United States Patent

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[72] Inventor **Victor Frederick Smith**
Highett, Victoria, Australia

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[73] Assignee **F. W. Davey and Company Proprietary Limited**
Victoria, Australia
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[33] **Australia**
[31] **62,221/69**

[54] **LIQUID PRESSURE ACCUMULATOR SYSTEMS**
1 Claim, 3 Drawing Figs.

[52] **U.S. Cl.** **138/30**
[51] **Int. Cl.** **F16l 55/04**
[50] **Field of Search** 138/30, 26; 239/89, 96

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Primary Examiner—Herbert F. Ross
Attorney—Wenderoth, Lind & Ponack

ABSTRACT: A liquid pressure tank is provided for storing liquid under pressure for use in domestic or commercial reticulated supply of the type having an impervious diaphragm dividing the tank into an air chamber and a liquid chamber, a constant amount of air being maintained in the chamber under pressure. A liquid pump and pressure switch system is provided for maintaining liquid in the chamber between preset pressure limits, the diaphragm being so configured and secured to form a pistonlike portion within the tank which reciprocates under variation of liquid pressure to minimize wrinkling or stretching of the diaphragm. Also a fixed plate can be arranged over the liquid outlet as protection from rupturing of the diaphragm at low liquid levels.

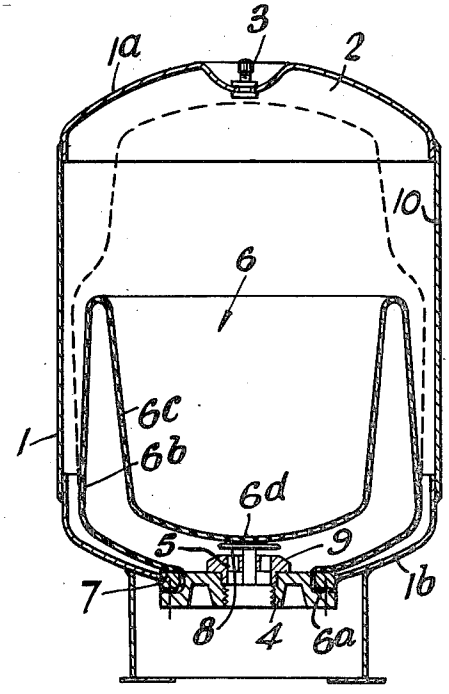


FIG. 1.

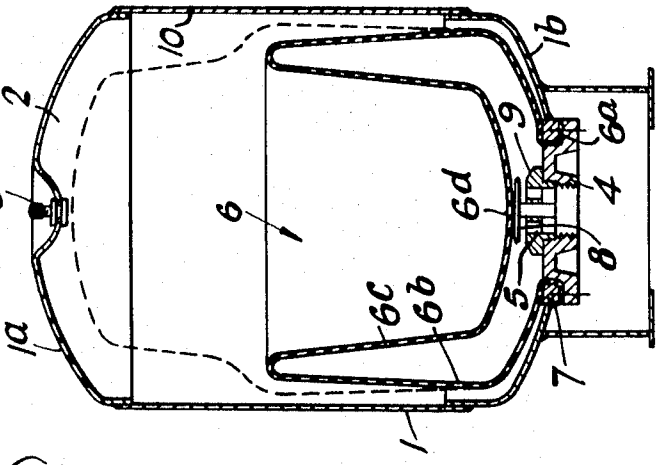


FIG. 3.

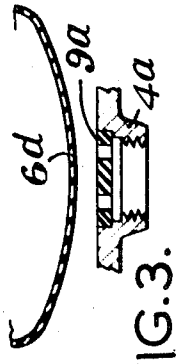
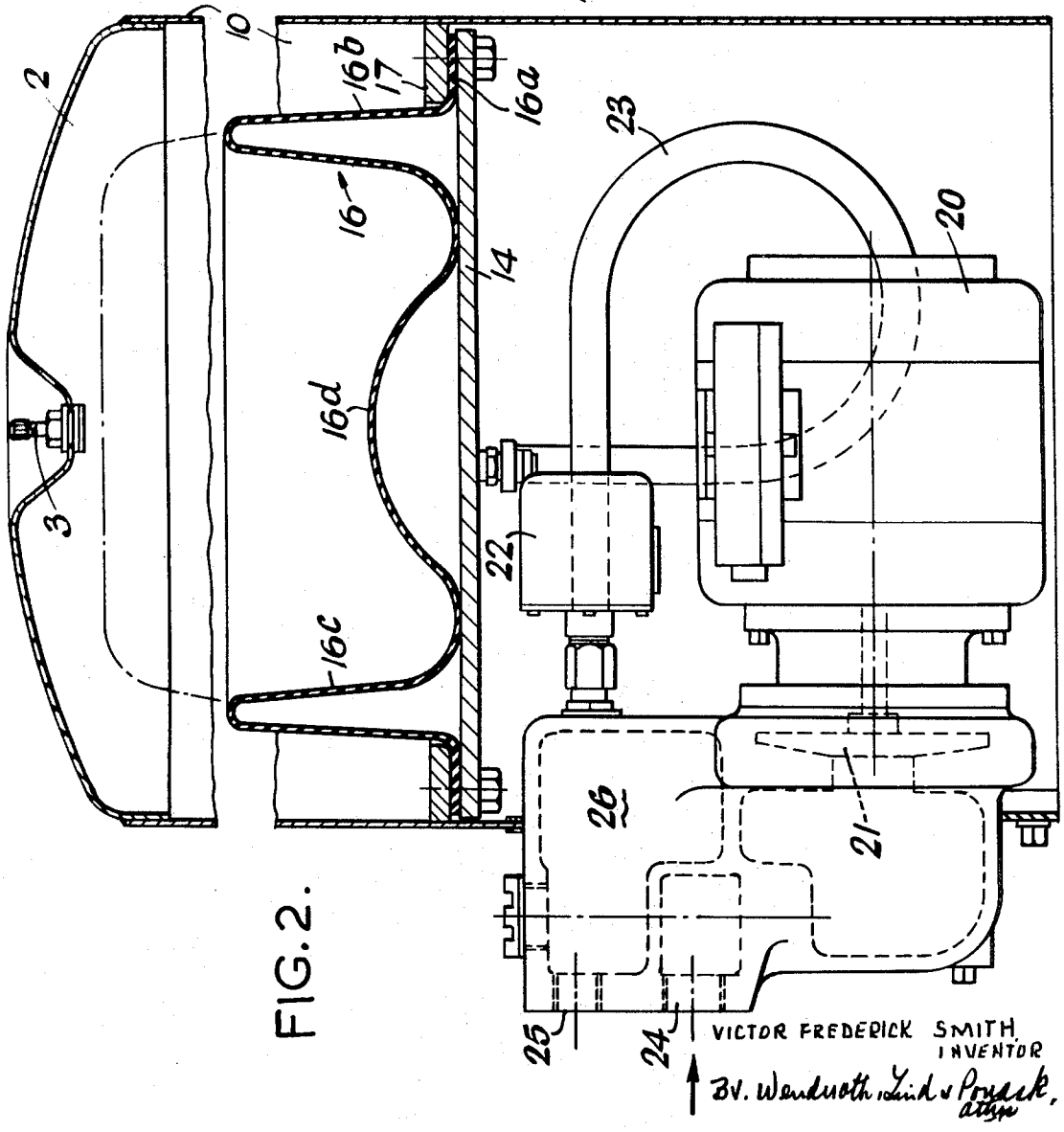


FIG. 2.



VICTOR FREDERICK SMITH
INVENTOR

BY Wenderoth, Lind & Ponack,
attys

LIQUID PRESSURE ACCUMULATOR SYSTEMS

This invention relates to liquid pressure tanks in which a liquid such as water is stored under pressure for use in domestic or commercial supplies. Thus one important application of pressure tanks is in rural districts where a pressurized water supply is not generally available and where it is necessary particularly for cleaning purposes or the like on primary or industrial premises. Pressure tanks for domestic home use also have appeal where only a low-pressure water supply is available.

The present invention will refer specifically to the supply of water, however it will be understood that the tank can be arranged to supply most fluids in a pressurized form.

The pressure tank is of the type in which a reserve supply of water is held under pressure. The tank is divided into two areas by a flexible diaphragm; one area containing water and the other compressed air. Water is arranged to be pumped into the tank against the pressure of air exerted on the diaphragm so that the column of air is displaced or compressed. Once a predetermined pressure has been reached the pump is automatically stopped.

In a practical installation the tank is connected to a home water supply so that upon opening of a tap in the home pressurized water is drawn off from the tank, when the pressure falls to a predetermined minimum the pump is restarted and the tank is replenished until maximum pressure is again reached.

The major problems associated with this apparatus lie in attaining trouble-free operation of the diaphragm which must be substantially air-impervious and have good resiliency. Furthermore undue crumpling or stretching of the diaphragm should be avoided in normal operation in order that its life expectancy can be increased considerably. Further problems are associated with the construction of the water outlet of the tank whereby the diaphragm will not be ruptured by pressure of air impinging thereon when the water tank is empty. Various constructions of outlet valves have been proposed in the prior art for the purpose of retaining some residual water in the tank to prevent such rupture, however these valves have not proved completely satisfactory in practice in that, due to their inherent construction, full flow of pressure liquid from the tank at times of maximum demand is reduced and also such valves tend to close prematurely before the complete storage of water has been used.

It is a principal object of this invention to provide a fluid pressure accumulator tank of the type having a diaphragm and in which the diaphragm is of improved construction.

It is a further objective of the invention to provide improved fluid outlet means for the fluid storage in which the above-mentioned disadvantages are effectively countered.

According to the present invention there is provided a pressure liquid accumulator tank including a hollow housing, a diaphragm secured within and dividing said housing into an air chamber and a liquid chamber, two ports in said housing one of each communicating with each chamber for admission of air under pressure to said air chamber and liquid under pressure to said liquid chamber respectively, the amount of air maintained in said air chamber being substantially constant when in use, the arrangement being such that as the quantity of liquid in said liquid chamber varies said diaphragm will move between two positions within said housing representing minimum liquid pressure and maximum liquid pressure, the position of securement and the configuration of the diagram being such that a pistonlike membrane portion is formed for reciprocatory movement along the length of said housing to prevent excessive wrinkling or stretching of said diaphragm during said movement.

Conveniently the liquid chamber is bounded solely by said diaphragm and a keeper plate securely sealing said diaphragm to said housing. The keeper plate includes the liquid port. In one arrangement the liquid port is covered by a plate extending substantially parallel to and spaced from said keeper plate, said plate being adapted to receive in abutting relation portion

of said diaphragm, said keeper plate including an annular shoulder of larger diameter than said plate, the space between said shoulder and said plate defining said liquid port, said shoulder having an inclined face adjacent said plate against which a portion of the diaphragm also abuts to effectively seal said liquid port when liquid pressure falls to a minimum. In an alternative form the outlet liquid port may be provided by a simple multiported plastic or like outlet piece snapped into an aperture in the keeper plate and against which the diaphragm abuts. The ports are of such diameter as to prevent rupturing of the diaphragm.

In one form said diaphragm in integral form includes two substantially concentric portions extending substantially parallel to the sidewalls of said housing one end of the outer concentric portion being free and adapted to be secured to said housing by the end keeper plate which is arranged to seal said housing, one end of the inner concentric portion being connected to the other end of said outer concentric portion, the diaphragm further including a membrane portion which extends substantially across said housing to join the other end of said inner concentric portion. The material of said diaphragm is of flexible, and substantially air-impervious, butyl rubber material.

The invention will now be described in further detail having reference to a practical arrangement which will be described with reference to the accompanying drawings in which:

FIG. 1 is a sectional view of a tank assembly in one arrangement of the invention.

FIG. 2 is a sectional view of a general assembly of a further arrangement in accordance with the present invention.

FIG. 3 is a partial sectional view of a modified outlet port.

The pressure tank 1 of one arrangement as shown in FIG. 1 is of cylindrical form having curved ends 1*a*, 1*b*, one end 1*a* forming part of the air chamber 2 and having a one-way valve 3 therein for charging this chamber with compressed air.

The other end of the tank housing is closed with a discal keeper plate 4 which includes an outlet duct 5. A diaphragm 6 manufactured in accordance with the invention is arranged to be secured within the housing by said keeper plate 4. In large high-pressure tanks the diameter of said keeper plate 4 is preferably maintained relatively small and is arranged to interconnect with a ring 7 about the open end of the housing proper. The ring 7 has studs (not shown) therein for securement of said plate and a free end 6*a* of said diaphragm 6 is arranged to be wrapped partially around said ring 7 prior to fitting and securement of said keeper plate 4.

In an alternative form as shown in FIG. 2 suitable for small lower-pressure tanks the keeper plate 14 is of similar diameter to that of the housing 10 and secures to a studded ring flange 17 extending around the housing circumference. The edge portion 16*a* of the diaphragm 16 is conveniently beaded to ensure a good seal when compressed between said keeper plate 14 and said flange 17. In this figure a schematic arrangement of the motor 20, pump impeller 21 and pressure switch 22 is shown in assembly. The pump is of a centrifugal jet, easy-priming type. The pressure switch 22 is preferably adjustable and controls operation of the motor within preset liquid pressure limits.

In this arrangement liquid at low pressure is drawn in through port 24 and pumped under high pressure into chamber 26 for supply either to outlet port 25 or through hose 23 to the pressure vessel. The pressure switch 22 is arranged to disconnect the motor 20 upon the pressure under the diaphragm 16 reaching a preset maximum. Further supply of liquid is provided from the tank until the pressure falls to a preset minimum whereupon the switch 22 connects said motor 20 and pumping recommences to provide further pressurized supply of liquid.

In high-pressure tanks such as that depicted in FIG. 1 the outlet port 5 in the keeper plate 4 is covered by a circular plate 8 spaced from the port 5. Furthermore the port 5 is surrounded by a chamfered shoulder 9. The shoulder 9 and the edge of the circular plate 8 presents a seating surface which is

arranged to be contacted and sealed by said diaphragm **6** during periods of minimum pressure in the tank. Sealing is arranged to take place only when a residual amount of water is left in the tank. An alternative form of outlet port is depicted in FIG. **3** comprising a multiported disc **9***a* of plastic or like material which presses or snap-fits into the apertured keeper plate **4***a*, the disc ports being of a size to support the material of the diaphragm without rupturing thereof.

Thus it will be understood that with the combination of suitable butyl rubber materials in the diaphragm and the construction of the outlet port in the keeper plate, the possibility of damage to the diaphragm is minimized while full performance in flow rates can be obtained from the pressure tank.

In a low-pressure tank as shown in FIG. **2** protection of the strong butyl rubber diaphragm is not necessary. The diameter of the outlet and pressure of liquid being such that no rupturing is likely to occur.

An important feature of this invention is the construction and configuration of the diaphragm **6** and **16** referring to FIGS. **1** and **2** respectively in the drawings. The free end **6***a* and **16***a* of the diaphragm in each instance is arranged to be secured within the housing adjacent the liquid outlet end, and in these arrangements is in substantially the same plane as the outlet. The diaphragm is formed with an upstanding outer portion **6***b*, **16***b* which extends from the free end substantially parallel to the walls of the housing **1** to **10** and then is turned through a U to extend back inside itself for a substantial distance to form an inner concentric portion **6***c*, **16***c* whence a membrane portion **6***d*, **16***d* is formed to complete the diaphragm shape. The membrane portion **6***d*, **16***d* is adapted to move in pistonlike fashion from the liquid outlet end where it is positioned at low pressures towards the other end, thereby displacing and increasing the pressure of air in the air chamber as the liquid pump operates to increase the liquid pressure in the tank.

It has been found that the above described construction of the diaphragm together with its attachment at or near one end of the housing provides for a rolling or peeling action as the membrane portion **6***d*, **16***d* reciprocates along the length of the housing according to variations in liquid pressure. Thus at maximum pressure the wall portions **6***b*, **6***c* and **16***b*, **16***c* of the diaphragms extend along substantially parallel to the wall of the housing as shown by the dotted lines depicting the expanded position of the diaphragms **6** and **16** in each figure but at low pressures the inside concentric wall portion **6***c*, **16***c* of each diaphragm is housed within the outside concentric wall portion **6***b*, **16***b*. Thus, the outer concentric wall remains substantially stationary while the inside wall peels off or rolls on relative to this outer wall portion. In this way a minimum of crumpling or stretching is incurred by the diaphragm material thus allowing for heavy-duty, air-impervious and flexible materials to be used. Butyl rubber has been found to have excellent characteristics in carrying this invention into effect. The use of pure butyl rubber in the manufacture of the diaphragm is preferred, however it has been found that a mixture of at least 25 percent (chlorinated) butyl rubber with the balance essentially natural rubber also has proved satisfactory.

It has been found that at relatively low pressures this material will not rupture and accordingly protection from rupturing at the liquid outlet is only necessary in the practical arrangement when relatively high liquid pressures and flow rates applicable in larger systems are used.

I claim:

1. A pressure liquid accumulator tank comprising a hollow cylindrical housing, a generally cylindrically shaped diaphragm extending the length of said housing secured within a dividing said housing into an air chamber and a liquid chamber, the liquid chamber being interior of said diaphragm, two ports in said housing one communicating with each chamber for admission of air under pressure to said air chamber and liquid under pressure to said liquid chamber respectively, a keeper plate securing said diaphragm to one end of said housing and includes the liquid port, said liquid chamber being bounded solely by said diaphragm and said keeper plate, means for maintaining the amount of air in said air chamber substantially constant when in use, said means comprising an arrangement whereby as the quantity of liquid in said liquid chamber varies said diaphragm will move between two positions within said housing representing a minimum liquid pressure and a maximum liquid pressure, said diaphragm being integrally formed solely of flexible rubber material and having two substantially concentric portions extending substantially parallel to the sidewalls of said housing, one end of the outer concentric portion being secured to the housing by said keeper plate in sealing relation, one end of the inner concentric portion being connected to the other end of said outer concentric portion, the inner concentric portion being joined to a membrane portion which extends substantially across the housing to close the other end of said inner concentric portion, said keeper plate also including an annular shoulder and a rigid circular immovable plate extending parallel to and spaced from the surface of said annular shoulder and keeper plate thereby defining said liquid port, said annular shoulder having a diameter larger than that of said circular plate, said fixed plate receiving in abutting relation a portion of said diaphragm membrane portion, said shoulder having an inclined fact adjacent said circular plate, said shoulder and the edge of said circular plate forming a seating surface against which a portion of the diaphragm membrane portion also abuts to effectively seal said liquid port when liquid pressure falls to a minimum.

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