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ACCUMULATOR

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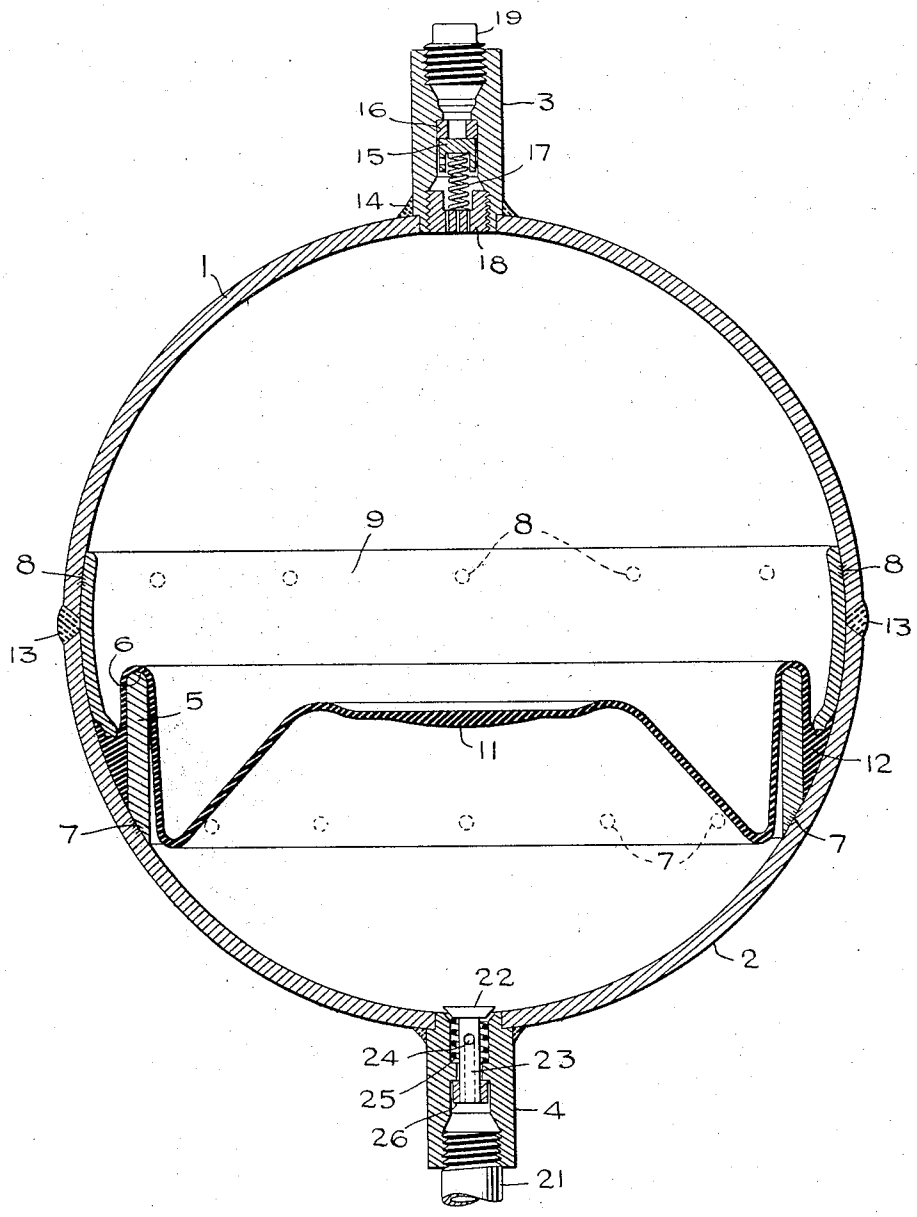

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ACCUMULATOR

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4 Claims. (Cl. 138—30)

This invention relates to accumulators for use in hydraulic systems and particularly to that known type of accumulator in which the hydraulic liquid is forced into the lower portion of the accumulator chamber against a trapped cushion of highly compressed gas.

In devices of this type, it is well known that the gas tends to become dissolved or occluded in the liquid and this occasions a gradual loss of gas. It is further objectionable because it tends to make the hydraulic medium elastic or to produce elastic pockets in the system in the event that some of the occluded gas separates from the liquid and becomes trapped in the lines.

It has heretofore been proposed to isolate the gas from the liquid in various ways including the interposition of a piston or a diaphragm between the two media. In receivers using a diaphragm (and to that class the present invention relates), difficulty has been encountered in mounting the diaphragm satisfactorily. This is particularly true where high pressures are used.

The outstanding virtues of the gas cushion accumulator are its compactness, and the lightness obtainable by the use of thin pressed steel shells which are welded and consequently are strong and absolutely gas-tight.

The present invention allows the use of such welded shells in conjunction with a flexible diaphragm which would be destroyed at temperatures far below the welding temperatures used.

It should be appreciated that in the normal operation of the device, the diaphragm is not subjected to substantial disruptive stresses. It then acts as a separating membrane between the gas and the liquid. However, since the gas is under heavy pressure, even when the liquid is nearly completely withdrawn from the accumulator, some means must be provided to protect the diaphragm from disruptive stresses at the outlet port. Such stresses would occur upon the depletion of liquid. The protective means must be of such character as not to subject the diaphragm to destructive abrasion or distortion. The provision of such a safe-guard is a feature of the present invention.

The preferred embodiment of the invention will now be described by reference to the accompanying drawing, in which:

The single figure is a vertical axial section of the accumulator embodying the invention, the accumulator being shown as it appears prior to charging with liquid and with gas.

The accumulator is formed of two hemispherical blanks 1 and 2 which are welded together to form a true sphere as will hereinafter be explained in further detail. Prior to such welding, each of the blanks 1 and 2 is formed with an opening. The opening in the blank 1 is intended to receive the housing 3 which encloses a check valve and a gas charging connection, as hereinafter more fully described. The blank 2 has an opening to receive the housing 4 which offers connection for the liquid line and which encloses a protective valve mechanism.

It is important to use a truly spherical form for the accumulator in any case where light weight is required because the stability of the spherical form permits the use of relatively thin gauge material for the shell. With such stable form, the only stresses which must be withstood are simple bursting stresses occasioned by the internal pressure.

Welded within the blank 2 is an annular cylindrical flange 5 which is formed with a rounded margin as indicated at 6. A convenient way to mount the member 5 is to spot-weld it to the blank 2 as indicated at 7. Member 5 is not subjected to heavy stresses and consequently the material used and the manner of attaching it to the blank 2 present no serious problems.

Mounted within and closely fitting the blank 1 and spot-welded thereto, as indicated at 8, is an internal lap strip 9 which overlaps the butt joint between the blanks 1 and 2 and which conforms to the interior of the marginal portion of blank 2 outside of the member 5. The strip also functions as a follower to retain the margin of the diaphragm.

A slack or corrugated diaphragm 11, which serves merely as a membrane to isolate liquid in the lower half of the accumulator from gas under pressure retained in the upper half of the accumulator, is arranged to fold over the upper rounded margin 6 of the member 5. It has a marginal bead or rim indicated at 12 which fits the seat outside the member 5 and between it and blank 2. This bead 12 is engaged by the lower margin of the lap strip 9 and is thus held under sealing pressure as clearly illustrated in the drawing. The sole function of the diaphragm is to separate the liquid (usually oil) and the gas (usually nitrogen) used in the accumulator. The diaphragm is not subjected to any disruptive stresses. Consequently moderate clamping of the bead 12 is sufficient.

The procedure in assembling the parts is to mount the diaphragm in the position shown in the drawing, pressing the bead 12 into its seat until it engages fairly all around. Then the up-

per blank 1 is applied and the two blanks 1 and 2 are clamped together with sufficient force to develop a proper sealing engagement of the lap strip 9 upon the bead 12. With the parts so clamped, water is introduced through the top opening in the blank 1 in sufficient quantity to submerge the diaphragm. The weight of the water will force the diaphragm 11 downward into practically continuous contact with the lower blank 2. This is possible because whether or not the blank 4 has then been mounted in place, the space below the diaphragm is freely vented.

The shell is then submerged in water nearly to the line of the weld to be made, whereupon a continuous weld indicated at 13 is formed in any suitable manner. This continuous weld connects the blanks 1 and 2 to each other and to the lap strip 9 so that adequate strength is secured. The water protects the flexible diaphragm 11 from damage by heat.

The material used for the diaphragm is preferably a synthetic rubber-like plastic which will resist attack by oils and by the gas used in the accumulator. The particular material used for the diaphragm 11 is not a feature of the present invention. Rubber has satisfactory mechanical properties but is usually adversely affected by oil and some gases so that it is considered inferior to certain synthetic plastics. The weld having been completed and tested for tightness, the accumulator is freed of water and dried.

While it is preferred to weld the housing 4 with its contained valve in place before the weld 13 is formed, this is not essential. If the housing 4 is in place, the valve 22 will be open. I prefer to plug the fitting 4 after water has been admitted above the diaphragm and before the lower half 2 is submerged in water preparatory to the formation of the weld 13. The reason for plugging it is to prevent the entrance of water below the diaphragm. Complete removal of such water would be difficult.

After the weld 13 is completed and after the interior above the diaphragm 11 has been dried, the shell is submerged in water far enough to protect the diaphragm from heat after which the housing 3 is welded to the blank 1. Such weld is indicated at 14.

As stated, the housing 3 encloses the gas charging valve which is an ordinary check valve for which no novelty is here claimed. It comprises a valve element 15 which coacts with an inserted seat 16. The valve closes outward and is urged in a closing direction by coil compression spring 17 which seats at its upper end against the valve and at its lower end against a ported spring seat 18 which is screwed into the inner end of the housing 3. The outer end of the housing 3 is internally threaded to receive a sealing plug 19 which is inserted after the space above the diaphragm 11 has been suitably charged with gas under pressure.

The housing 4 is internally threaded to connect with the high pressure liquid line 21. Mounted in the housing 4 is an inwardly opening valve 22 which is of the poppet type and which seats in a recess in the inner end of the housing 4. The parts are so proportioned that when the valve 22 is closed against its seat the top of the valve forms a smooth continuation of the interior of the shell so that there will be no tendency for the valve to cut the diaphragm 11.

The stem 23 of the valve 22 has an axial port indicated in dotted lines and this communicates with the lateral or cross port 24. The valve is urged in an opening direction by a coil compression spring 25 and its opening movement is limited by the external collar 26 which is attached to the end of the valve stem in any suitable manner. The spring 25 is mounted under substantial stress and is adequate to hold the valve open against any outward flow of liquid which is likely to occur. The only time that the valve 22 is intended to close is just as the liquid has been completely discharged from the space below the diaphragm 11. At such time it closes under thrust exerted by the diaphragm 11, and presents a smooth surface to the diaphragm.

Under normal operating conditions, liquid flows through the connection 4 to and from the accumulator without any interference offered by the valve 22. However, if the liquid in the accumulator is substantially exhausted (a condition which is not intended to occur but may occur occasionally as a result of faulty manipulation or of accident), the valve 22 when engaged by the diaphragm will close and protect the diaphragm from stress to which it would otherwise be subjected. Obviously, if the outlet port remained open and the diaphragm were blown against it by a gas pressure of say 2000 pounds per square inch, the diaphragm could be ruptured.

Accumulators of this type derive their technical importance from the fact that they are light and compact and when used under high pressures permit the storage of considerable energy. Their energy storage capacity is a function of the pressure used and the accumulator here disclosed is intended for use with pressures ranging between 2000 and 3000 pounds per square inch. 3000 pounds per square inch is approximately the maximum working pressure economically attainable under present commercial conditions with displacement pumps, but it is anticipated that improvements in other components may permit the use of even higher pressures.

Since the diaphragm 11 is not subjected to any disrupting stress, the only limitation on the pressure used is the ability to construct accumulator shells and fittings of adequate strength. The higher the storage pressure the greater the energy storage capacity. Furthermore, the use of high pressures permits operation against greater loads without commensurate increases in weight.

The invention permits the use of a relatively thin diaphragm of flexible plastic material in an accumulator shell formed of pressed sheet steel and welded throughout. This construction eliminates the possibility of leakage and very greatly reduces the weight of the accumulator shell.

The preferred practice in charging the accumulator is to introduce the maximum charge of liquid through the liquid line 21 and then charge the space above the diaphragm 11 with nitrogen under suitable pressure through the fitting 3. After this has been done the plug 19 is inserted and would be removed only in the event of loss of a part of the gas charge. It is not strictly necessary that the entire liquid charge be introduced before charging with compressed gas.

While the construction illustrated and hereinabove described in detail is believed to be definitely advantageous, modifications within the scope of the appended claims are possible and are contemplated.

I claim:

1. A hydraulic accumulator of the type in which the hydraulic liquid reacts against a cush-

ion of trapped compressed gas, comprising in combination, a shell composed of separately formed sections having edge portions which meet substantially on a junction plane; means within one of said sections and forming with said section a confining annular seat which is displaced from the junction plane; a flexible diaphragm mounted with its margin received in said seat; a lap strip carried by the other section, closely fitted within the margins of both sections, and engaging the margins of the diaphragm to confine it in said seat; and means comprising a weld substantially at said junction plane serving to connect the margins of the two sections to the lap strip and to each other.

2. A hydraulic accumulator of the type in which the hydraulic liquid reacts against a cushion of highly compressed gas, comprising in combination, two hemispherical metal sections adapted to be joined by a butt joint to form a spherical shell; a slack diaphragm of flexible material having a circular marginal bead; an annular member attached to one section, and displaced from said joint, said member forming with the shell a circular seat for the bead of the diaphragm and a rounded guide over which said diaphragm may fold; a lap strip attached to the other section and fitting within the margins of both sections, said strip engaging said bead and compressing the same in said seat; and means comprising a weld serving to connect the margins of the two sections to said lap strip and to each other.

3. A hydraulic accumulator of the type in which the hydraulic liquid reacts against a cushion of trapped compressed gas, comprising in combination, a shell composed of separately formed sections having edge portions which meet substantially on a plane of junction; an annulus mounted within one of said sections, and forming with a portion of said section an annular channel-like seat which is near to but spaced from said junction plane; a flexible diaphragm mounted with its margin in said seat; a second annulus overlying said margin and serving to clamp the same in said seat, said second annulus being connected with at least one of said sections; and a weld at the junction plane serving to connect said sections together.

4. A hydraulic accumulator of the type in which the hydraulic liquid reacts against a cushion of trapped compressed gas, comprising in combination, a shell composed of separately formed sections having edge portions which meet substantially on a plane of junction, said sections carrying respective complemental portions of a bead-clamping means one of which comprises an annular channel within one section and spaced from said plane of junction and the other of which is a rim in the other section which laps said plane of junction and enters said channel; a flexible diaphragm serving to separate gas and liquid spaces within said shell, and having a marginal bead clamped in said channel by said rim; and a weld at the junction plane serving to connect said sections.

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