said thick portion to said discs to promote a rolling action upon telescoping and expanding, one of said discs being adapted to cover the hydraulic opening when the liquid is removed, and the other being adapted to cover said gas opening when the gas is removed, so that the bladder will not be extruded into said openings when subjected to pressure.

5. An accumulator comprising a shell having an opening in which there is an inwardly projecting flange and an annular shoulder, a bladder in said accumulator having an outwardly projecting flange about the opening thereof adapted to fit over the inwardly projecting flange of the shell, said annular shoulder forming an inclined face which slopes downwardly from the smaller diameter of the annular shoulder for engaging said outwardly projecting flange, plug means in said shell opening resting on said shoulder and fitting said bladder opening snugly to lock said bladder in place, and means to hold said plug to said shell.

6. An accumulator comprising a shell having a pair of openings therein for admitting fluid, a bladder secured in said shell at one of said openings and comprising two portions, one portion of which is adapted to telescope into said other portion, said bladder having a thinned circumferential bladder portion connecting said two portions for facilitating bending within a predetermined area, and disc elements secured to said one portion and adapted to cover said openings at times.

7. An accumulator bladder having a preformed shape of inner and outer connected concave walls, the inner wall disposed within but spaced from the outer wall, said bladder being thinned at the juncture between the concave walls to cause it to expand by a rolling action.

8. An accumulator of the bladder type comprising a shell having axial symmetry and openings at opposite ends of the axis of symmetry, a flexible bladder also having axial symmetry and having an opening connecting with one of said shell openings, whereby said bladder constitutes a movable fluid-tight barrier between said openings, said bladder having substantially rigid disc elements on its axial end opposite the bladder opening, one disc being on the inside, and the other on the outside of the bladder, the inside disc being adapted to cover one of said openings in the shell when the bladder is collapsed and the outside disc being adapted to cover the other opening in the shell when the bladder is extended, to prevent extrusion of said bladder into said shell openings, the bladder-contacting surface of the said outside disc being substantially higher near its center than at its peripheral edge, whereby it imparts to the end portion of the bladder a reverse bulge when the bladder is distended against said outside disc.

9. An accumulator bladder for use in an accumulator shell of generally spherical shape having first and second openings, said bladder communicating with one of said openings and having a stationary portion adapted to retain itself against the containing shell solely by the expansive force resulting from its stiffness, and having a flexible portion adapted to telescope into and expand out of the stationary portion with a rolling action, at least that part of the flexible portion adjacent to the stationary portion being of a thinner section to aid in said rolling action.

10. An accumulator having in combination a rigid container of circular cross-section having openings at opposite ends, and a bladder of molded flexible rubber material disposed within said container and having one end portion secured to the container and lying in constant contact with the interior of said container, said end portion communicating with one of said openings and the remaining end portion of the bladder tapering in thickness from the circle of said constant contact progressively to the free end of the bladder.

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