Aug. 20, 1957 R. S. EDENS 2,803,371

FLOATING ROOF SEAL CONSTRUCTION

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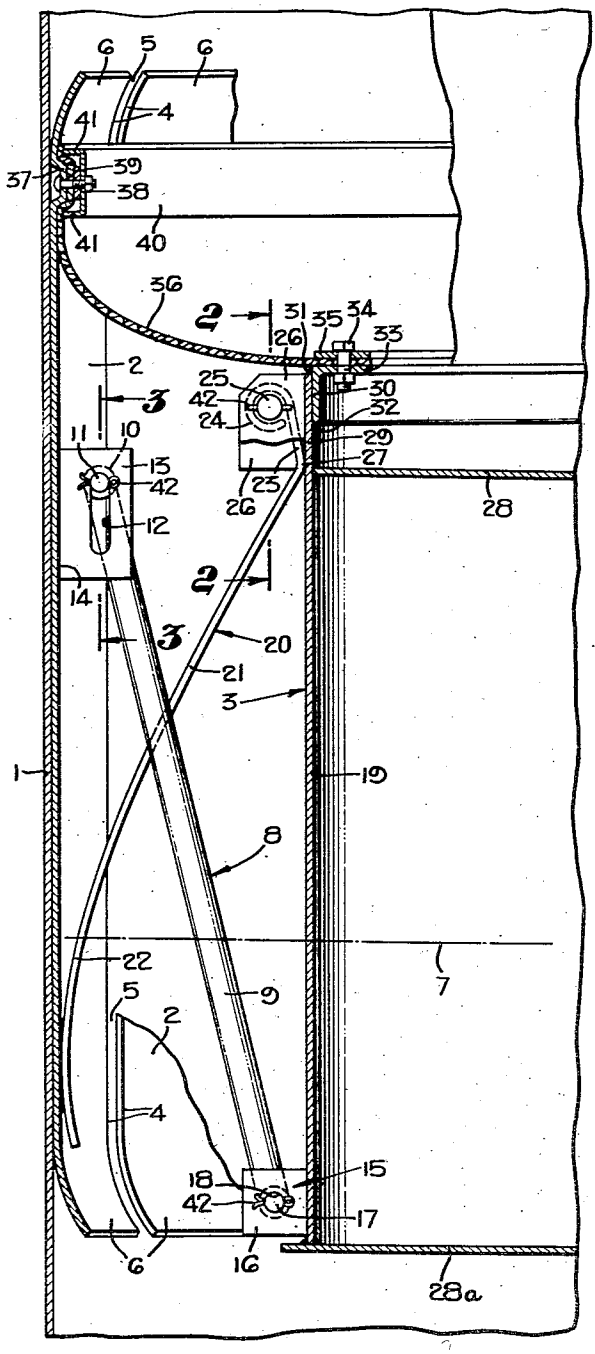


FIG. 1.

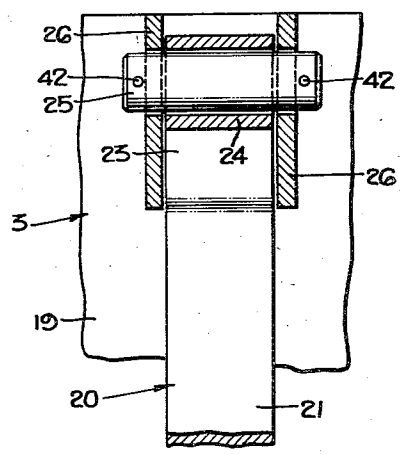


FIG. 2.

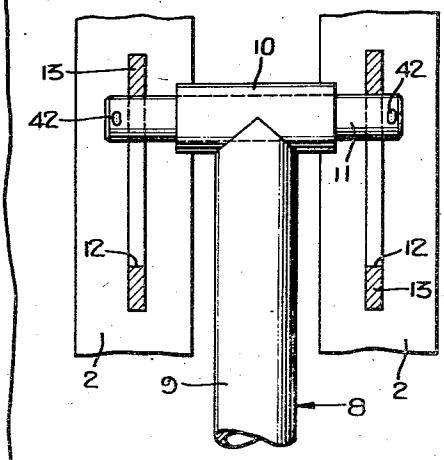


FIG. 3.

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FLOATING ROOF SEAL CONSTRUCTION

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6 Claims. (Cl. 220—26)

This invention relates to tanks for containing volatile liquids such as gasoline or other volatile liquids. Such tanks are usually of large diameter and many of them are provided with floating roofs usually of somewhat smaller diameter than the inside diameter of the tank. The tanks are practically always cylindrical in form, and are built of plate steel.

In order to prevent escape of volatile vapors from the contained liquid, it is the usual practice to provide means for sealing the annular space between the side of the floating roof and the tank wall. As the liquid level in such a tank varies, problems are encountered in maintaining this seal referred to, intact, and heretofore it has been the custom to employ shoes of arcuate plate form that are held pressed against the inner face of the tank and connected with the floating roof, so that these shoes will rise and fall as the roof rises and falls with the changes in the liquid level.

One of the objects of this invention is to provide simple means for maintaining the floating roof substantially centered on the axis of the tank, and for returning the same to true position in case it is moved to the side by strong winds or by movements due to earthquakes, in case such tanks are in use in countries subject to earthquakes.

While it is necessary to impart any considerable rise or fall of floating roofs to the shoes, it is not essential to impart such movements on very slight up or down movements of the floating roof.

In other words, if there were a positive connection between a floating roof and the shoes very slight up or down movement of the roof would be imparted to the shoes, and these movements would probably increase the wear and tear on the shoes and on the sealing flexible diaphragm that is generally employed to supplement the considerable sealing effect that results from the use of the shoes referred to, which are disposed with their side edges near together around the inner face of the wall of the tank.

Another object of this invention is to provide simple means for establishing a lost-motion connection between the shoes and the floating roof which will enable the shoes to move with the roof when the roof is under considerable movement, but which will absorb or dissipate short movements that are insignificant, but which would increase the wear on the shoes if they were obliged to move with the roof at all times.

This invention particularly concerns the construction and use of loaded springs mounted between the floating roof and the side of the tank for maintaining the roof in its centered position, and also for establishing a lost-motion between the roof and the shoes.

Another object of the invention is to provide connection from the roof to the shoes which will prevent their upper edges from moving radially outwardly beyond the upper edge of the tank in case the roof rises to an unusually high level.

Further objects of the invention will appear from a careful reading of this specification and a study of the accompanying drawing.

The invention consists in the novel parts and combinations of parts to be described hereinafter, all of which contribute to produce an efficient floating roof seal construction.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

In the drawing:

Figure 1 is a vertical section taken on a substantially radial plane from the axis of the tank and taken adjacent to the location of one of the preloaded springs that keep the roof centered and also adjacent to one of the connections for causing the shoes to ride up or down with any considerable movement of the floating roof as the liquid level changes. This view is a fragmentary view showing only a short portion of the tank wall in vertical section and showing only the edge portion of the floating roof.

Figure 2 is a vertical section taken about on the line 2—2 of Figure 1, further illustrating the preferred detail of the mounting for one of the preloaded springs.

Figure 3 is a vertical section taken about on the line 3—3 of Figure 1 showing the detail of a preferred lost-motion connection. This view, like Figure 2, is upon an enlarged scale.

Referring particularly to Figure 1, 1 indicates a portion of the wall of a cylindrical tank, such as is usually employed as a container for a volatile liquid.

In applying the invention to such a tank a plurality of shoes 2 are provided that are disposed around the interior of the tank, and held pressed against the wall thereof. These shoes are composed of any suitable metal and are of arcuate form in horizontal sections on the same radius as the inner surface of the tank wall so that they conform closely to the same, thereby enabling them to function throughout their cross-sections as seals for preventing the vapors from the liquid in the tank from ascending past the floating roof 3.

These shoes are located rather close together at their side edges 4 at which gaps such as the gap 5 occur throughout the circumference of the roof. At the upper and lower edges the shoes are preferably bent to provide them with curved arcuate tips 6.

In order to connect these shoes to the floating roof so as to enable them to rise and fall with changes in the liquid level within the tank, which may be located at any point such as indicated by the line 7, I provide means preferably including one or more strut links 8 corresponding to each shoe. This connecting means preferably includes a lost motion connection which functions in such a way that it will not impart every small up and down movement of the roof to the shoes, but if a considerable movement in either direction occurs, such a movement will be imparted to the shoes. In order to accomplish this I prefer to mount the strut links so that they are disposed in a vertical plane that extends substantially radially from the axis of the roof and tank which, of course, substantially coincide with each other.

In providing this last named connection, it should be understood that it can be associated with these strut links in any way. In the present instance, the bodies 9 of the strut links may be formed of a length of pipe, the upper end of which may be provided with a cross-T or sleeve 10 carrying a through pin 11 the ends of which extend through a pair of slots 12 which are formed in a vertical plane in two fins 13 of plate form that may be welded at their inner ends 14 to the inner face of the shoe.

At the lower end a connection 15 can be made which includes the use of two parallel fins 16 similar to the fins

13, with the exception that in this case the slots are omitted, and each connection includes a cross pin 17 capable of oscillating slightly in eyes or openings 18 fitting to the diameter of the cross pins.

Between the side wall 19 and the floating roof at each shoe I prefer to provide loaded spring means that exerts yielding pressure in an outward direction against the inner face of the shoes to maintain them closely against the wall of the tank. In addition to this function this means can be applied to maintain the floating roof centered on the axis of the tank. In order to assure this, these springs should not have too liberal a tolerance as regards the force they are capable of exerting against the shoes, so that when the floating roof is in a center position all of the loaded springs will be exerting substantially the same pressure upon the shoes.

In the present instance, the loaded springs I employ preferably consist of flat leaf springs 20 composed of a good quality of steel, and these springs are preferably mounted on the roof as indicated in Figures 1 and 2. It will be evident that each leaf spring has a relatively long body 21, the upper portion of which is disposed in a substantially straight line inclining downwardly and outwardly toward the location of the shoes, and the lower portion of each spring merges into the curved or arcuate extension 22, the outer face of which maintains a condition of tangency on the inner face of its corresponding shoe. At its upper end the body 21 of each spring is bent to form a relatively short shank 23, the tip of which is secured to the side wall of the roof 3 by being bent in the form of a tube or eye 24 to receive a cross pin 25, which pin is supported between two fins 26 that may be welded to the outer face of the side wall 19 of the floating roof. In other words, at the junction between the shank 23 and body 21*a* bend or knee 27 is formed which is pressed by the resiliency of the loaded spring against the outer face of the side wall 19 of the floating roof.

At the level of this knee 27, I prefer to locate the upper head or deck 28 of the floating roof beyond which the side wall 19 of the roof extends up to form a coaming 29. This deck 28 is, of course, welded at this edge to the side wall 19 and if desired, may be reinforced by radial angle iron or other strongback structure, in case the plating at 28 is relatively thin, and the floating roof of relatively large diameter.

I prefer to employ at least two loaded springs to correspond to each shoe. Of course, this would depend upon the width of the shoes, and in tanks of relatively small diameter it might be possible to use only one spring if a relatively great number of shoes were employed; but for best efficiency, at least two shoes are recommended, using more if the width of the shoes is unusually great.

In order to complete the sealing of the annular space or gap between the side wall of the floating roof and the side of the tank it is preferable to provide a continuous steel angle "iron" 30, the vertical web of which may be attached by welding as at 31 and 32 to the inner face of the side wall 19. The flange 33 of this angle is punched to receive bolts 34 to attach a follower ring 35 to clamp down on the inner edge of an annular flexible diaphragm 36, composed of any suitable material made, of course, impervious to the action of a volatile liquid that is contained in the tank.

In order to establish this very effective seal to the upper portions of the shoes I provide an inward offset 37 extending transversely on each shoe and all the way across it. The bottom of this gutter or offset is punched to receive clamping bolts 38 which clamp on a clamping ring 39 that is drawn forcibly against the upper edge of the fabric of the diaphragm. Preferably, this assembly at this gutter is completely enclosed in a continuous casing 40 of channel form, also held in position by the nuts of the bolts, so that the edges of the flanges 41 are pressed against the surface of the diaphragm at each side of the channel or gutter 37.

All of the pins 11, 17, and 25 are provided with split pins 42 to prevent them from working loose.

Many other embodiments of this invention may be resorted to without departing from the spirit of the invention.

I claim as my invention and desire to secure by Letters Patent:

1. In a seal hanger construction for a floating roof in a tank having a substantially cylindrical upright wall, for containing a volatile liquid or the like, the combination of a floating roof within the tank, to float on the liquid, and to rise and fall with changes of the liquid level, a plurality of arcuate sheet metal shoes disposed around the inner face of the tank wall and conforming to the wall so as to cooperate with a flexible diaphragm to seal the tank against evaporation of liquid from the tank, means including at least two strut members corresponding to each of said shoes, each of said strut members being independent of any other, said strut-members extending in an inclined direction upwardly and outwardly between the side of the corresponding shoe, a pivotal connection for the lower end of each strut member including a pair of spaced brackets attached to the side of the roof with a pivot pin carried there by and passing through the lower end of the strut member; a lost-motion connection at the upper end of each strut-member including a pair of spaced plates secured to the shoe, projecting toward the roof and having parallel slots extending substantially vertically in the same, with a transverse pin carried by the upper end of the strut member with its ends running in said slots, and permitting a limited up-and-down movement of the roof independently of the shoe, a plurality of leaf springs corresponding to said shoes, bracket means for each spring including two spaced plates projecting from the side of said roof with a pin attached to the same, each spring having an eye at its upper end carried on its corresponding pin, said spring having a shank extending toward the side of the roof with a knuckle connecting to the body of the spring and pressing forcibly against the side of the roof, said spring having a straight extension from the shank with an arcuate extension with its convex side riding on and pressing by its own resilience and its cooperation with said knuckle, to maintain the spring in a loaded state, all of said leaf springs cooperating to maintain the roof centered in the tank.

2. A seal hanger construction for a floating roof according to claim 2 in which the said spaced slotted plates are welded at their outer edges to the faces of the shoes.

3. A seal hanger construction for a floating roof according to claim 2 in which the strut-member is of tubular form, and the said eye is of sleeve form.

4. In a roof hanger construction for a circular floating roof floatable on a liquid in spaced relation to a vertical cylindrical wall of a tank, a flexible diaphragm sealing means sealing the space between the circular roof and vertical cylindrical wall preventing the escape of fluid therebetween, a plurality of circumferentially spaced arcuate hanger shoes slidably engaging the cylindrical wall of the tank, annular means connecting the diaphragm to the hanger shoes adjacent the cylindrical wall and for retaining the hanger shoes thereagainst, said roof hanger construction including rigid means providing a lost motion connection between the floating roof and the hanger shoes and resilient means for centering the floating roof relative to the cylindrical wall of the tank, said rigid means including a plurality of unitary strut link members, at least one strut-link member for each hanger shoe, said strut-link members lying in radial planes relative to the vertical axis of the floating roof and extending upwardly and outwardly therefrom, upper and lower support means for each strut-link member, said support means supporting each strut-link member only at each respective end, each of said lower support means comprising a pivot means pivotally mounting the respective lower ends of the strut-link members to the floating roof, each of the

upper support means comprising a pin and slot connection slidably mounting the respective upper end of the strut-link members to the respective hanger shoes, whereby slight rising and falling movement of the floating roof in relation to the vertical cylindrical wall of the tank may occur without sliding said hanger shoes, said resilient means comprising a plurality of leaf springs, at least one for each hanger shoe, for centering the floating roof and for pressing the hanger shoes against the cylindrical wall of the tank, each of said leaf springs being pivoted at their upper ends on the floating roof and being outwardly and downwardly included with respect to said vertical axis, into contact with a lower portion of the respective hanger shoe, each leaf spring having an inwardly bent knee below the respective pivotal connection, said knee engaging the floating roof and loading the spring to exert yielding pressure against the lower portion of the respective hanger shoe.

5. In a seal hanger construction for a circular floating roof carried on a liquid in a tank having a cylindrical wall, said roof rising and falling with the level of the liquid and having a plurality of hanger shoes of arcuate form to slide up and down on the inner face of the tank wall, the combination of a plurality of leaf springs disposed between the periphery of the roof and the side wall of the tank, each of said springs having a substantially straight body portion extending downwardly and outwardly into engagement with a hanger shoe and each spring having an integral shank at its upper end projecting upwardly and outwardly at an angle so as to form a knee resting against the periphery of the roof, and pivotal means securing the end of said shank to the periphery of the roof, and the engagement of said knees with the periphery of the roof placing said springs in a loaded state and maintaining the roof centered in the tank; a plurality of single strut-link members disposed in pairs corresponding to each of the arcuate shoes, each of said strut-link members having a pivoted connection to the periphery of the roof at their lower ends and extending upwardly and outwardly toward the shoes and each having lost-motion connection respectively at the upper end thereof to the inner face of the respective shoe.

6. In a seal hanger construction for a floating roof in a tank having a substantially cylindrical upright wall, for containing a volatile liquid or the like, and a circular floating roof within the tank spaced from the cylindrical wall, to float on the liquid, and to rise and fall with changes of the liquid level, a plurality of arcuate hanger shoes disposed around the inner face of the tank wall conforming to and slidably engaging the wall, an annular flexible diaphragm having its outer periphery connected to the hanger shoes and its inner periphery connected to the roof to seal the tank against evaporation of liquid therefrom; the improvement comprising at least two unitary strut-link members corresponding to each of said shoes, each of said strut-link members being independent of any other, said strut-link members extending in an inclined direction upwardly and outwardly between the roof and the corresponding hanger shoe, a pivotal connection for the lower end of each strut member including a pair of spaced brackets attached to the roof with a pivot pin carried thereby and passing through the lower end of the strut member; a lost motion connection between the upper end of each strut-member and the corresponding hanger shoe including a pair of spaced plates secured to the hanger shoe, projecting toward the roof and having parallel slots extending substantially vertically therein, a transverse pin carried by the upper end of the strut member having its ends running in said slots, and permitting a limited up-and-down movement of the roof independently of the hanger shoe, a plurality of leaf springs, at least one for each of said hanger shoes, bracket means for each spring including two spaced plates projecting from the periphery of said roof, a pin attached to said plates, each spring having an eye at its upper end carried on its corresponding pin, said spring having a crank shank extending toward the periphery of the roof with a knee connecting to the body of the spring and pressing forcibly against the periphery of the roof, said spring having a substantially straight portion extending downwardly and outwardly from the shank with an arcuate portion at its lower end having the convex side thereof riding on and pressing against the corresponding hanger shoe, the pressure of the knee against the periphery of the roof maintaining the spring in a loaded state, said springs maintaining the roof centered in the tank.

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