Nov. 27, 1945. W. A. LIPPINCOTT 2,389,791

ACCUMULATOR

Filed April 6, 1944 2 Sheets-Sheet 1

Fig. 1

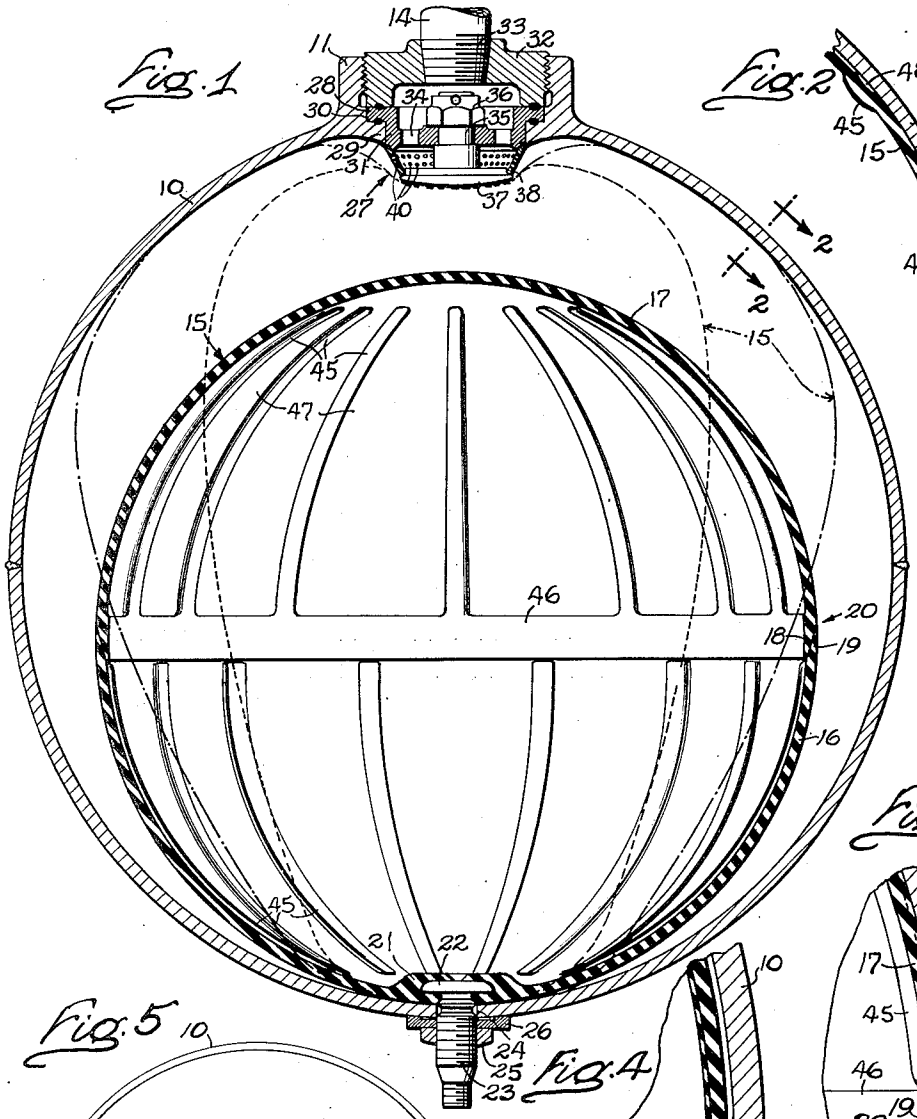


Fig. 2

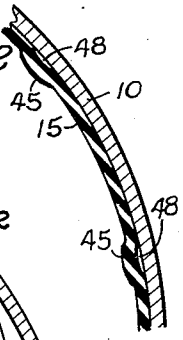


Fig. 3

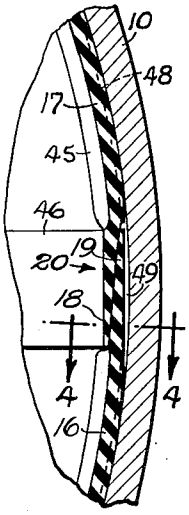


Fig. 4

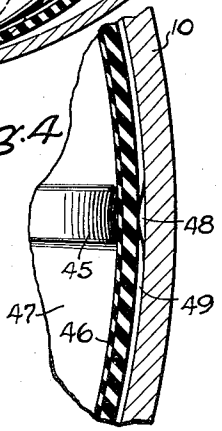
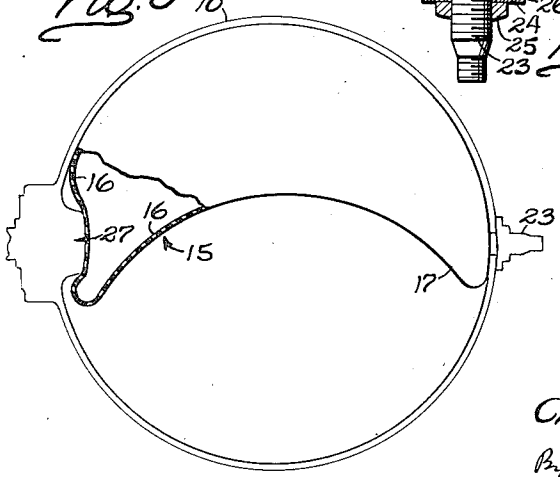


Fig. 5



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Fig. 6

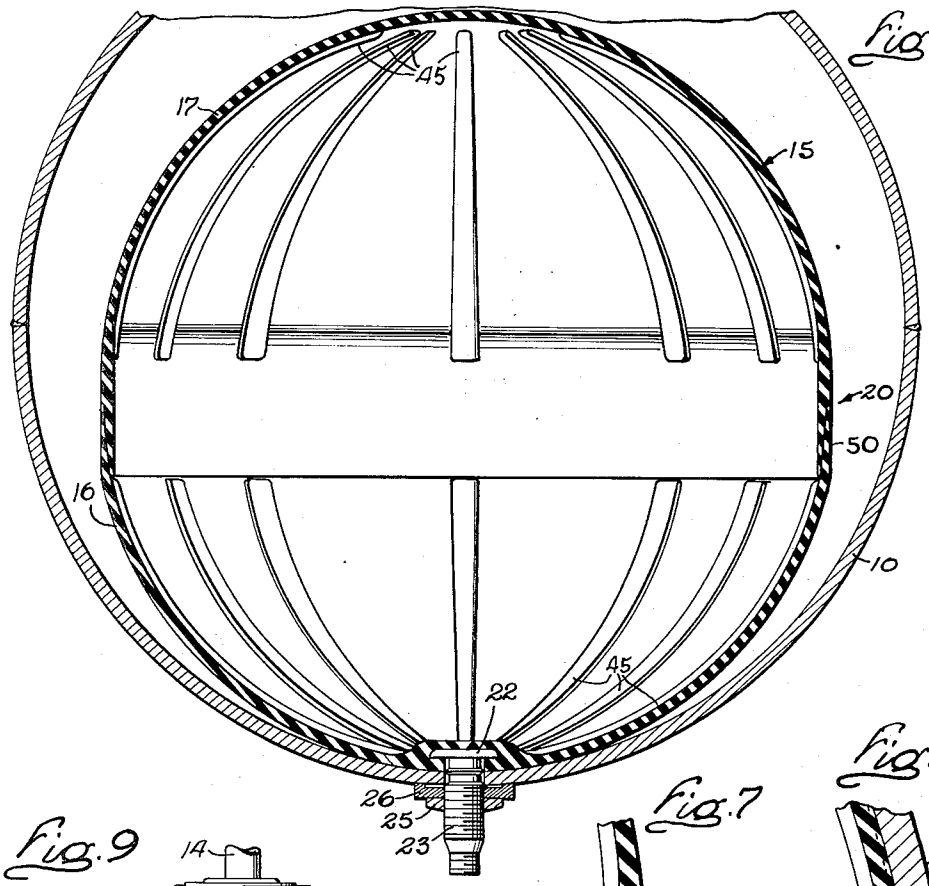


Fig. 9

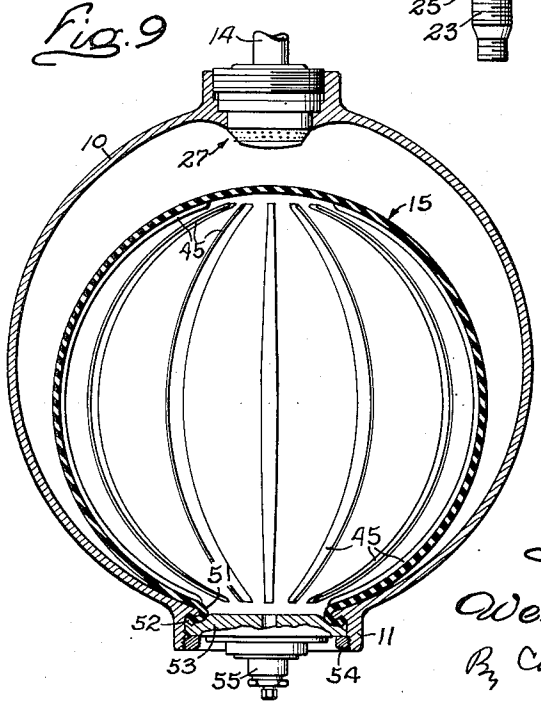


Fig. 7

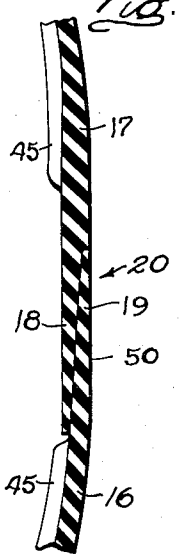
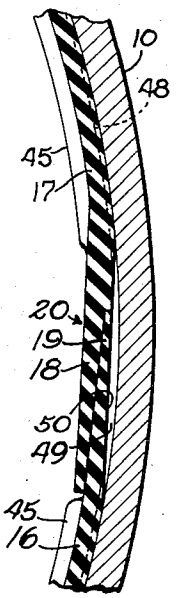


Fig. 8



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UNITED STATES PATENT OFFICE

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ACCUMULATOR

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Application April 6, 1944, Serial No. 529,714

5 Claims. (Cl. 138—30)

This invention relates to hydraulic accumulators of the type which comprise a rigid container and flexible diaphragm or bladder therein composed of oil resisting rubber material or the like and separating a body of hydraulic fluid from a body of compressed gas by which the fluid is maintained under pressure and caused to flow out of the container as the diaphragm inflates within the container.

One object is to provide an accumulator of the above character which has a high volumetric efficiency by virtue of the provision of means for preventing the trapping of liquid between the diaphragm and the inner tank wall as the diaphragm becomes fully inflated.

Another object is to provide an accumulator diaphragm incorporating novel means which, as an incident to expansion of the diaphragm against the tank, forms external channels through which trapped fluid may escape to the fluid outlet of the tank.

A further object is to provide a diaphragm which is adapted to form the fluid escape channels above described and which is constructed in two separately molded parts.

Another object is to provide an accumulator of the above character having a fluid outlet of novel construction.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a transverse sectional view of an accumulator embodying the novel features of the present invention.

Fig. 2 is a fragmentary sectional view taken along the line 2—2 of Fig. 1 when the diaphragm is inflated against the tank wall.

Fig. 3 is an enlarged sectional view of a portion of Fig. 1 with the diaphragm expanded against the equator of the container.

Fig. 4 is a fragmentary sectional view taken along the line 4—4 of Fig. 3.

Fig. 5 is a diagrammatic view of the accumulator with its axis disposed horizontally.

Fig. 6 is a fragmentary view similar to Fig. 1 showing a modification.

Fig. 7 is an enlarged cross-sectional view of the joint between the bag parts.

Fig. 8 is a similar enlarged view showing the bladder substantially fully inflated.

Fig. 9 is a view similar to Fig. 6 showing the bladder molded in one piece.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment. It is to be understood, however, that I do not intend to limit the invention by such disclosure, but aim to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

In the drawings the invention is shown embodied in an accumulator comprising a rigid spherical tank or container 10 formed at one end with a flange 11 defining a liquid inlet and outlet. Hydraulic fluid forced into or withdrawn from the tank through a pipe 14 is maintained under pressure by air contained within an inflatable diaphragm or bladder 15 formed of resiliently yieldable material such as synthetic rubber which remains relatively flexible at low temperatures.

The bladder comprises a bag preferably of generally spherical form as shown in full in Fig. 1. It may be molded in one piece as shown in Fig. 9, or, as shown in Figs. 1 and 6, it may comprise two hemispherical cups 16 and 17 having smooth or unribbed external surfaces. The cup lips 18 and 19 overlap each other and are tapered and cemented together to form a spliced seam 20 having a smooth outer surface flush with the exterior of the cups. One cup may, if desired, be made slightly smaller in diameter than the other, the cup 16 being the larger in the form shown in Figs. 6 to 8.

Referring now to Figs. 1 to 5, the center of the cup 16 is thickened as indicated at 21 and has molded therein the head 22 of a valve stem 23 which projects through a hole 24 in the tank axially alined with the flange 11. A nut 25 threaded onto the outer end of the stem is tightened down against a washer 26 to draw the thickened portion of the bag against the inner surface of the tank. A seal is thus formed around the opening 24, and the bottom of the cup 16 is fastened securely to the tank. The remainder of the bag is unsupported in the present instance, and, therefore, is free to float on the liquid in the tank and assume various shapes. Air may be introduced into the bag through the stem 23 which includes the usual check valve.

The size of the spherical bag relative to that of the spherical tank will depend on the character of the rubber material and the conditions under which the accumulator is used. For example, if, as in the case of accumulators subject to very low temperature, it is desirable to avoid substantial stretching of the rubber, the diaphragm sphere would be made relatively large, for ex-

ample, to have a surface area equal to about 60 to 70 per cent of the area of the internal tank wall. For operation at higher temperatures, a smaller diaphragm would be suitable.

A spherical bag of the character shown tends to remain spherical as it inflates within the tank. However, under the buoyant forces exerted on the air filled bag by the liquid in the tank, these forces will change the shape of the diaphragm in different positions of the tank. Thus, if the fluid outlet is at the top of the tank as shown in Fig. 1, the free end of the sphere will be buoyed upwardly somewhat as shown in dotted outline and this end may contact the fluid outlet end of the tank. If the tank is positioned with the axis of the fluid opening disposed horizontally, the diaphragm may be buoyed against one side of the tank. Such a condition is shown in Fig. 5, it being assumed that the diaphragm has not recovered its normal size after having been stretched substantially at very low temperature.

The invention contemplates the construction of the fluid opening of the tank in such a way that it is not covered or restricted by the bag when the latter, due to buoyant forces thereon or during expansion, comes against the outlet end of the tank. To this end, a hollow projection 27 extended into the tank encloses the fluid opening so that the end of the projection holds the bag spaced from fluid inlet and outlet holes 40 formed around the side of the projection.

To form the projection 27 in the present instance, an inturned flange 29 is formed on the tank around the fluid opening and adjacent the inner tank wall, the opening through this flange being large enough to permit the bag, when deflated, to be inserted into the tank. The flange 29 provides a shoulder 30 against which a flange 28 of a fitting 31 is sealed by a plug 32 screwed into the flange 11 and having a threaded central opening 33 receiving the pipe 14. The fitting has holes 34 therein and a shouldered bolt 35 extends therethrough. A wide head 37 of slightly rounded and smooth end contour is formed on the bolt and spaced from the fitting so as to support a frusto-conical ring 38 which may be clamped between the head 37 and the fitting by tightening a nut 36 against the fitting. Small holes 40 punched in the ring provide passages for the flow of fluid between the pipe 14 and the tank. It will be observed that these holes are at the sides of the projection 27 whose end 37 holds the bag away and prevents covering of the holes, at least until substantially all of the liquid has been withdrawn from the tank.

No provision is made in the present instance for controlling the shape that the bag assumes or the manner of its contacting the internal tank wall during expansion. That is to say, no predetermined part of the bag always contacts the tank wall first. The first part to contact will vary with different bags and with operating conditions including the position of the tank axis at the time of expansion, manufacturing variations in the bag wall thickness, etc. For example, in expanding from the partly collapsed condition indicated in dotted outline in Fig. 1, the intermediate portion of the cup 17 may be the first to engage the tank as shown in dot-dash outline. In such a case, fluid would become trapped between the tank and the cup 16 at the other end of the tank.

The present invention contemplates the provision of means for permitting the escape of any fluid that may thus become trapped between the tank and any area of the bag wherever that area may be. This means is incorporated in the wall structure of the bag and operates automatically as an incident to full expansion of the bag against the interior of the tank to create channels through which trapped liquid may escape to the outlet openings 40. For this purpose, spaced thickened portions or ribs 45 are molded on the inside walls of the cups 16 and 17 along meridian lines, and, in the form shown in Figs. 1 to 4, the seam 20 is made thicker as indicated at 46 than the portions of the cups between the ribs 45. Preferably, the meridian ribs 45 extend from the cup bottoms clear to the equatorial rib or thickened portion 46 with which they merge so that the bag is divided both axially and circumferentially into areas 47 of thin section separated by comparatively narrow areas of thicker section formed by the thickened sections 45 and 46. It is unnecessary to aline the ribs 45 on the two cups 16 and 17 in assembling the latter to form the bag.

Owing to their greater thickness, the rib sections will resist stretching more than the thinner intervening portions 47. Thus, as different portions of the bladder expand against the tank, the thinner areas stretch to a greater degree and are the first to contact the tank, the thicker areas remaining spaced from the tank. As a result, external meridian channels 48 are created temporarily opposite the ribs 45, and a channel 49 is formed opposite the thickened portion 46. The channels 48 and 49 communicate with each other, and the channels in the cup 17 extend clear to the tank outlet thereby providing an escape route for fluid that may be trapped between the tank and any part of the external surface of the diaphragm. As the fluid thus escapes, the thickened portions also may expand into full contact with the tank. The arrangement thus provided minimizes the possibility of fluid becoming trapped thereby providing for optimum volumetric efficiency of the accumulator. By extending the ribs 45 along meridian lines, the fluid escape channels 48 are of minimum length, and manufacture of the bag is facilitated.

The increased wall thickness at the ribs 45 and 46 is not sufficient to impair the ready flexibility of the bag. For example, the thickness of the bag at the ribs will be on the order of 1½ to 2 times the thickness of the areas 47 which are usually made $\frac{1}{16}$ to $\frac{3}{32}$ of an inch thick, depending on the size of the accumulator and other circumstances.

The diaphragm shown in Fig. 6 is of the same construction as that described above except that the cup 17 is made slightly smaller in diameter than the cup 16, and its tapered lip 19 is formed with a substantially cylindrical outer surface 50. With this construction, the parts will assume the positions shown in Fig. 8 after the thin portions of the cups 16 and 17 have expanded against the tank wall, the equatorial channel 49 being formed as before and communicating with the meridian channels 48.

When the bladder is molded in one piece as shown in Fig. 9, it is formed with a neck 51 providing an opening of substantial size with a flange 52 that may be clamped by a disk 53 against a shoulder around the interior of the flange 11, the disk being held by a ring 54 threading into the flange 11. A valve 55 is carried by the disk 53. In this case, the meridian ribs 45 are extended from the neck continuously to the

unsupported end of the bag. It is unnecessary, therefore, to thicken the bag wall around the equator.

I claim as my invention:

1. An accumulator having, in combination, a spherical tank having a fluid outlet, a generally spherical bladder of somewhat smaller size, and means securing one portion of the bladder against the interior of said tank so that the unsupported portion will be stretched during inflation of the bladder, said last mentioned portion having thickened portions on the inner side thereof extending along annularly spaced lines toward said tank outlet so as to provide areas which stretch to a lesser degree than the intervening areas and temporarily form external channels permitting the escape of any liquid becoming trapped between said unsupported portion and the internal tank wall when the bladder is expanded against the wall.

2. An accumulator having, in combination, a tank having a fluid outlet, a flexible walled bladder smaller than said tank supported within the tank from at least one end and inflatable to force fluid out of the tank through said outlet, and meridian ribs formed on the interior of said bladder and operating during inflation of the bladder to create channels disposed between the interior of the tank and the exterior of the bladder and permitting the escape of trapped fluid toward said outlet.

3. A bladder for accumulators comprising two hemispherical cups of flexible material overlapping each other and joined at their open ends to form a generally spherical bag having an equatorial seam forming a rib of greater thickness than the adjacent portions of the bladder wall, and meridian ribs formed on the inner surface of said bag in annularly spaced relation and extending from the equatorial rib toward each end of the bag.

4. An accumulator diaphragm comprising a bag of flexible material having a smooth external surface and formed with thick portions of narrow width and adjacent thinner portions of greater width, the thick portions extending axially and circumferentially of the bag.

5. An accumulator diaphragm comprising a flexible walled inflatable bag, and meridial ribs integral with and spaced around the internal wall of said bag.

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