March 2, 1948. F. L. PLUMMER 2,437,125

FLOATING ROOF FOR TANKS

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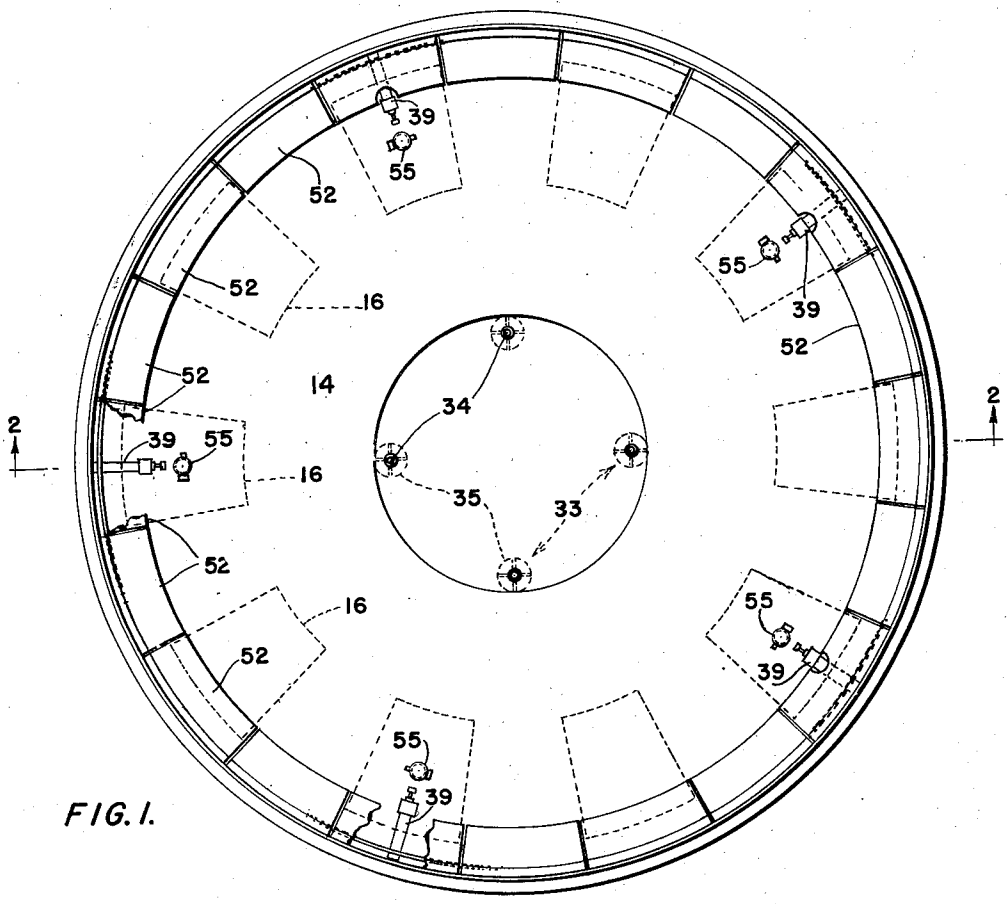


FIG. 1.

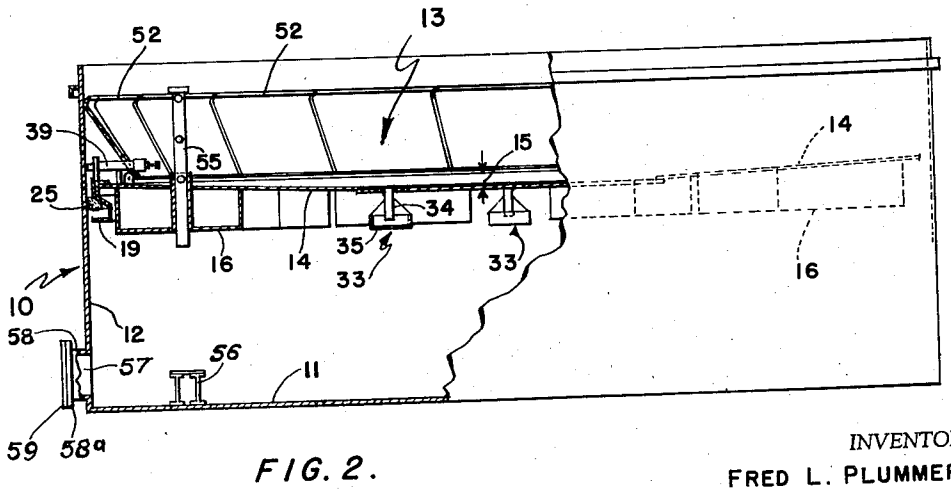


FIG. 2.

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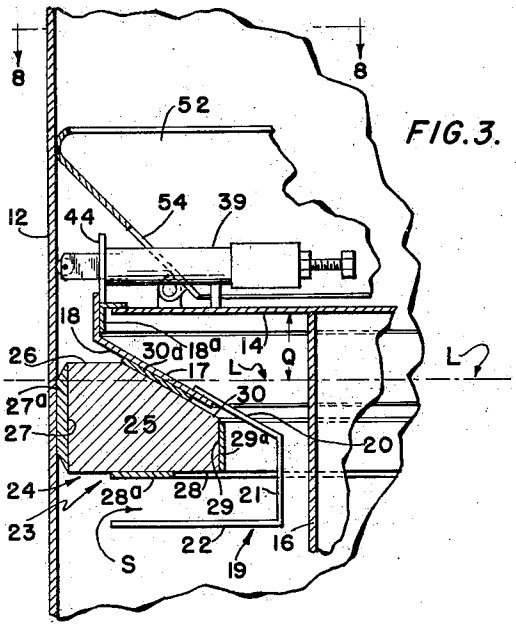


FIG. 3.

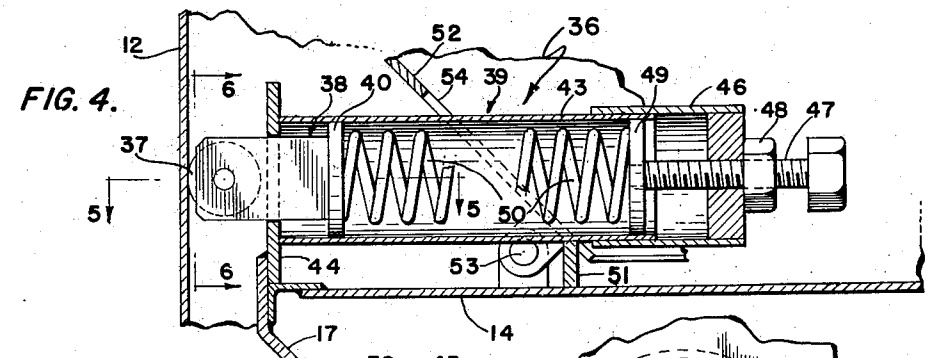


FIG. 4.

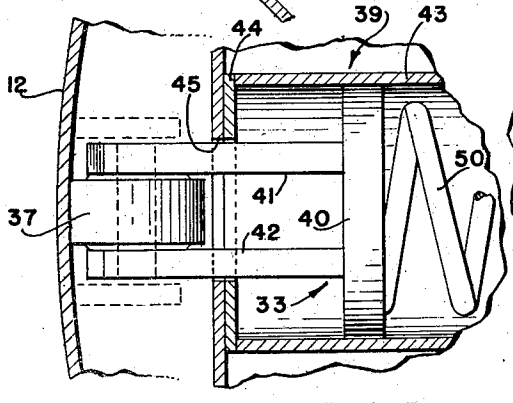


FIG. 5.

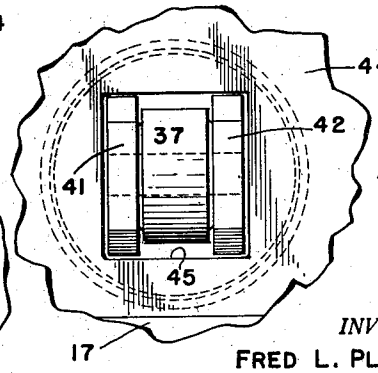


FIG. 6.

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FIG. 7.

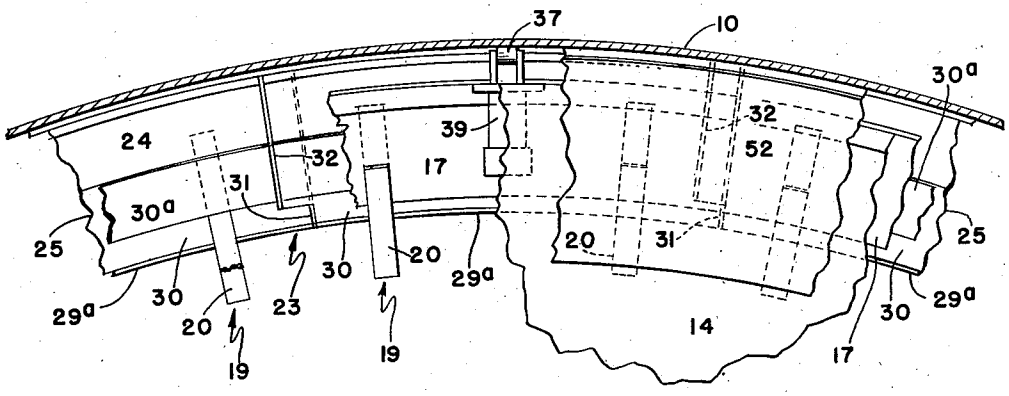
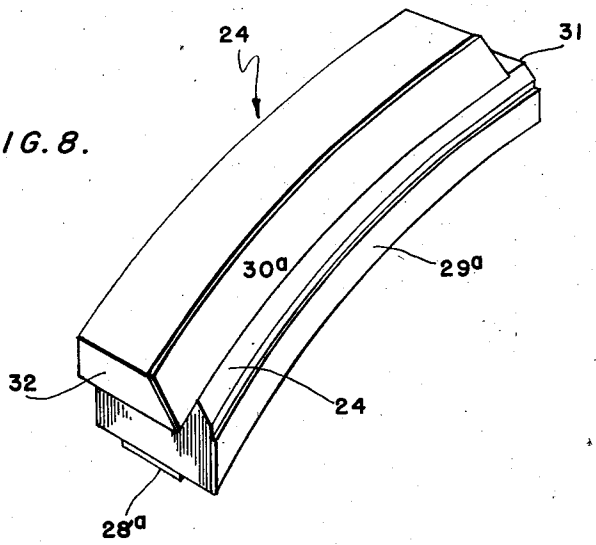


FIG. 8.



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FLOATING ROOF FOR TANKS

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Application September 9, 1944, Serial No. 553,348

2 Claims. (Cl. 220—26)

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This invention relates to storage tanks for liquids, for example oil storage tanks, requiring a roof, or top, or cover structure capable of moving piston-like up or down within the tank in accordance with changes of volume of the tank content and having sealing relationship with the tank wall.

More particularly, this invention relates to improvements in tanks having a pontoon-supported roof structure adapted normally to float upon the liquid in the tank by reason of the buoyancy of the pontoon bodies which are connected with or constitute part of the roof structure. The improvements according to this invention lie mainly in the provision of novel means for sealing the roof structure during its up and down movement against the inner side of the tank wall, although accessory features are also included in an example of the invention. Therefore, it is among the objects of this invention to provide sealing means which are non-binding and yet effective, which are adapted to compensate for structural inaccuracies of the roof structure relative to the tank, and which are of great durability.

These objects are attained by providing sealing means in the form of a ring-like structure which may be roughly likened to a piston ring in that it may expand in establishing sealing relationship between the tank wall and the roof structure. The ring-like structure is loosely confined in an annular space provided by and between the inner face of the tank wall and the roof structure. The ring-like structure is expansible by reason of being subdivided into sector-like blocks which will herein be termed the sealing blocks. The blocks are of buoyant material and normally sufficiently immersed in the liquid in the tank and otherwise so disposed relative to associated structure that buoyancy urges them upwardly and outwardly into sealing engagement with both the tank wall and the roof structure. The deformation thus attainable of the ring structure as a whole helps to maintain an effective seal without imposing undue friction or wear and tear upon the sliding members.

According to one feature the sealing blocks or component members of the sealing ring join or engage one another loosely butt-wise by way of an overlap allowing for a degree of individual and substantially horizontal compensatory motion of each block. The overlap functions to prevent any appreciable escape of the gas or vapor from the tank.

According to another feature the sealing blocks

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or members have sealing contact with an inverted conical portion unitary with the roof structure, whereby buoyancy is caused to urge the blocks outwardly into sealing contact with the tank wall.

According to another feature, the sealing blocks are of a high buoyancy material provided with wearing strips which present sealing faces for sliding contact with the inverted conical face of the roof structure and the inner face of the tank respectively.

According to another feature, the sealing blocks comprise a high buoyancy material having air bubbles occluded in it, such as foam glass. More specifically, a block of such buoyant material is provided with wearing strips. This material may be physically defined as a highly buoyant glass material deriving its buoyancy from innumerable shut-in minute air bubbles constituting a rigidified foam-like mass.

The best embodiment now known to me is illustrated in the accompanying drawings, but their showing and the description thereof should be taken as illustrative and not restrictive for, obviously, the invention lends itself to other embodiments and manifestations, as well as to modified details of construction.

In the drawings: Fig. 1 is a plan view upon the tank and the roof structure thereof. Fig. 2 is a part-sectional side view of Fig. 1 showing the roof construction including the arrangement of the sealing means and the resiliently yielding guide rollers. Fig. 3 is an enlarged detail view taken from Fig. 2 showing particularly and more clearly the sealing means and the guide roller arrangement. Figs. 4, 5 and 6 are further enlarged detail views showing structural details of the guide roller mounting. Fig. 7 is an enlarged plan view of a marginal portion of the tank shown in Fig. 1 with parts broken away to show the disposition of the sealing blocks, and Fig. 8 is a detail view in perspective of an individual sealing block.

There is herein shown an oil storage tank 10 of round shape, having a bottom 11 and a cylindrical wall 12. The roof structure 13 is movable up and down within the tank and comprises a horizontal cover portion or plate 14 shown to be formed with a shallow central depression 15. Fixed to the underside of the cover plate 14 are pontoon bodies 16 by virtue of which the cover plate 14 may float upon the liquid in the tank. Extending fixedly along the margin of cover plate 14 is a depending annular plate or skirt portion 17 presenting outwardly an inverted

frusto-conical face 18. The skirt portion 17 is shown to be fixed or welded to the cover plate 14 through an annular member 18a of angular profile. Further down from the frusto-conical skirt portion 17 extend strips 19 of flat stock bent to form an inclined portion 20, a vertical portion 21 and the horizontal portion 22. The strips together with the skirt portion 17 and the tank wall define an annular space or cage "S" within which are loosely confined sealing means or a sectionalized sealing ring 23 presently to be described.

The sectionalized sealing ring 23 comprises or is composed of individual sector blocks 24 herein also called the sealing blocks. These blocks are shown to comprise mainly a body 25 of highly buoyant material, for example, a material in the nature of foam glass which derives its high buoyancy from the many air spaces or bubbles occluded in it. In the example shown the body 25 has a top face 26, an outer vertical face 27, a horizontal bottom face 28, a vertical inner face 29, and a frusto-conical face 30 which corresponds to or is complementary to the frusto-conical face 18 of the skirt portion 17. The faces 27, 28, 29 and 30 are protected by wearing strips 27a, 28a, 29a and 30a nailed or otherwise suitably fastened to the body 25.

The blocks 24 join one another endwise in loose fashion by way of an overlapping engagement or overlap which is more clearly recognizable from Figs. 7 and 8; that is to say, each block 24 is shaped at one end with a lower overlap portion 31 and at the other end with an upper overlap portion 32, the one being in fact complementary to the other.

The sealing blocks 24 must be sufficiently immersed in the liquid in the tank so that buoyancy will produce adequate sealing pressure between the sealing faces of the blocks and the corresponding faces of the roof structure and of the tank wall respectively. The degree of immersion is indicated in Fig. 3 by the dot-and-dash line L designating the level of the liquid in the tank. Between the level L and the cover plate 14 is a space Q which may be occupied by vapors forming due to the vaporizing of the liquid or of volatile constituents thereof such as the volatile constituents in oil that may be stored in the tank.

Liquid-sealed venting devices 33 are shown to be provided upon and fixed to the underside of the cover plate 14, which devices also function as syphon drains for rain water collecting on the roof, in the depression 15 thereof. A device 33 comprises a depending pipe 34 and a sealing tray or pan or open container 35 surrounding the lower end portion of the vent pipe 34 and having fixed relationship thereto. These devices 33 of which four are herein shown, are shown to be disposed at the lowest point of the shallow depression 15 of the cover plate 14. The pipe 34 and pan 35 are filled with water which may stand at an elevation of say five or six inches below the cover plate 14 since the liquid or oil stored in the tank has a lower specific gravity than the collected water. Thus when rain water falls on the roof 13 it flows to the low spots, that is to the devices 33 and then through the pipe 34 to the pan 35 and over the edges of the pan through the body of oil in the tank to the bottom of the tank whence it can be drained off or removed in some suitable manner. The device 33 prevents the evaporation of the lighter than water liquid from the tank since the area of the pan 35 presenting a water

well for the pipe 34 is sufficiently large so that water can evaporate from the pipe over a considerable period without any of the storage liquid such as oil from the tank entering the pipe; in other words, the water in the pan thus acts as a seal against the oil rising into the pipe 34. The device 33 also has the advantage that the water in the pipe 34 stands several inches below the level of the roof plate 15, and, therefore, will not flow out onto the roof if for any reason such as additional weight on the roof, the roof with its pontoons should ride deeper in the stored liquid in the tank.

The roof structure is substantially centered relative to the surrounding tank wall by means of guide roller units 36. As shown in Figs. 3, 4, 5 and 6, such a guide roller unit comprises a guide roller 37 engaging the tank wall 12 and mounted for rotation about a horizontal axis on a plunger member 38 which in turn is horizontally slidable in a cylindrical member or housing 39 extending horizontally and radially with respect to the tank wall. The plunger member 38 consists of a plunger head or plate 40 and a pair of parallel arms 41 and 42 extending from the plunger head 40 and carrying between them the guide roller 37. The housing 39 comprises a cylindrical body portion 43, and a front end plate 44 having a square opening 45 bearing such relationship to the arms 41 and 42 as to prevent undesired rotation of the plunger member 38.

The rear end of the cylindrical body portion 43 is closed by a screw cap member 46 into which is threaded a screw bolt 47 secured in an adjusted position by a lock nut 48. Within the cylindrical housing 39 to screw bolt 47 engages a plate 49, the position of which can be adjusted by the adjustment of the screw bolt 47. A compression coil spring 50 is provided within the housing 39 and confined between the adjustable plate 49 and the plate 40 of the plunger member 38. The housing 39 is fixed to the cover plate 14 as indicated by the front end plate 44 as well as a supporting brace portion 51 being welded to the cover plate 14.

In order to protect the sealing means against the weather, that is from immediate contact with snow and rain, there are provided shielding members 52 which are pivoted as at 53 upon the cover plate 14. Openings 54 are provided in some of the shielding members to accommodate the guide roller units 36.

Vertically adjustable brace members 55 are shown to penetrate some of the pontoon bodies 16, allowing the roof structure to be stopped at a lower limit of its downward movement, as the free lower end of the brace members 55 engage and come to rest upon corresponding abutments 56 rising from the bottom of the tank. When the tank top is thus resting upon supporting members 56 after the liquid has been drained from the tank the sealing members 25 will no longer be supported by a buoyant force due to the absence of the liquid. They will however be positioned so as to enable them to resume their sealing relationship with the adjoining structural parts due to the fact that they will not drop to the bottom of the tank but will be intercepted by and rest upon the lower free end portion 22 or on the strips 19. These strips 19 in effect form a cage surrounding the inner and bottom portions of the sealing elements constituting the sealing ring. Near the bottom the tank wall is shown to be provided with an opening 57 for access, comprising a short neck 58 having a

flange 58a closed by a removable plate 59.

I claim:

1. A circular storage tank for holding a body of liquid, provided with a pontoon-supported roof structure adapted to float on the liquid in the tank at substantially the liquid-level in the tank and vertically movable as that liquid-level fluctuates, an inverted conical skirt portion fixed to the roof and lying between the pontoons of the roof and the tank wall while extending from above the tank's liquid-level to below that level, spring pressed means for centering the roof in the tank, a freely floating sectionalized ring unconnected to either tank or roof and greater in width than the distance between the roof top and the tank wall so that the roof and ring are in overlapping relationship with the top of the ring being below the top of the roof whereby the ring has the sole function of sealing the space between tank wall and roof when there is liquid in the tank; said ring comprising buoyant sector blocks adapted to engage one another endwise to provide for substantially horizontal compensatory play therebetween, each block having an inner face complementary to the outer conical face of the skirt portion and having an outer face complementary to the wall of the tank, a representative specimen of said block being of a highly buoyant glass material deriving its buoyancy from innumerable shut-in minute air-bubbles constituting a rigidified foamlike mass which is non-absorbent, non-corroding, non-puncturable, chemically inert, and non-sinkable, as well as impervious to liquid and gas, such block being urged upwardly by vertical buoyant force of such magnitude as to insure lateral force components to exert a desired degree of self-sufficient sealing pressure with respect to said skirt portion and the tank wall respectively, and wearing strips on the blocks to engage slidably the respective complementary faces of the skirt and the tank wall.

2. A circular storage tank for holding a body of liquid, a pontoon-supported roof structure therefor adapted to float on the liquid in the tank at substantially the liquid-level thereof and vertically movable as that liquid-level fluctuates, an inverted conical skirt portion fixed to the roof and lying between the pontoons of the roof and the tank wall while extending from above the tank's liquid-level to below that level, spring-pressed means for centering the roof in the tank, a freely floating sectionalized ring unconnected to either tank or roof and greater in width than the distance between the roof top and the tank wall so that the tank and ring are in overlapping relationship with the top of the ring being below the top of the roof whereby the ring has the sole function of sealing the space between tank wall and roof when there is liquid in the tank, supports extending upwardly from the tank bottom for supporting the roof above the tank bottom when there is insufficient liquid in the tank to float the roof, and means depending from the skirt portion forming collectively a cage about the ring the lower free extremity of which cage extending outwardly underneath the ring provides a limit defining a lower non-sealing position of the ring when the roof rests on said supports.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,445,092	Kueffer	Feb. 13, 1923
1,650,340	Glass	Nov. 22, 1927
1,673,984	Kuhl	June 19, 1928
1,712,321	Afonin	May 7, 1929
1,825,639	Shanor	Sept. 29, 1931
1,861,868	Larson	June 7, 1932
1,989,624	Matter	Jan. 29, 1935
1,990,627	Wiggins	Feb. 12, 1935
2,006,505	Lentschewsky	July 2, 1935
2,036,372	Stough	Apr. 7, 1936

FOREIGN PATENTS

Number	Country	Date
291,618	England	June 7, 1928
607,596	Germany	Jan. 3, 1935

OTHER REFERENCES

"Foamglass"—Advertising leaflet published by Pittsburgh Corning Corp., May 1942. (Copy available in Div. 5).