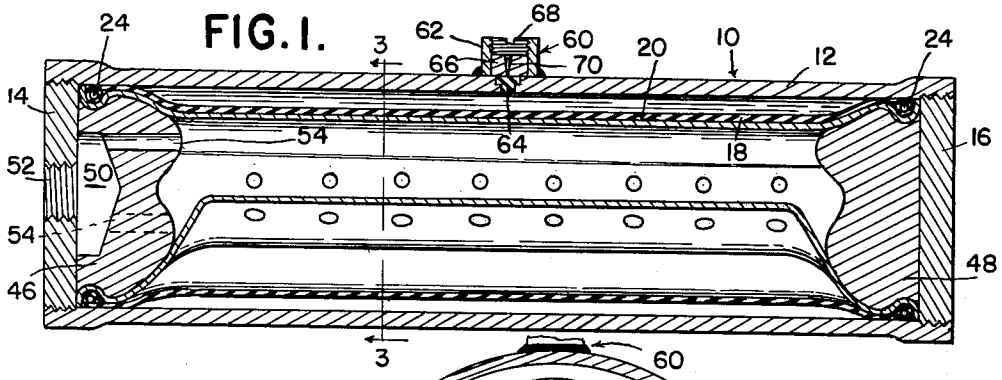
Aug. 4, 1964 W. H. PEET 3,143,144

ACCUMULATOR

Filed Nov. 27, 1961

FIG. 1.



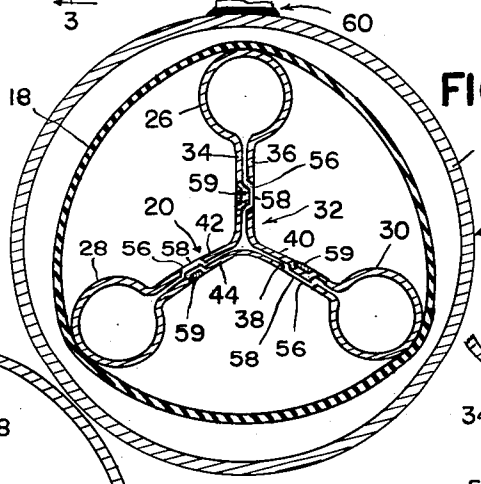
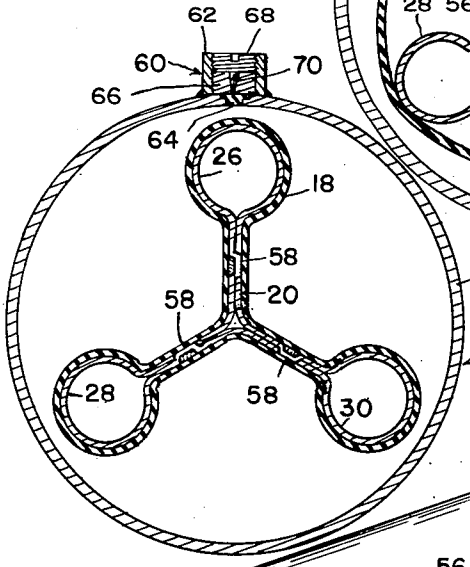


FIG. 3.

FIG. 4.



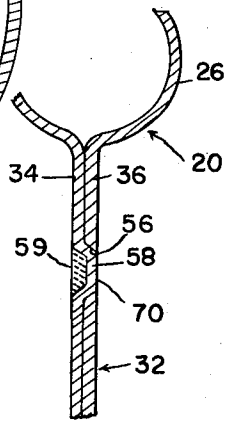


FIG. 5.

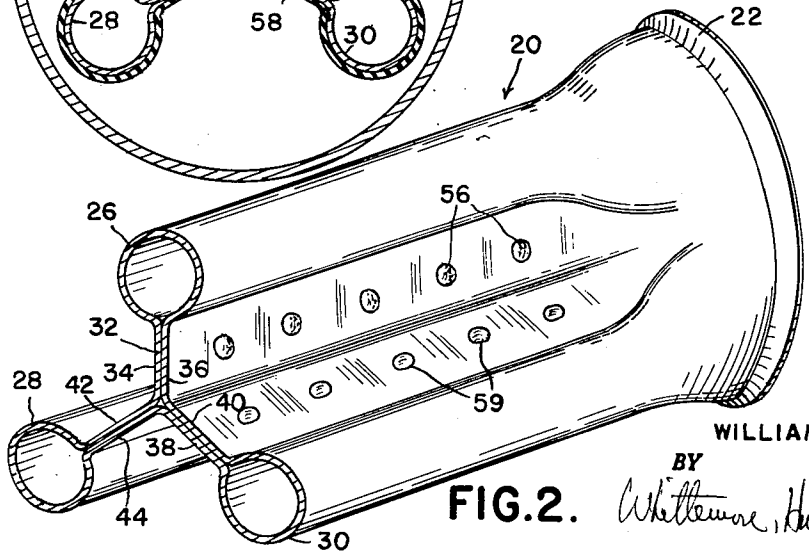


FIG. 2.

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This invention relates generally to accumulators and refers more particularly to accumulators of the flexible diaphragm type.

An essential object of the invention is to provide an accumulator of simple and inexpensive construction of the type having a flexible tubular diaphragm disposed coaxially within an elongated cylindrical casing, in which an improved internal backing core structure is provided for the diaphragm.

Another object is to provide an accumulator having increased volumetric efficiency.

Another object is to provide an accumulator having a diaphragm supporting core the periphery of the convoluted section of which is approximately equal to the inside circumference of the diaphragm tube in its free state.

Another object is to provide a core which is constructed to better support the flexible diaphragm tube with less stress, contributing to longer life of the diaphragm tube.

Another object is to provide a valve construction for the core having better liquid flow characteristics.

Another object is to provide an accumulator having a core provided with ports for the flow of fluid into and out of the core, the core being constructed to close and fill the ports in response to the collapse of the diaphragm tube so that the tube will not extrude into the ports.

Another object is to provide an accumulator having a core including confronting walls relatively movable toward and away from each other, the walls being adapted to support on their outer surfaces spaced portions of the tube when collapsed and to be moved toward each other to a limiting position by the pressure of the collapsed tube, ports in one of the walls for the flow of fluid into and out of the core, and elements on the other wall respectively opposed to the ports and operative to enter and substantially completely fill the ports upon relative movement of the walls toward each other to the limiting position.

Another object is to provide an accumulator wherein the outer surface of the other wall referred to in the preceding paragraph is smooth and the outer surface of the aforesaid one wall is smooth except for the ports therein, the ends of the elements on the other wall being disposed flush with the outer surface of the one wall in the limiting position of the walls.

The foregoing as well as other objects will become more apparent as this description proceeds, especially when considered with the accompanying drawing wherein:

FIGURE 1 is a longitudinal sectional view of an accumulator embodying my invention.

FIGURE 2 is an enlarged fragmentary perspective view of the core employed in the accumulator shown in FIGURE 1.

FIGURE 3 is an enlarged sectional view taken on the line 3—3 of FIGURE 1 and showing the core in its normal free state permitting the flow of fluid into and out of the core.

FIGURE 4 is a view similar to FIGURE 3 but showing both the diaphragm tube and core collapsed.

FIGURE 5 is an enlarged fragmentary sectional view of a portion of the structure shown in FIGURE 4.

Referring now more particularly to the drawing, the accumulator is generally designated **10** and comprises a rigid outer cylindrical casing **12** which is internally

threaded at both ends. Discs **14** and **16** are threaded into the ends of the cylinder to close the same.

A flexible diaphragm tube **18** which in its normal free state is preferably of uniform circular cross-section throughout its length is disposed within the cylinder **12** and extends from one end disc to the other. The diaphragm tube is formed of rubber or like material, and in its free state has a diameter somewhat less than the inside diameter of the cylindrical casing **12**. The diaphragm tube **18** is shown in its free state in FIGURE 3, and while it does not appear to be of true circular outline, it will be understood that this is because the walls of the tube have flattened out or sagged somewhat between the lobes of the core described more fully hereinafter. With further reference to the construction of the diaphragm tube, it will have, in its free state, straight walls in longitudinal section.

Extending within the flexible diaphragm tube **18** is the core **20** provided to interiorly support the tube. The core is of the tubular construction shown, its ends being circular and formed with the annular grooves **22** which are adapted to receive the beads **24** on either end of the tube. The beads of the tube are accordingly clamped between the grooves **22** of the core and the inner surface of the casing **12**, and the bead ends of the tube are only slightly stretched, if at all.

Referring to FIGURES 2–4, it will be seen that the cross-section of the major intermediate portion of the core forms the three lobes or tubular portions **26**, **28** and **30** which are spaced 120° apart and are parallel to and displaced radially equal distances from the central longitudinal axis of the casing **12**. The core has the central portion **32** bridging the space between the tubular portions or lobes **26**, **28** and **30** which has external surfaces shaped to blend smoothly with the external surfaces of the tubular portions for the uniform support of the tube when collapsed without sharp bends.

Actually as seen in the drawing, the central portion **32** includes the pairs of confronting walls **34**, **36** extending from the tubular portion **26**, the pairs of confronting walls **38**, **40** extending from the tubular portion **30**, and the confronting walls **42**, **44** extending from the tubular portion **28**. These walls for the major part of their length are flat planar portions of the core. However, near either end of the core the walls **34–44**, as well as the tubular portions **26–30**, blend smoothly into the circular form of the core. This can be best seen in FIGURE 2.

The core may be formed from an initial tube of uniform circular outline throughout its length corresponding generally to the circular form of the core shown at either end. The nodal form of the core between its ends is formed by deforming the intermediate portion of the initial tube.

A bolster reinforcement is provided at either end of the accumulator. The bolster reinforcements are designated **46** and **48** and are of the same exterior form and are confined within the casing **12** by end discs **14** and **16**. They are provided to interiorly support the ends of the core and have a special surface contour designed to conform with the interior shape of the core at its ends and partially into the portions thereof joining the intermediate nodal portion. The bolster **46** is provided with a chamber **50** which is in communication with the port **52** in end plug **14**. The port **52** is adapted to be connected to a source of hydraulic fluid in the line to which this accumulator is designed for connection. Leading from the chamber **50** are the three passages **54** which respectively open into the tubular portions **26**, **28** and **30** of the core. Hence there is a free communication of hydraulic fluid into and out of the tubular portions of the core through the chamber **50** and passages **54** in the bolster **46**. The other bolster **48** may be of solid construction.

The core is formed of a flexible resilient metal such

as steel and is shown in its normal free state in FIGURE 3, in which the opposed pairs of walls of the central portion 32 thereof are spaced from each other so that there is a free communication of hydraulic fluid between the tubular portions 26–30 at this time.

A longitudinally spaced series of ports 56 is provided in each of the walls 36, 38 and 42. In each of the confronting walls 34, 40 and 44 there is provided a longitudinally spaced series of valve-like elements 58. The valve elements 58 are respectively opposed to the ports 56 and may be formed by deforming or depressing the metal of the walls themselves, as shown. The valve elements 58 are generally frusto-conical in shape, and the ports in the opposite walls are of a complementary frusto-conical shape adapted to provide a full surface seating engagement with the valve elements when they enter the ports (FIGURE 5). It will be noted that the concave sides of the valve elements are filled with a solder 59 or similar material to preserve the flat smooth surface on the outer sides of the walls.

A suitable charging structure 60 is provided for filling the chamber defined between the diaphragm tube and casing with air under pressure. The charging structure comprises a cylindrical housing 62 welded or otherwise permanently secured to the exterior surface of the cylinder 12 over an opening in the wall of the cylinder. A rubber plug 64 fills the opening in the cylinder wall. Within the housing 62 is a disc 66 having a tapered through passage overlying the plug 64. A screw cap 68 threads into the upper end of the housing 62 to confine the disc 66, and is provided on its underside with a complementary tapered projection 70 formed to enter and fill the tapered passage in the disc so that the lower small end of the projection lies flush with the under surface of the disc and engages the rubber plug.

To charge the accumulator with air, the screw cap 68 is removed and a hypodermic type air injection needle is inserted into the tapered passage in disc 66 and through the plug 64. Air under pressure is then admitted to the space surrounding the tube 18 via the needle to charge the accumulator. Thereafter, the needle is removed and the cap 68 replaced. The hole pierced in the plug by the needle automatically seals itself when the needle is withdrawn. The time interval between removal of the needle and replacement of the cap 68 is not enough for the rubber plug 64 to extrude through the small tapered passage in the disc 66. However, since in time the rubber of the plug would extrude through the extremely small diameter tapered passage, the projection 70 on the cap 68 is provided to fill the passage.

FIGURE 4 illustrates the diaphragm when collapsed. This occurs when the pressure of air surrounding the tube exceeds the hydraulic pressure inside the tube. Under these circumstances, the tube gradually collapses first about the tubular portions 26–30 and then inwardly and progressively along the walls of the central portion 32. At final full collapse, the walls of the tube even press against the walls of the central portion near their junction at the axis of the core. As the tube thus collapses progressively radially inwardly, the confronting walls of the central portion are flexed toward one another, and the valve elements 58 gradually enter ports 56. Actually, the walls of the central portion of the core begin to move toward one another while the tube is still collapsing only around the tubular portions 26–30, that is, before the tube actually engages the walls of the central portion of the core.

FIGURE 4 shows the tube fully collapsed at which time the confronting walls of the central portion are actually in surface-to-surface engagement with each other, defining the limit of movement of such walls toward one another. At this time, the outer flat surfaces 70 of the valve elements are disposed flush with the outer surfaces of the walls of the central portion in which the ports are formed and the frusto-conical surfaces of the valve elements are seated in full surface-to-surface engagement with the frusto-conical complementary surfaces defining

the ports (FIGURE 5). Hence the ports are fully closed and extrusion of the rubber tube into the ports is effectively prevented. When the hydraulic pressure increases and forces more liquid into the core, the core will be permitted to expand enough so that the liquid can escape through the ports and to that same extent the tube will expand.

Hence it will be seen that the ports in the core are entirely responsive to the demands of the system and will close automatically under the pressure of the tube whenever the tube approaches the ports, thereby preventing extrusion of the rubber. On the other hand, the core is likewise responsive to the increases in hydraulic pressure permitting the outflow of the hydraulic fluid into the space between the tube and the core. Actually the core tends naturally to assume the open position of FIGURE 5, due to its own resilience, when the external pressure is relieved.

The outer surfaces of the tubular portions and central portion of the core, as well as the junctures between such portions, are smooth and sharp corners have been entirely avoided so that whenever thetube collapses it will be supported uniformly and without sharp bends. The solder 59 preserves the smooth outer surfaces of the walls bearing the valve elements, and the ends 70 of the valve elements preserve the smooth continuity of the outer surfaces of the walls having the ports. The valve elements are primarily for the purpose of preventing extrusion of the rubber diaphragm through the ports, and for that reason substantially fully close the ports so that hardly a crack exists between the heads of the valve elements and the outer surfaces of the ported walls when the valve elements extend fully into the ports as in FIGURE 5. In this position, flow of liquid through the ports is effectively blocked, although as stated, the primary purpose is to prevent extrusion of the rubber.

The perimeter of the central portion of the core is substantially equal to the inside circumference of the tube in its free state so that when collapsed, as in FIGURE 4, the rubber need merely flex and is not required to stretch. The diameter of the tube in its free state is very close to the inside diameter of the casing so that the tube does not have to stretch much before it reaches the confining limit defined by the casing 12. Hence the rubber of the tube is subjected to little stress, confined almost wholly to flexing as distinguished from stretching, contributing to longer life.

What I claim as my invention is:

1. A backing for interiorly supporting the flexible diaphragm tube of an accumulator, said backing comprising a hollow core, said core including spaced confronting walls adapted to support on their outer surfaces spaced portions of the diaphragm tube when the latter is collapsed and to flex toward and into contact with each other by the pressure of the collapsed tube, and means providing fluid communication between the hollow interior of said core and the space surrounding said core including a port in one of said walls, said port being substantially closed by the other of said walls when said walls flex toward and into contact with each other as aforesaid.

2. The backing defined in claim 1, wherein an element is provided on the other of said walls opposed to said port and adapted to enter and substantially completely fill said port upon flexing of said walls toward and into contact with each other.

3. A backing for interiorly supporting the flexible diaphragm tube of an accumulator, said backing comprising a core having a plurality of elongated, angularly spaced tubular portions, said core having a central portion bridging the space between said tubular portions and having external surfaces shaped to blend smoothly with the external surfaces of said tubular portions for the uniform support of said tube when collapsed without

sharp bends, said central portion of said core including a pair of spaced confronting walls associated with each tubular portion and extending inwardly therefrom, the walls of each pair being laterally spaced from each other and defining a passage communicating with the associated tubular portion, said walls of each pair being adapted to support spaced portions of the tube when the latter is collapsed and to flex toward and into contact with each other by the pressure of the collapsed tube, and means providing fluid communication between said passages and the space surrounding said core including ports in one wall of each pair, said ports being substantially closed by the other wall of each pair when said walls flex toward and into contact with each other as aforesaid.

4. The backing defined in claim 3, wherein said core is of one-piece construction and is resilient, said core has at least three tubular portions and at least three pairs of confronting walls, and each wall of each pair of confronting walls extends into a wall of another pair and into a wall of its associated tubular portion.

5. The backing defined in claim 4, wherein said pairs of confronting walls meet at a common vertex which is the axis of said core.

6. The backing defined in claim 5, wherein the other wall of each pair is provided with elements respectively opposed to the ports in said one wall of each pair, said elements being operative to enter and substantially completely fill said ports upon flexing of said walls of each pair toward and into contact with each other.

7. The backing defined in claim 6, wherein the outer surface of each of the said other walls is smooth, the outer surface of each of the ported walls is smooth except for said ports and the ends of said elements lie flush with the outer surface of the ported walls when the pairs of walls are in contact with each other.

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