Dec. 26, 1967 A. ELMER 3,360,009

HYDRAULIC FLUID ACCUMULATOR HAVING SEPARATING WALL TENSIONER

Filed July 2, 1965 3 Sheets-Sheet 1

FIG.1

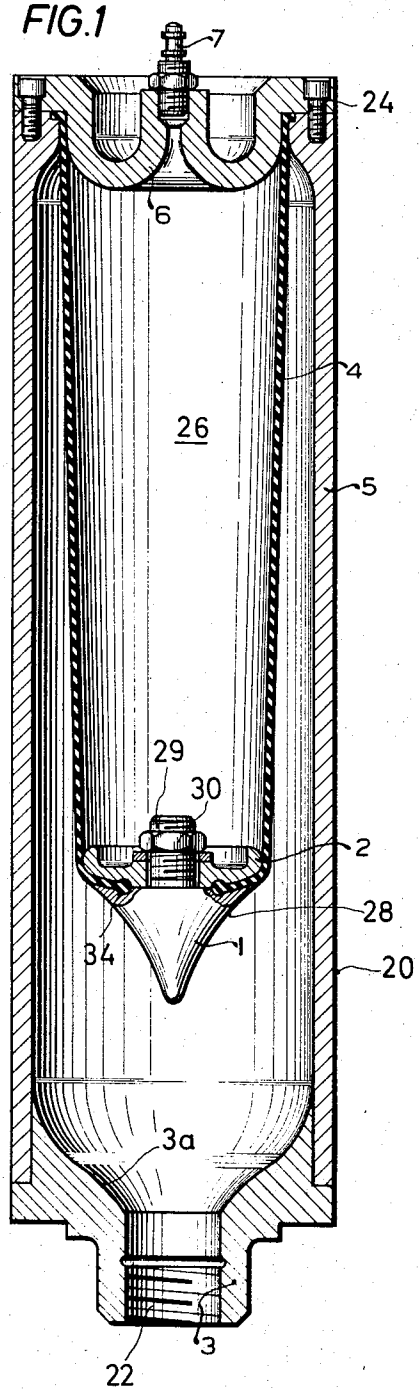

FIG.2

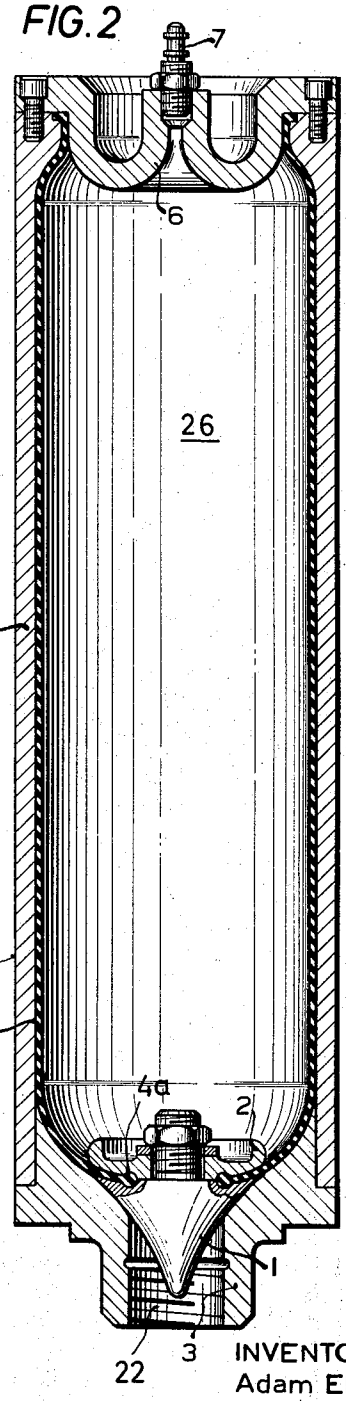

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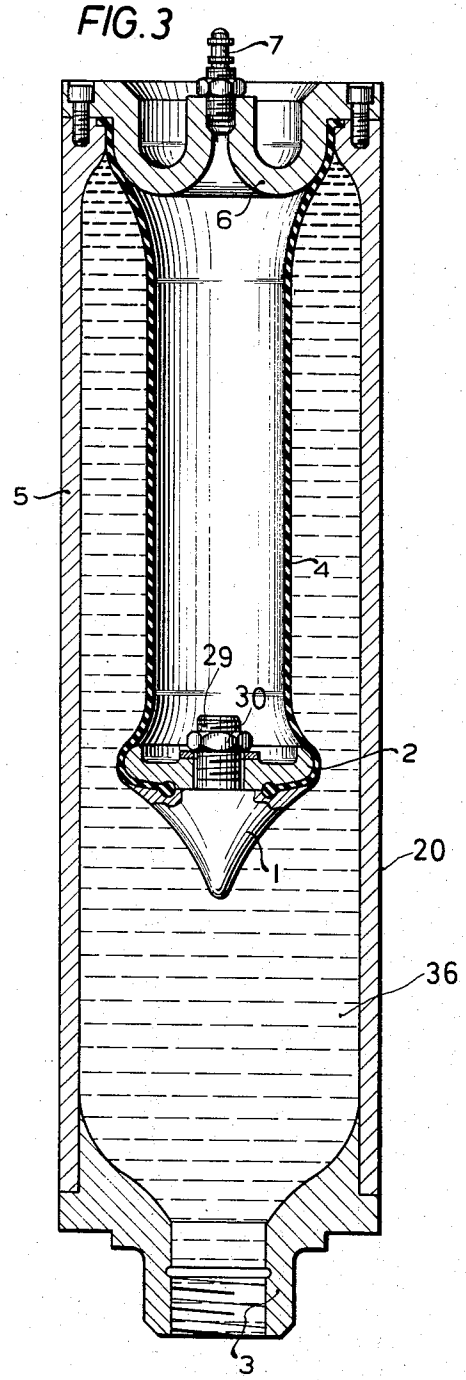
FIG. 3



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Filed July 2, 1965 3 Sheets-Sheet 3

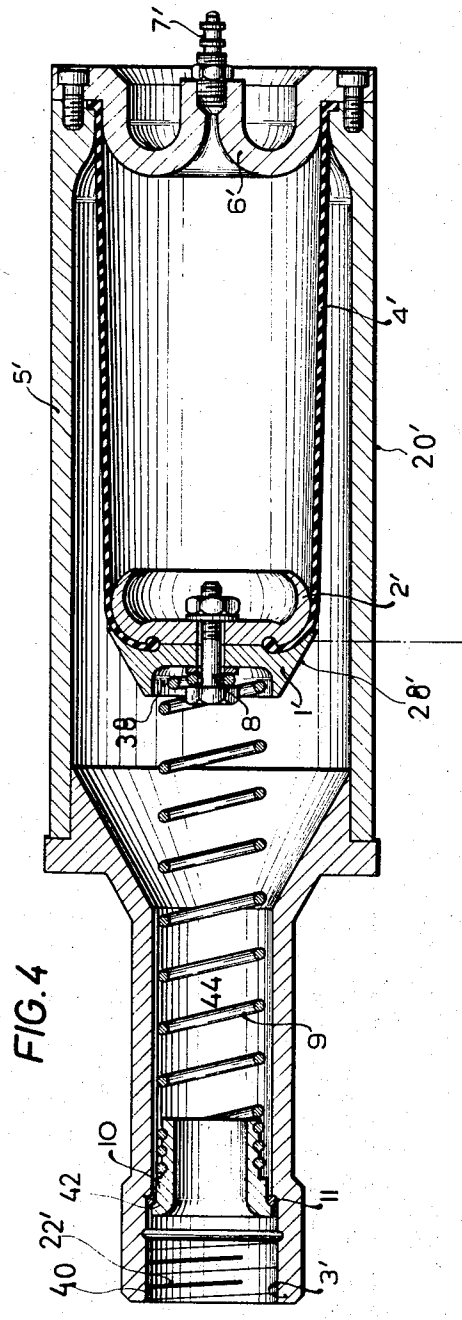

FIG. 4

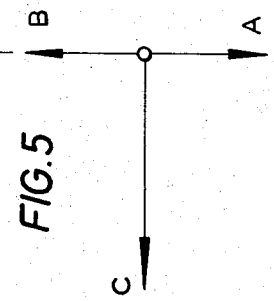

FIG. 5

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HYDRAULIC FLUID ACCUMULATOR HAVING SEPARATING WALL TENSIONER

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8 Claims. (Cl. 138—30)

ABSTRACT OF THE DISCLOSURE

A hydraulic fluid accumulator includes a cylindrical housing and a cylindrical member or separating wall member having straight cylinder-forming walls. The cylinder member is clamped at one end to the housing and is provided with closure means at the other end which exert a weight on this end to maintain the member in a stretched condition. A feature of the construction is that the closure means for the end of the cylinder member, which divides the interior of the housing into a gas chamber on the interior of the member and a hydraulic fluid chamber on the exterior, is constructed of a material having sufficient weight to urge the interior member downwardly in a stretched condition even when fluid is present in the chamber on the exterior of the cylinder member. The closure member is of a weight which is at least great enough to overcome any lifting force exerted by the fluid even when the member is in a normal or unstretched condition.

Summary of the invention

This invention relates in general to the construction of accumulators, and in particular to a new and useful hydraulic accumulator of cylindrical configuration having a resilient gap cushion enclosed in an elastic member.

One of the first types of hydraulic accumulators employed comprises a pressure tank which was widely employed with a piston pump. Usually this was a long cylindrical vessel arranged in a vertical position. The pressure of the upwardly pumped fluid compressed the air enclosed in the vessel which then exerted an equalizing effect on the pressure thrust of the pistons of the pump. Inasmuch as such water conveying pumps usually had to handle only pressure differences of three to four atmospheres, the fusion of the air into the fluid in the pressure tanks was of secondary importance and it was possible to do so without a separation of the air cushion from the pump fluid. In the field of oil hydraulics, however, this is no longer possible in view of the high pressures employed. Too much gas would be lost since the oil is very absorbent and the fusion increases with increasing pressure. For this reason the gas cushion is separated from the pressure oil in all high pressure hydraulic accumulators.

At the present time three types of separation are known:

(1) By a piston which is slidable within the cylinder of a hydraulic accumulator;

(2) By a separating fluid between gas and hydraulic oil, for example water saturated with salt; and

(3) By a separating wall consisting of a rubber-like elastic synthetic material.

For functional reasons the last-named method (3) has become most important. A flexible separating wall of oil-proof rubber follows practically without inertia the pressure thrust of the oil and provides satisfactory separation of the gas cushion from the oil. Using a cylindrical vessel for the original pressure tank, it is preferable to provide a separating wall which is of cylindrical shape. Very soon, however, it was found that a long cylindrical and vertically installed bag made of a resilient material for separating the two fluids will buckle and wrinkle and will result in a premature leakage due to the swinging movements of the wall. For this reason in a modified construction of a hydraulic accumulator the cylindrical shape has been abandoned in favor of a spherical shape. A rubber diaphragm arranged in the medium plane of the spherical bag is less inclined to buckle and wrinkle than a long cylindrical bag. The spherical housing, however, is less advantageous than the cylindrically shaped one in regard to the stability. For the same contents a spherical bag is more expensive to manufacture than a long cylinder which may be made from commercially available tubes. Some manufacturers of cylindrical hydraulic accumulators recommend the installation of their accumulators in a horizontal position in view of the buckling of the bag. This, however, only decreases the inclination to buckle and wrinkle but does not eliminate it, and this is particularly true with regard to wrinkling.

In accordance with the present invention, the buckling and wrinkling of the separating elastic element or bag is prevented, and thus the long life of the separating wall is insured. In accordance with the invention, the separating wall is made with means for preventing the buckling and wrinkling thereof which in one embodiment includes a bevel-shaped separating wall arranged at the lower end of the elastic separating element and forming a heavy metal closure. The closure is of a weight such that it will overcome the upward pressure of the oil and urge the separating wall downwardly into the oil. With regard to its shape, the closure means is formed so as to prevent the formation of wrinkles. For this purpose it advantageously includes two parts, one of which causes the rounding out of the lower portion of the separating wall and the other of which is angled downwardly so that it may fill a discharge opening formed at the bottom end of the accumulator.

In accordance with another embodiment of the invention, the closure forms an anchoring means for a tension spring which is anchored in the discharge or entrance opening for the hydraulic fluid and tensions the elastic wall so that it extends downwardly into the fluid at all times, even if it is installed horizontally.

Accordingly, it is an object of the invention to provide an improved accumulator construction.

A further object of the invention is to provide an accumulator construction which includes a cylinder having a separating wall which is anchored by means extending downwardly into the cylinder from the upper end thereof and which includes a closure for the separating wall arranged centrally in respect to the lower end and engaging and holding the lower end in a weighted fashion.

A further object of the invention is to provide means for biasing a separating wall downwardly into the hydraulic fluid of an accumulator.

A further object of the invention is to provide an accumulator which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIG. 1 is a transverse sectional view of a hydraulic accumulator construted in accordance with the invention without the gas and oil contents therein;

FIG. 2 is a view similar to FIG. 1 with the gas contents in the gas chamber portion but without oil pressure;

FIG. 3 is a view similar to FIG. 1 of the accumulator with the gas within the gas chamber and with full oil pressure of the hydraulic system;

FIG. 4 is a view similar to FIG. 1 of another embodiment of the invention; and

FIG. 5 is a schematic indication of the forces acting on the closure wall.

Referring to the drawings in particular, the invention embodied therein comprises an accumulator generally designated **20** which includes a tubular housing or container **5** having an outlet fitting **3** at one end with a small size opening **22** and being closed at its opposite end with a lid or cover member **6** which is bolted in position by means of bolts **24**.

In accordance with the invention, a gas chamber **24** is defined by an elastic bag member or cylindrical separating wall **4**. The separating wall **4** is advantageously made of rubber tubing or other elastic material and is secured in position in accordance with the invention by the cover or flange lid **6**. The lid **6** made to reach deeply into the interior of the cylinder **5**, for example, by a depth equal to from one half to three quarters of the diameter of the cylinder **5**. The interior of the flange lid **6** is advantageously concentrically rounded to provide a backing curvature to insure that there will be no formation of wrinkles on the elastic separating wall **4** even when the latter has lost its stability of form, for example because of the increased pressure of the hydraulic fluid as indicated in FIG. 3.

The flange lid **6** also carries a gas filling valve **7** which is centrally located in the flange lid. The large size opening at the top of the cylinder **5** which is closed by the flange lid **6** permits the easy exchange of the separating wall **4** in the event the latter has been damaged such as by unsuitable hydraulic fluid or by faulty handling, or it has reached the end of its normal operating life span.

In accordance with a further feature of the invention the separating wall **4** is biased to an extended position by means of a centralized holding member or closure generally designated **28** which includes a lower part or conical-shaped part **1** and a flat plate rounded part **2** which is secured thereto as by means of a bolt **29**. The bolt **29** extends from the lower part **1** through an opening in the rounded part **2** and is secured by means of a nut **30**. The parts **1** and **2** together define an annular groove **34** at their mating end faces which provides a seat for a widened bead or end portion **4***a* of the separating wall **4**. When the two parts **1** and **2** are clamped together, they hold the separating wall end in a central position within the cylinder **5** and in a position aligned with the center of the discharge opening **22** of the discharge fitting **3**. The flat plate part **2** is rounded on the sides and on its upper portion in order to provide a rounded backing for the separating wall **4** which prevents the formation of wrinkles in the wall even when subjected to high pressure as indicated in FIG. 3.

The lower part **1** is advantageously made with a projecting portion which can be centered in the opening **22** and which is advantageously of a configuration complementary to the curvature **3***a* of the interior of the fitting **3**. As indicated in FIG. 2, the lower part **1** closes the opening **22** when the oil is drained out of the cylinder **5** due to a drop in pressure of the oil.

In the view shown in FIG. 1, the cylindrical separating wall is suspended in its manufactured shape and without expansion in the tube **5**. It expands only when filled with gas and then fills the entire interior of the hydraulic accumulator when the pressure in the hydraulic system is low, as indicated in FIG. 2. In operation, the separating wall is compressed by the pressure of the hydraulic oil **36** and it loses its expansion as soon as the pressure of the oil has compressed the separating wall to its original size. If the pressure of the oil is further increased, the flexible separating wall **4** loses its stability of form and the walls will be bent inwardly (as indicated in FIG. 3) around the rounded projection of the interior flange lid **6** and around the rounded plate **2**.

The flexible separating wall is not only subject to the pressure of the oil originating from the pumping operation, but it is also effected by an upward pressure which results from the gravity of the oil which forces the wall **4** upwardly. This upward pressure is independent from the oil pressure and has an effect similar to that of submerging a slack, bag-like element in an oil container under atmospheric conditions. The upward pressure causes the buckling and wrinkling of the container **4** without the provision of the construction of the invention.

Since during operation a separating wall is never in a completely idle position but always follows the pressure impulses of the hydraulic fluid **36**, the swinging motion of the wall would be apt to cause rupturing and breakage without the construction of the invention. With the invention the buckling and wrinkling is counteracted by the closure **28** as well as by the walls **6** of the lid. The closure **28** is of a weight such as to overcome the upward pressure of the oil and to urge the wall downwardly into the oil. In addition, the closure **28** is formed so as to prevent the formation of wrinkles in the separating wall **4**.

In the embodiment indicated in FIG. 4, it has been found desirable to include as a closure member a spring **9** which provides means for urging the wall **4'** to an extended position by itself or in combination with a closure member generally designated **28'** which is secured to the ends of the separating wall **4'** in the manner of the other embodiment.

In a vertical installation of the hydraulic accumulator generally designated **20'**, the spring **9** in the embodiment illustrated in FIG. 4 supplements the weight of the parts **1** and **2** of the closure member generally designated **28'**. In a horizontal installation three forces act on a separating wall **4'** and the parts **1'** and **2'** of the closure means. As indicated in FIG. 5, the force A is a force of gravity of the separating wall **4** and its closure means **28'**. B is the upward pressure of the fluid acting on these parts, and C is the force of the spring **9**.

The weight of the parts **1'** and **2'** may be determined so as to compensate for all practical purposes for the upward pressure of the separating wall **4'** and its closure parts **28'** in a horizontal installation of the accumulator **20'**.

The spring **9** is tensioned by coiling it around a spring holder **10** which is provided with a spiral groove on its exterior surface. After insertion of the separating wall **4'** into the housing by securing the closure lid **6'**, the holder **10** may be pulled outwardly by means of a suitable tool through the bottle neck formed by the closure fitting **3'** and a snap ring **11** is inserted into a larger diameter portion **40** of the fitting and engaged in an exterior groove of the holder **10** and wedged against the ledge formation **42** and the fitting **3'**. In this position the snap ring **11** tightly clamps the holder in position with the spring **9** under tension. A troublefree inflow and outflow of the fluid through the tube inlet opening **22'** will be possible.

Since spring **9** should not act as a barrier of resistance to the pulsating in- and outflow of fluid, the fastening of the spring in the inlet fitting **3'** would normally be a difficult constructional task. However, this was solved in accordance with the invention by making the diameter of the thread of the spring **9** so large that the spring will just barely pass through the bore **44** of the fitting **3'** so that it may be anchored by the holder **10**.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end and terminating on the interior of said housing at its inner end, a closure lid closing said first end of said housing and said member, and wall closure means engaged with the inner end of said member and biasing the periphery thereof toward the hydraulic opening, said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said cylinder wall to maintain its straight form without collapse.

2. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end and terminating on the interior of said housing at its inner end, a closure lid closing said first end of said housing and said member, and closure means engaged with the inner end of said member and biasing the periphery thereof toward said hydraulic opening, including spring means aiding in biasing said separating wall in a direction away from said closure lid toward said opening, and of a force to exert said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said cylinder wall to maintain its straight form without collapse.

3. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end and terminating on the interior of said housing at its inner end, a closure lid closing said first end of said housing and said member, and closure means engaged with the inner end of said member and biasing the periphery thereof toward said hydraulic opening, including a coil spring connected to said separating wall and biasing said separating wall in a direction away from said closure lid toward said opening and of a force to exert said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said cylinder wall to maintain its straight form without collapse, and holder means anchoring said coil spring under tension adjacent said hydraulic discharge opening.

4. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end and terminating on the interior of said housing at its inner end, a closure lid closing said first end of said housing and clamping said member to the housing around the periphery of said member, and closure means engaged with the inner end of said member and clamping the periphery thereof at a location in alignment with and opposite the hydraulic opening, said member closure means together with said member and said closure lid defining a separate gas chamber within said member and a fluid chamber between said member and said housing, said closure means being of a weight to exert a downward force at least greater than the lifting action of the hydraulic fluid in said cylinder forming a straight wall to urge it to maintain its straight form without collapse.

5. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end, a closure lid closing said first end of said housing and said member and clamping said member to the housing around the periphery of said housing and said separating wall, and member closure means engaged with the inner end of said cylindrical and clamping the periphery thereof at a location in alignment with and opposite the hydraulic opening, said member defining a separate gas chamber within said housing on its interior and a hydraulic fluid chamber on its exterior, said closure lid comprising a first substantially conical part adapted to fit into the hydraulic opening to close the same upon reduction of hydraulic pressure and a second plate part having curved sides and top portions for forming the separating wall into a curved configuration upon increase of hydraulic pressure, said closure means being of a weight to exert a downward force at least greater than the lifting action of the hydraulic fluid and acting on said cylinder forming wall to urge it to maintain its straight form without collapse.

6. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end, a closure lid closing said first end of said housing and clamping said member to the housing around the periphery of said housing and said member and terminating on the interior of said housing at its inner end, and closure means engaged with the inner end of said member and clamping the periphery thereof at a location in alignment with and opposite the hydraulic opening, said closure means together with said member and said closure lid defining a separate gas chamber within said housing, said closure lid comprising a first substantially conical part adapted to fit into the hydraulic opening to close the same upon reduction of hydraulic pressure and a second plate part having curved sides and top portions for forming the separating wall into a curved configuration upon increase of hydraulic pressure, said closure means being of a weight and construction to urge said separating wall to extend into the hydraulic fluid which may flow into said tubular housing through said hydraulic opening, and a spring means biasing said closure wall in a direction away from said closure lid toward said opening, and a force to exert said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said cylinder wall to maintain its straight form without collapse.

7. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a substantially tubular resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end, a closure lid closing said first end of said housing and clamping said member to the housing around the periphery of said housing and said member, closure means engaged with the inner end of said member and clamping the periphery thereof at a location in alignment with and opposite the hydraulic opening, said closure means together with said member and said closure lid defining a separate gas chamber within said housing, said closure means comprising a first part and a second plate part having curved sides and top portions for forming the member into a curved configuration upon increase of hydraulic pressure, and a spring means biasing said closure wall in a direction away from said closure lid

toward said opening, and of a force to exert said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said cylinder wall to maintain its straight form without collapse, said spring means including a coil spring connected to said closure and a holder anchoring said coil spring under tension adjacent said hydraulic discharge opening.

8. A hydraulic fluid accumulator comprising a cylindrical housing having a first end and a second end with means at said second end defining a fitting with a hydraulic opening therein, a cylindrical resilient separating member having a straight cylinder forming wall, said member extending into said housing from said first end, a closure lid closing said first end of said housing and clamping said member to the housing around the periphery of said housing and said member, and closure means engaged with the inner end of said member and clamping the periphery thereof at a location in alignment with and opposite the hydraulic opening, said closure means together with said member and said closure lid defining a separate gas chamber within said housing, said closure lid comprising a first substantially conical part adapted to fit into the hydraulic opening to close the same upon reduction of hydraulic pressure and a second plate part having curved sides and top portions for forming the separating wall into a curved configuration upon increase of hydraulic pressure, said closure means including a coil spring biasing said closure wall in a direction away from said closure lid toward said opening including a coil spring connected to said closure, and a force to exert said closure means being of a weight to exert a downward stretching force on said member at least always greater than the lifting action of the hydraulic fluid to urge said

cylinder wall to maintain its straight form without collapse, and holder means anchoring said coil spring under tension in the fitting adjacent said hydraulic discharge opening, said fitting having curved walls of the same configuration as the outer end portion of said closure, said closure lid including a portion extending into said tubular housing and adapted to engage over the inner peripheral end of said separating wall and being curved to form said separating wall in a curved configuration when the latter is subjected to pressure, a bolt holding said first and second parts of said closure means together, a coil spring retained by said clamping bolt at its one end, a holder comprising a cylindrical member having a helical groove defined thereon holding said coil spring in said grooves, and a retaining ring engaged with said holder and with the interior walls adjacent the opening of said hydraulic fitting anchoring said spring under tension within said housing.

References Cited

UNITED STATES PATENTS

2,342,356	2/1944	Mercier	138—30
2,421,076	5/1947	Linton	138—30
2,546,648	3/1951	Mercier et al.	138—30
2,604,118	7/1952	Greer et al.	138—30
2,804,884	9/1957	Knox	138—30
2,811,925	11/1957	Crookston	138—30 X
3,075,558	1/1963	Forell	138—30
3,139,112	6/1964	Mercier	138—30
3,211,348	10/1965	Greer	138—30 X

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