Sept 10, 1957 H. N. LOVE 2,805,684

ACCUMULATOR

Filed June 23, 1954 2 Sheets-Sheet 1

Fig. 1

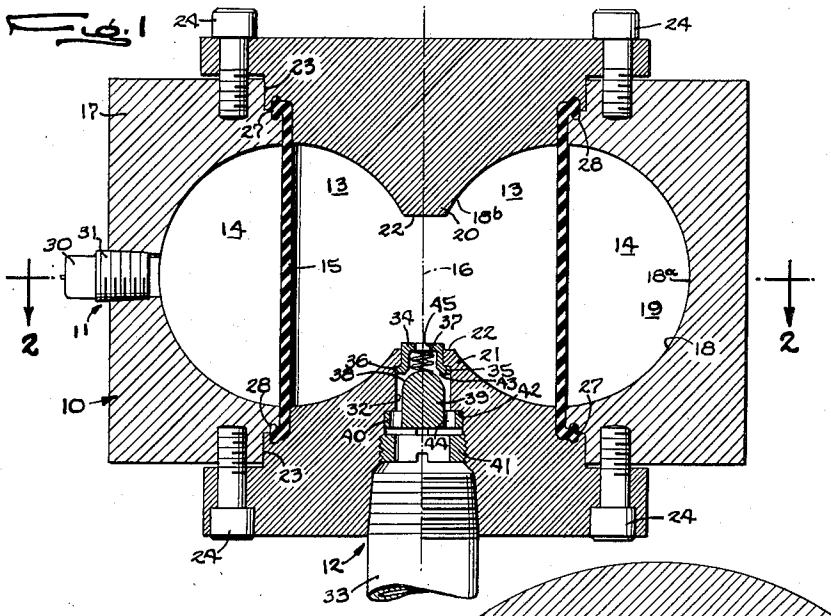


Fig. 2

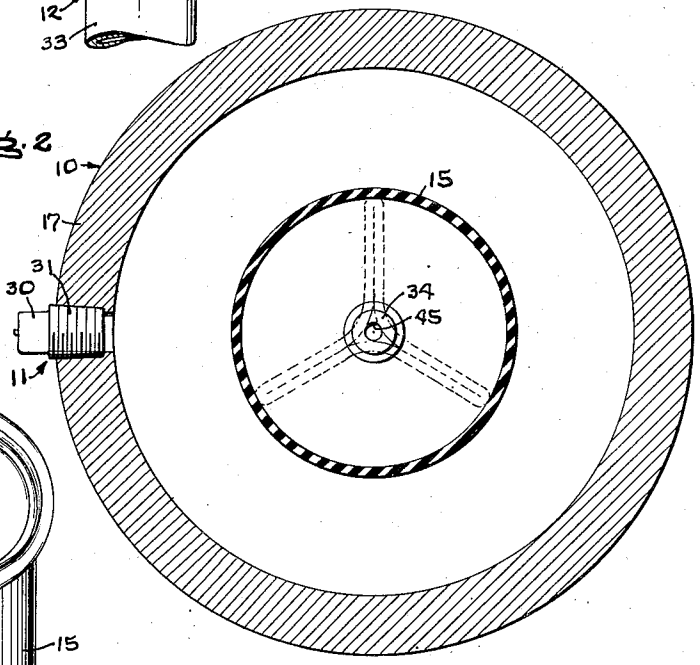
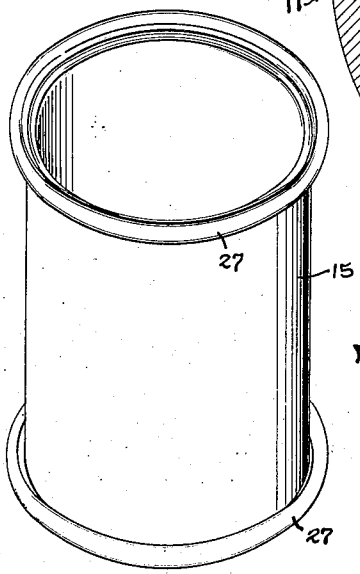


Fig. 3



INVENTOR

Harold Norris Love

By Carlson, Pitzner, Hurtadoll & Hoffe

ATTORNEY

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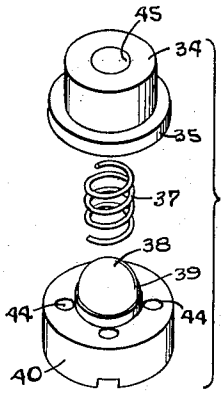
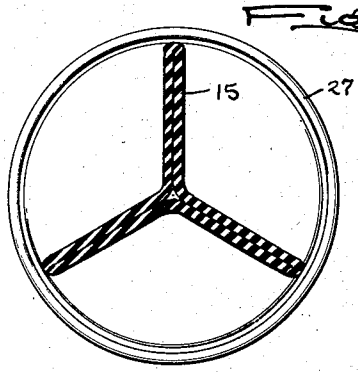


Fig. 4

Fig. 5



INVENTOR
Harold Norris Love
By Carlson, Pitzer, Hufford & Hyde
ATTORNEYS

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ACCUMULATOR

Harold Norris Love, Chicago, Ill., assignor to Ideal Roller and Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application June 23, 1954, Serial No. 438,843

3 Claims. (Cl. 138—30)

This invention relates to accumulators of the type in which a rigid casing provides air and fluid spaces separated by a flexible partition diaphragm which flexes back and forth with changes in the relative pressures in the spaces due to the supply or withdrawal of fluid from one or the other of the spaces. In prior accumulators, this partition has taken the form either of a circular sheet or of a bag of rubber material secured to the interior of the tank in such a manner that it may, under certain conditions of service use, become ruptured due to excessive folding or elongation of the diaphragm material or rupture by rubbing against the interior of the tank.

The primary object of the present invention is to overcome the shortcomings of prior accumulators by a novel shaping of the air and liquid chambers and a novel mounting of the diaphragm separating the two chambers.

A more detailed object is to form the accumulator tank of generally toroidal internal cross-section with inner and outer wall portions of rounded or arcuate cross-section cooperating with a diaphragm of generally tubular form having two widely separated areas of attachment to the tank wall.

Another object is to shape the diaphragm and the chamber walls so as to minimize the stretching of the diaphragm material as an incident to full collapse or expansion of the diaphragm.

Still another object is to provide an accumulator which, for a given volumetric capacity, will occupy less space than prior accumulators and this, without danger of rupturing the diaphragm under severe operating conditions.

A further object is to provide novel means for closing the liquid outlet valve in response to collapse of the diaphragm to a predetermined degree whereby to prevent extrusion of the diaphragm material into the outlet.

The invention also resides in the novel shaping of the air and liquid chambers and in location and construction of the air and liquid valves.

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 diametrical sectional view of an accumulator embodying the novel features of the present invention.

Fig. 2 is a cross sectional taken along the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of the diaphragm.

Fig. 4 is an exploded view of the parts of the outlet valve.

Fig. 5 is a view similar to Fig. 2 showing the diaphragm fully collapsed.

Generally stated the improved accumulator as shown in the drawings by way of illustration comprises a rigid tank **10** having an air opening **11** and one or more liquid openings **12** and defining annular chambers **13** and **14** defined by walls of arcuate shape and separated by a tube-like diaphragm **15** which surrounds the axis **16** of

the chambers **13** and **14** and has two annular ends concentric with the axis **16** and secured to the tank around their entire peripheries.

In the preferred form shown, the tank comprises a thick walled generally circular casting **17** having flattened ends and cored out to provide an internal wall **18** which defines a recess **19** of generally toroidal shape. The outer half portion **18a** of the wall **18** is semi-circular in radial cross section while the inner half portion is of similar arcuate cross-sectional shape except that, for the purpose of reducing the overall diameter of the tank, the inner part of each radial section of the wall intersects a corresponding part of the diametrically opposite section along a chord formed by the axis **16**. Herein the inner part **18b** of the wall **18** is interrupted short of the axis of the toroid so that opposite ends of the recesses **13** are defined by frusto conical projections **20** and **21** whose apices **22** are spaced apart along the axis **16**. The projections **20** and **21** are formed as separate pieces projecting through holes **23** counterbored in opposite ends of the casting **17**, the parts being clamped rigidly together by screws **24**.

In the form shown in Fig. 1, the diaphragm **15** which defines the inner wall of the outer chamber **14** and the outer wall of the inner chamber **13** is a molded cylindrical tube preferably composed of oil resistant rubber and corresponding in initial or unstretched axial length to the length of the toroidal recess **19**. Opposite end portions of the tube fit closely around the projections **20**, **21** and within the holes **23** and at their outer ends are turned outwardly and formed with enlargements **27** by which the ends of the tube are secured to the tank **10**. To this end, the enlargements **27** are, when the screws **24** are tightened, clamped in seats **28** formed in opposed parts of the tank and the pieces **20** and **21**.

In the present instance, the tube **15** is made of uniform wall thickness and, when constructed and mounted as described above, the intermediate portion between the points of anchorage is, as shown in Fig. 1, substantially cylindrical when the chambers **13** and **14** are at the same pressure, this being the shape to which the tube is molded. The unsupported intermediate portion of the tube is thus free to expand or contract.

Usually, the outer chamber **14** contains air while the liquid to be delivered by the accumulator is contained in the inner chamber **13**. Only one air opening **11** is required this being formed by a fitting **31** (Fig. 1) threaded into a hole in the outer peripheral portion of the tank **10** and enclosing the usual spring closed air check valve **30**.

The combined liquid inlet and outlet **12** is substantially smaller in diameter than the ends of the diaphragm and extends through the projection **21** along the axis **16** thereof. Herein, the outlet comprises a passage **32** adapted for threaded connection with an external pipe **33** and is somewhat smaller at its inner end than the generally flat inner end of the frustum **21**.

Extrusion of any part of the diaphragm into the passage when all of the liquid has been withdrawn from the tank and the diaphragm is fully collapsed is prevented effectually by the action of a normally open valve which is disposed within the inner end portion of the passage **32** and is closed by the action of the diaphragm as the latter becomes fully collapsed. The liquid thus trapped in the passage **32** blocks the latter and prevents the flow of the rubber material therein thus avoiding possible rupture of the diaphragm.

In the form shown, the valve includes a hollow cylindrical cup **34** slidable in the inner end of the passage **32** and having an outturned flange **35** which normally abuts against a shoulder **36** at the end of a counterbored por-

tion of the passage. This condition is normally maintained by a spring **37** between the bottom of the inverted cup and the rounded end **38** of a projection **39** upstanding from a disk **40**. The outer edge of the latter is clamped by a nut **41** against a shoulder **42**. The surface **38** cooperates with a complemental surface **43** on the interior of the cup **34** to form the valve. When the cup is seated against the shoulder **36**, the surfaces **38** and **43** are spaced apart as shown in Fig. 1 thus permitting the free flow of liquid in either direction through holes **44** in the disk and a hole **45** in the bottom of the cup. This condition of the valve obtains during normal operation of the accumulator.

The cup **34** projects a short distance beyond the end **22** of the cone **21** so as to be engaged by the diaphragm when substantially all of the liquid has been withdrawn from the tank chamber **13**. If, at this time, any part of the collapsed diaphragm is bent across the end of the cone **21**, the part will engage the projecting end of the cup and, during further withdrawal of the liquid will press the cup outwardly. As a result, the surface **43** will come against the projection **39** thus closing the valve to present further escape of fluid from the tank. The liquid thus trapped within the cup thus blocks the hole **45** and effectually prevents any of the rubber material from being extruded into the tank outlet. Now, when fluid is again forced into the tank the pressure applied to the flanged end of the cup forces the latter inwardly thus opening the valve whose member **34** is then held in open position by the spring.

The accumulator constructed as above described is charged with air and liquid and used in the same manner as the devices now available commercially. When, during such use, enough liquid is withdrawn from the chamber **13** to collapse the diaphragm and move the cup **34** outwardly, the valves **38**, **43** is thus closed preventing further escape of the liquid from the tank so as to eliminate any danger of damaging the diaphragm by complete emptying of the chamber **13**. To recharge the accumulator, oil is pumped into the tank through the pipe **33** and under sufficient pressure to overcome the prevailing pressure on the cup **34**. As soon as the cup starts to move inwardly, the valve is opened and the oil forced directly into the chamber **13** will again expand the diaphragm.

It will be observed that the diaphragm is anchored to the tank wall around two widely spaced and continuous peripheral edges which surround the axis **16** and are at opposite ends of the diaphragm when the latter is of tubular form as shown in the drawings. As a result, the diaphragm is held securely and against floating within the tank so that its shape and the manner of its flexing remain substantially the same irrespective of the position in which the axis of the tank is disposed in service use. The diaphragm expands and contracts by flexing of the rubber material between the two annular lines of anchorage and full expansion is accompanied by no more than about 50 percent elongation of the rubber. This is due to the rounded character of the toroidal recess and the arcuate shape of the rigid tank walls which limit the elongation of the rubber as the diaphragm expands and contracts.

This application is a continuation-in-part of my application Serial No. 341,105, filed March 9, 1953 and now abandoned.

I claim as my invention:

1. In an accumulator, the combination of, a tank having an internal wall defining a recess in the form of a toroid, said wall terminating along the axis of the toroid in inwardly extending projections axially spaced apart at their inner ends, a tubular diaphragm of flexible material enclosing said projections within said recess, means securing the ends of said diaphragm to said projections whereby to divide said recess into inner and outer annular chambers, means controlling the flow of liquid into and out of said inner chamber including a passage extending axially through one of said projections, a valve member slidable along said axis within said passage and having one end normally extending inwardly beyond the end of the projection for engagement by said diaphragm when the latter is collapsed, a seat within said passage cooperating with said member to form a valve which is closed by movement of the member by said diaphragm, and means urging said member inwardly to hold the valve normally open.

2. In an accumulator, the combination of, a tank having an internal wall defining a recess in the form of a toroid, said wall terminating along the axis of the toroid in inwardly extending projections axially spaced apart at their inner ends, a tubular diaphragm of flexible material enclosing said projections within said recess, means securing the ends of said diaphragm to said projections whereby to divide said recess into inner and outer annual chambers, means controlling the flow of liquid into and out of said inner chamber including a passage extending axially through one of said projections, a cup slidable in the inner end of said passage with its bottom normally projecting inwardly beyond the end of the passage for engagement with said diaphragm, said bottom having a hole therethrough, a member disposed within said passage and cooperating with the open end of the cup around the interior thereof to form a valve, and means urging said cup inwardly to maintain the valve open until the cup is forced outwardly by said diaphragm, said cup being forced inwardly to open the valve when liquid under pressure is delivered to the outer end of said passage.

3. In an accumulator, the combination of, a tank having an internal wall defining an annular recess in the form of a toroid, said wall terminating along the axis of the toroid in inwardly extending projections axially spaced at their inner ends whereby to leave the central portion of the toroid open, a tubular diaphragm of flexible material enclosing said projections and the toroid axis within said recess, means securing the ends of said diaphragm to said wall whereby to divide said recess into inner and outer annular chambers, means controlling the flow of fluid into said inner chamber including a passage extending axially through one of said projections, a valve member disposed within said passage and having a portion normally extending inwardly beyond the end of the projection for engagement by said diaphragm when the latter is collapsed, a seat within said passage cooperating with said member to form a valve which is closed by movement of the member by said diaphragm, and means urging said member inwardly to hold the valve normally open.

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