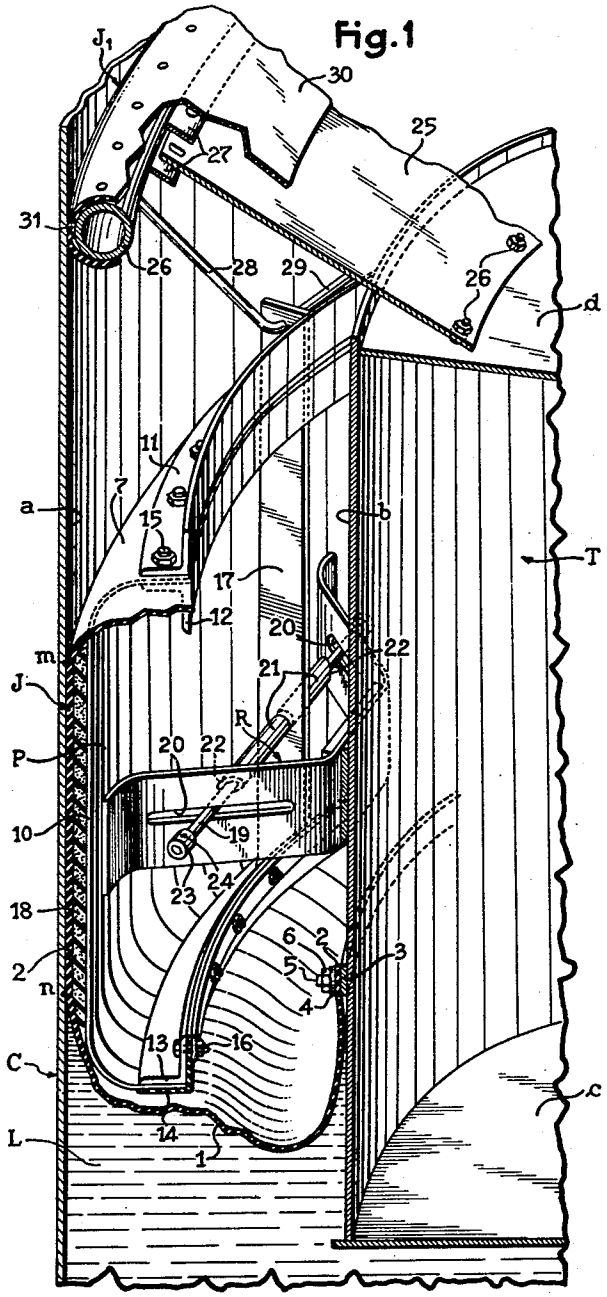
May 25, 1965 R. LECLER 3,185,335

SEALING MEANS FOR A LIQUID-STORING RESERVOIR HAVING A FLOATING ROOF

Filed Nov. 21, 1962 3 Sheets-Sheet 1

Fig.1



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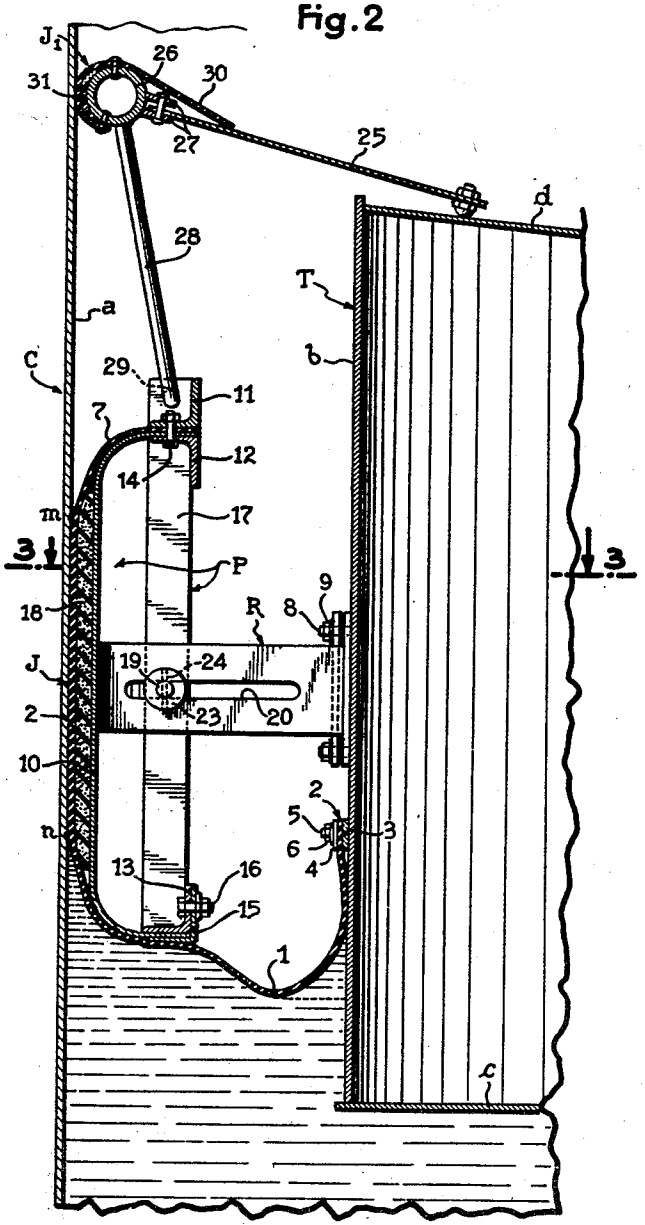
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SEALING MEANS FOR A LIQUID-STORING RESERVOIR HAVING A FLOATING ROOF

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Fig.2



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SEALING MEANS FOR A LIQUID-STORING RESERVOIR HAVING A FLOATING ROOF

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Fig. 4

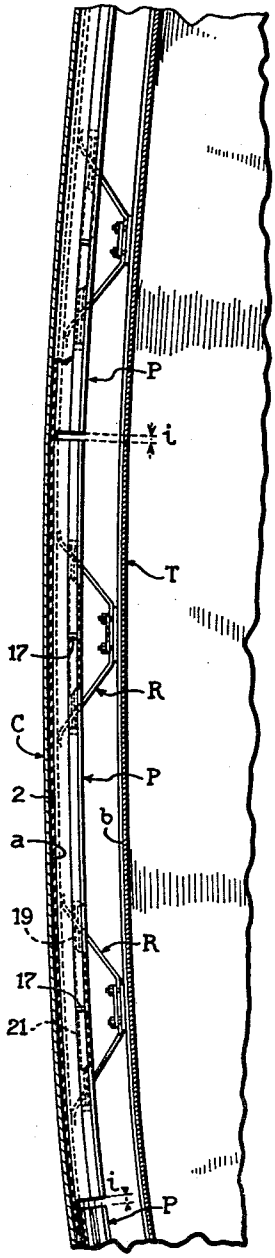
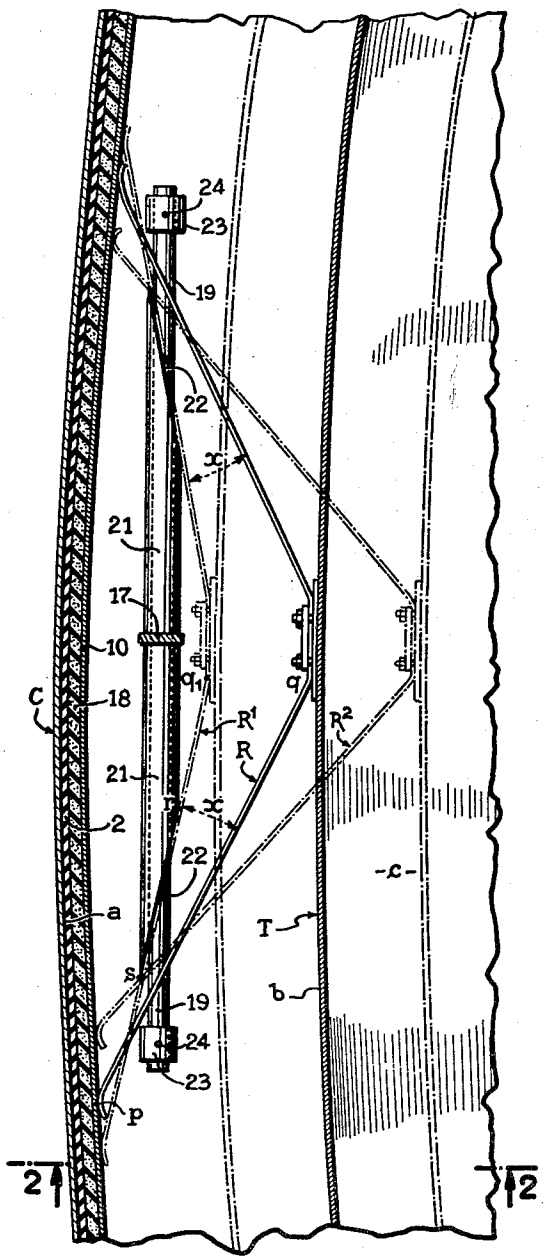


Fig. 3



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United States Patent Office 3,185,335 Patented May 25, 1965

3,185,335

SEALING MEANS FOR A LIQUID-STORING RESERVOIR HAVING A FLOATING ROOF

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8 Claims. (Cl. 220—26)

The present invention relates to sealing means for reservoirs for storing hydrocarbon and other liquid products of the type having a cylindrical tank of vertical axis and a floating roof over the liquid within the tank.

The outside diameter of the floating roof is substantially less than the inside diameter of the tank so as to permit its free upward movement, and the sealing means has for function to fill the annular space resulting from this difference in diameter and not only to seal the assembly but also to center the roof of the tank.

Numerous sealing means have already been proposed but they are generally complicated in construction and in many of them the seal obtained is often imperfect, owing to local defects in shape or defects in the general shape resulting from manufacturing tolerances.

The object of the invention is to provide an improved sealing means for a reservoir having a floating roof and intended to store liquids, this sealing means being simple in construction and affording a strictly fluidtight seal. The sealing means comprises a flexible, fluidtight and annular wall which is secured to the roof at the inner edge of the wall and extends, by its peripheral portion in contact with the inner face of the tank, alongside slides which are independent of one another and are maintained against said peripheral portion by springs interposed between said slides and the roof.

Owing to this arrangement, a strictly fluidtight seal is obtained throughout the periphery of the roof owing to the continuity of the flexible wall, despite small gaps separating the slides from each other.

Preferably and in accordance with another feature of the invention, each slide comprises a resilient buffer, between the peripheral portion of the continuous flexible wall and a rigid reinforcement.

This buffer can easily accommodate, without adversely affecting the seal, the local defects in the shape of the tank, defects in the general shape thereof (ovalization) being accommodated by displacements of the slides relative to each other.

In a preferred embodiment, the rigid reinforcement of each slide rests on at least two centering springs carried by the cylindrical wall of the roof in such manner as not to hinder the deflections of these springs.

Another object of the invention is to provide a reservoir having a floating roof provided with the aforementioned improved sealing means.

Further features and advantages of the invention will be apparent from the ensuing description, with reference to the accompanying drawings to which the invention is in no way limited.

In the drawings:

FIG. 1 is a perspective view, with parts cut away of the upper part of the tank of a liquid reservoir connected to the floating roof of the reservoir through the medium of the improved sealing means;

FIG. 2 is a vertical sectional view, taken along line 2—2 of FIG. 3, of the roof and the sealing means without taking into account the circular shape of the vessel and the sealing means, that is, the parts of the elements extending beyond the plane of the section have not been shown in order to render the drawing more clear;

FIG. 3 is a partial horizontal sectional view, along line 3—3 of FIG. 2, and

FIG. 4 is a view similar to FIG. 3 on a reduced scale showing a complete slide and a part of each of the adjacent slides.

In the illustrated embodiment, the reservoir incorporating the sealing means according to the invention comprises, in the known manner, a cylindrical tank C having an inner cylindrical face *a*, a vertical axis and a floating roof T comprising a cylindrical wall having an outer face *b*, a lower end wall *c* and an upper end wall *d*, this roof being adapted to float on the liquid L stored in the tank.

The roof T must be maintained more or less centered in the tank C, the diameter of its outer face *b* being less than that of the inner face *a* of the tank so as to provide therebetween an annular space in which is disposed the sealing means J, to which the invention is more particularly related.

This sealing means comprises a continuous, annular, flexible, and strictly fluidtight wall 1, it being for example of an elastomer such as natural or synthetic rubber (neoprene), a mixture of neoprene and polyvinyl chloride, or superpolyamide. Alternatively, it can be constituted by a stratified wall composed of alternate layers of fabric and plastic.

This wall 1 is secured in a region adjacent its inner edge 2 to the cylindrical wall of the roof T in a fluidtight manner, for example by clamping it between rings 3 and 4 by means of studs 5 and nuts 6. The outer peripheral portion of the wall 1 is applied against the inner face *a* of the tank C to the extent of a height *mn* by a series of slides or pressing elements generally designated by the reference letter P. The slides are disposed in alignment round the entire periphery of the roof, as can be seen in FIG. 4 which shows a complete slide and adjacent portions of two other slides, these various slides being separated from each other by a very slight gap *i* which allows them to function individually in the radial direction in the course of movements of the roof T relative to the tank C. The wall 1 therefore surrounds all the slides, its outer peripheral portion 7 being formed over the upper part of the slides to which latter this wall is secured in the manner explained hereinafter.

The slides P are supported by springs R which are rigidly secured to the roof T, for example by studs 8 and nuts 9. These springs advantageously have the general shape of a V, as can be seen in FIG. 3 and 4. Each slide is carried by at least two springs R which insure at the same time its resilient application against the wall 1 so as to apply the latter against the inner face *a* of the tank C over a height *mn* (FIGS. 1 and 2). The slides P are identical to each other and constructed of prefabricated elements. Each slide consists of the combination of a rigid reinforcement, a resilient buffer and means for securing it to the springs R.

The rigid reinforcement comprises: a shoe 10 which has a C-shaped axial radial section as shown in FIGS. 1 and 2, whereas in plan it has an arcuate shape corresponding to the radius of curvature of the inner face *a* of the tank; an upper bowed element constituted by two angle-irons 11, 12; and a lower bowed element constituted by one angle-iron 13.

The two upper angle irons are interconnected by screws 14 and they clamp therebetween the upper portion of the shoe 10 and the peripheral portion 7 of the flexible wall 1, whereas an annular region of this wall is secured under the lower bowed element 13 and the lower portion of the shoe 10 by means of a strip 15 composed of a material similar to that of the wall 1. This region and this strip are interconnected by vulcanization and the strip 15 extends upwardly alongside the angle-

iron 13 and is connected to the latter by bolts 16. The entire lower portion of the wall 1 between the central attachment and the strip 15 remains free to apply itself exactly against the liquid L so as to prevent any emanation of gas from the liquid and therefore any formation of gas pockets above this liquid.

The slide reinforcement is stiffened by as many vertical strips 17 as there are springs R per slide, namely two in the presently-described embodiment, each of these strips which constitutes a bracing element being rigidly secured to the angle-irons 11 and 13.

The reinforcement just described carries on its shoe 10 a resilient buffer 18 constituting a cushion between the rigid wall 10 and the flexible wall 1 so as to apply the latter in a hermetic manner, but without danger of damage, against the face *a* of the tank C, irrespective of the local defects in the shape of the latter.

This buffer 18 is preferably composed of a cellular plastic material, that is, an expanded material, for example of plastified and stabilized polyvinyl chloride, expanded polyurethane or any other like material.

The means for securing each slide P to the two springs R comprise, in respect of each spring, a horizontal rod 19 carried by the corresponding vertical strip 17, on each side of which latter the rod 19 extends to an extent sufficient to extend through two horizontal slots 20 each of which is formed in one of the two branches of the spring R. Consequently, these branches can move relative to the rod 19 in the course of displacements of the floating roof P relative to the tank.

Secured on each side of the strip 17 on this rod 19 are two spacer members 21 which are chamfered at 22 at their ends remote from the strip 17, these chamfers being convergent in the direction of the roof T and each making an angle *x* with the corresponding branch of the spring R for the mean position of elastic deformation of the latter shown in full line in FIG. 3.

It is clear that beyond this mean position of the spring, the latter can be flattened until it reaches the position R^1 shown in dot-dash line after having resiliently bent throughout the length of each of its branches *pq*. Beyond the position R^1, the useful bendable length of each branch is limited to the portion rq_1 of the branch between the roof and the end *r* of the chamfer 22. Conversely, the spring is capable of normally springing back to the position R^2 shown in dot-dash line, in which each branch of the spring abuts at *s* against the other end of the chamfer 22.

It will be observed that abutments 23 for maintaining the rod 19 in position are secured, for example, by pins 24 extending through the ends of the rod 19.

The reservoir is completed by an annular hood, such as 25, of sheet metal which rests on the top *d* of the roof T, the seal between this hood 25 and the upper portion of the wall of the tank C being insured by an auxiliary sealing means J_1. This sealing means comprises an annular tubular support 26 provided with fins 27 for securing it to the hood 25 and two connecting rods 28 which are rigidly secured to the support 26 by welding or otherwise and are pivotally mounted at their lower ends at 29 on the upper portions of the bracing strips 17.

Secured to the support 26 is a rubbing sealing element 30 and, disposed between the portion of the element in contact with the inner face *a* of the tank and the support 26, is a resilient cushion 31 for example composed of one of the materials suggested for the buffer cushion 18 of each slide.

The operation of the assembly just described will be obvious. The springs R tend to maintain the roof T in a concentric position relative to the tank C in bearing through the medium of their branches against the corresponding shoe 10 of the reinforcement of each slide P, which latter in turn applies, through the medium of the buffer 18, the corresponding outer peripheral portion of the wall 1 against the inner face *a* of the tank C to the vertical extent *mn*.

If for any reason the roof T moves radially relative to the tank C, for example toward the latter on one side of the roof and away from the tank C an equal distance on the other side, at least one of the springs R is compressed whereas the diametrally opposed spring or springs expand. The two springs are deformed throughout the length of their branches until one spring reaches the position shown at R^1 and the other spring simultaneously reaches the position shown at R^2 (FIG. 3).

That one of the springs which assumes the position R^2 cannot continue to expand since its branches abut at *s* against the chamfer 22 of the corresponding spacer members 21, whereas the diametrally opposed spring, which is compressd until it reaches the position R^1, can continue to be compressed, but as its branches only bend in the shortened lengths rq_1 thereof this spring has now only a reduced flexibility.

Briefly, the spacer members 21 provided on the support devices of the slides do not modify the action of the springs so long as the roof T remains more or less centered inside the tank C, whereas they restrict the possibilities of a large movement of the roof, on the one hand, in stiffening the spring which works under compression (position R^1) and, on the other hand, in eliminating the extension force of the diametrally opposed spring which is rendered inoperative (position R^2) owing to its contact at *s* with the corresponding spacer members 21.

The advantages of the construction according to the invention have been more or less mentioned in the preamble. They will now be repeated for the sake of clarity.

The seal obtained due to the sealing means J is complete throughout the periphery of the roof owing to the continuity of the wall 1, notwithstanding the gaps *i* between the slides.

This seal is perfect owing to the large area of contact, to the vertical extent *mn*, between the wall 1 and the face *a* of the tank; to the flexible nature of this wall 1; and to the presence of the resilient cushion 18 interposed between the rigid reinforcement of each slide and the wall 1.

The height *mn* of the contact between the wall 1 and the inner face *a* of the tank C remains constant irrespective of the extent to which the roof floating in the tank becomes eccentric to the latter, so that the action of the sealing means is strictly permanent.

The wall 1 is in contact throughout its lower face with the liquid and absolutely no gas pocket below the sealing means can form.

The independence of the prefabricated slides, on the one hand permits perfectly adapting the wall of the sealing means against the tank despite local defects or an ovalisation of the whole of the tank, and this permits employing the sealing means according to the invention in reservoirs which were not previously designed to be equipped with a floating roof, and, on the other hand, leaves the metal parts free to expand and permits a simplified assembly of the elements.

The combined action of the flexible wall 1 and the cushions 18 permits avoiding the use of the solid and/or liquid filler materials with their associated disadvantages.

All the component parts of the sealing means remain visible after installation and may therefore be inspected during service.

All the joints and assemblies are located above the float plane and are accessible from above.

The floating wall 1 could be, if desired, replaced without need to drain the reservoir of its contents.

The non-abrasive nature of the wall 1 in contact with the inner face *a* of the tank allows this face to be protected by a coat of paint.

The suspension device for the slides permits maintain-

ing the joint means in a horizontal plane and obtaining an automatic centering of the roof.

Although specific embodiments of the invention have been described, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a liquid reservoir having a tank and a floating roof forming an annular space therebetween and the tank: sealing means comprising a flexible, fluidtight and annnular wall which has an inner edge secured to the roof and an outer peripheral portion extending alongside and in contact with the inner face of the tank, slides which are independent of one another and bear against the peripheral portion of the annular wall, springs interposed between the slides and the roof for resiliently biasing the slides against the annular wall so that the wall resiliently bears against the inner face of the tank, the slide comprising a rigid reinforcement having an upper bowed element, a lower bowed element, a sheet metal slide body interconnecting the bowed elements and constituting a shoe, two vertical strips bracing the bowed elements, horizontal rods respectively carried by the strips and vertically resting against the springs so as to support the slides on the roof, and a resilient buffer interposed between the peripheral portion of the wall and the rigid reinforcements.

2. In a liquid reservoir having a tank and a floating roof forming an annular space therebetween and the tank: sealing means comprising a flexible, fluidtight and annular wall which has an inner edge secured to the roof and an outer peripheral portion extending alongside and in contact with the inner face of the tank, slides which are independent of one another and bear against the peripheral portion of the annular wall, springs interposed between the slides and the roof for resiliently biasing the slides against the annular wall so that the wall resiliently bears against the inner face of the tank, the slide comprising a rigid reinforcement having an upper bowed element, a lower bowed element, a sheet metal slide body interconnecting the bowed elements and constituting a shoe, two vertical strips bracing the bowed elements, horizontal rods respectively carried by the strips and vertically resting against the springs so as to support the slides on the roof, and a resilient buffer interposed between the peripheral portion of the wall and the rigid reinforcements, each spring being a substantially V-shaped leaf spring secured to the roof and including two flexible branches provided with two horizontal elongated openings in which the corresponding rod freely extends.

3. In a liquid reservoir having a tank and a floating roof forming an annular space therebetween and the tank: sealing means comprising a flexible, fluidtight and annular wall which has an inner edge secured to the roof and an outer peripheral portion extending alongside and in contact with the inner face of the tank, slides which are independent of one another and bear against the peripheral portion of the annular wall, springs interposed between the slides and the roof for resiliently biasing the slides against the annular wall so that the wall resiliently bears against the inner face of the tank, the slide comprising a rigid reinforcement having an upper bowed element, a lower bowed element, a sheet metal slide body interconnecting the bowed elements and constituting a shoe, two vertical strips bracing the bowed elements, horizontal rods respectively carried by the strips and vertically resting against the springs so as to support the slides on the roof, and a resilient buffer interposed between the peripheral portion of the wall and the rigid reinforcements, each spring being a substantially V-shaped leaf spring secured to the roof and including two flexible branches provided with two horizontal elongated openings in which the corresponding rod freely extends, the rod having in respect of each branch of the spring an oblique abutment which cooperates with the branch and limits the deformation of the branch when the spring is compressed and also limits the deformation of the branch when the spring extends.

4. In a liquid reservoir having a tank and a floating roof, an annular space being provided between the tank and roof: sealing means comprising a flexible, fluidtight and annular wall which has an inner edge secured to the roof and an outer peripheral portion extending alongside and in contact with the inner face of the tank, slides which are independent of one another and bear against the peripheral portion of the annular wall, springs interposed between the slides and the roof for resiliently biasing the slides against the annular wall so that the wall resiliently bears against the inner face of the tank, the sealing means further comprising an annular protecting hood structure located above the annular space and supported on the roof so as to be transversely slidable thereover, an auxiliary annular sealing element provided on the outer periphery of the hood structure and in rubbing contact with the inner face of the tank, and rods pivotally mounted in the slides and connected to the hood structure so that the hood structure is retained in position on the roof and participates in the movements of the roof and slides relative to the tank.

5. Sealing means as claimed in claim 4, further comprising an elastically yieldable material acting as buffer cushion interposed between the sealing element and the hood structure.

6. In a liquid reservoir having a vertical axis, a cylindrical tank wall and a cylindrical floating roof, an annular space being provided between the tank wall and the roof: sealing means comprising in combination a pliant, fluidtight annular continuous wall having an inner peripheral marginal portion and a vertically extending annular portion in contact with the inner face of the tank wall, a circumferentially extending row of substantially rigid radially movable pressing elements in spaced relation to the roof, a cushioning layer of an elastomer interposed between the pliant wall and the pressing elements, the pressing elements extending vertically a sufficient distance to exert outward radial pressure on the entire vertical extent of the annular portion of the pliant wall, each pressing element being circumferentially spaced from the adjacent pressing elements a very small distance which is just sufficient to allow the pressing elements freedom of radial movement in operation of the sealing means, means for supporting the pressing elements between the tank and roof, springs interposed between the pressing elements and the roof for resiliently biasing the pressing elements against the layer of elastomer and the annular portion of the wall and urging the annular portion in close sealing contact with the cylindrical tank wall, the inner marginal portion being secured to the roof in a fluidtight manner and the annular portion of the wall being supported by the pressing elements, the resistance to deformation of the annular portion of the pliant wall and the elastomer layer being less than the resistance to radial deformation of said circumferentially extending row of pressing elements, whereby the roof is held in a central position in the tank notwithstanding possible large-scale deformation of the latter, whereas the weak resistance to deformation of the annular portion of the pliant wall and the elastomer layer enables the annular portion of the pliant wall to snugly and sealingly fit against the tank wall notwithstanding relatively small-scale irregularities in the surface of the tank wall.

7. In a liquid reservoir having a vertical axis, a cylindrical tank wall and a cylindrical floating roof, an annular space being provided between the tank wall and the roof: sealing means comprising in combination a pliant, fluidtight annular continuous wall having an inner peripheral marginal portion, an outer peripheral marginal portion, and an intermediate vertically extending annular portion in contact with the inner face of the tank wall, a circum-

ferentially extending row of substantially rigid radially movable pressing elements in spaced relation to the roof and exerting an outward pressure against the whole of the periphery of the intermediate portion except in regions corresponding to very small clearances between successive pressing elements in said rows, said clearances being just sufficient to allow the pressing elements freedom of movement radially of the reservoir in operation of the sealing means, means for supporting the pressing elements on the roof, springs interposed between the pressing elements and the roof for resiliently biasing the pressing elements in the direction of the intermediate annular portion of the pliant wall so as to apply the intermediate portion resiliently and sealingly against the tank wall: a layer of radially resiliently compressible material interposed between the pliant wall and the pressing elements and constituting a cushion for applying the pliant wall hermetically against the inner face of the tank wall notwithstanding possible localized irregularities in said inner face, the inner marginal portion of the wall being secured to the roof in a fluidtight manner and the outer marginal portion of the pliant wall being secured to the pressing elements, whereby inspection of the sealing means during operation of the latter is possible through the space between the pressing elements and the roof.

8. Sealing means as claimed in claim 7, wherein the material of the pliant wall is an elastomer and the compressible material is a cellular material.

References Cited by the Examiner

UNITED STATES PATENTS

1,514,116	11/24	Wiggins	220—26
2,523,292	9/50	Goldsby et al.	220—26
2,740,549	4/56	Graham et al.	220—26
3,043,468	7/59	Horner	220—26
3,059,805	10/62	Joor	220—26

FOREIGN PATENTS

1,196,283	5/59	France.

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