March 19, 1968 J. V. KIDD 3,373,891

SEAL FOR FLOATING TANK ROOF

Filed April 6, 1965

Fig. 3

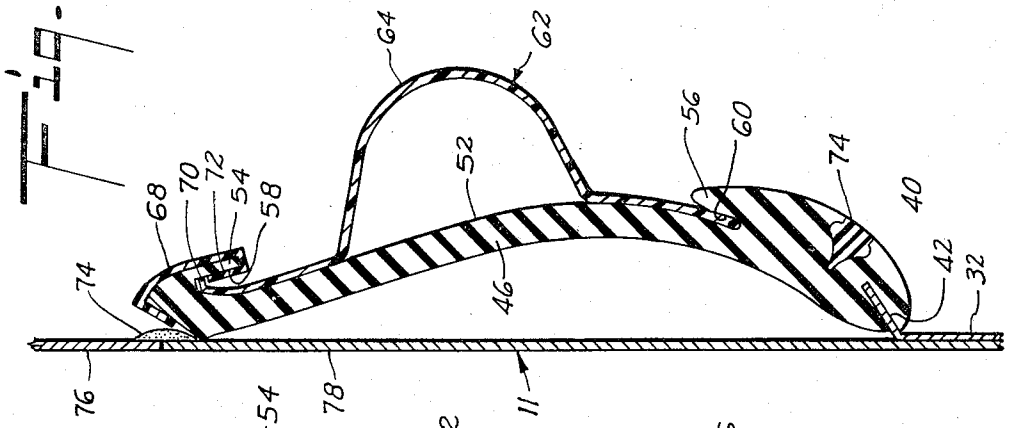


Fig. 2

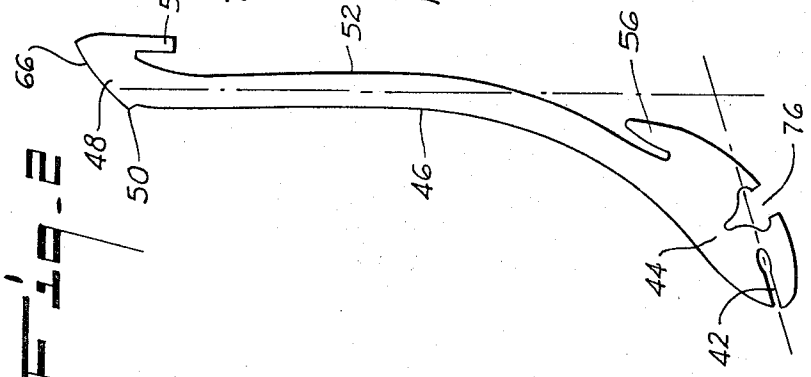
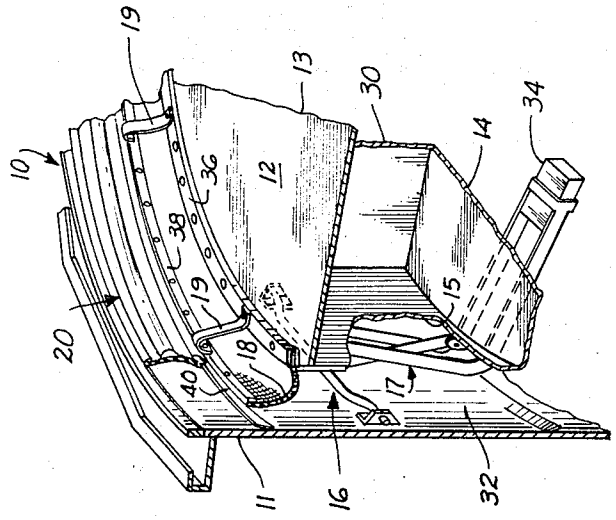


Fig. 1



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SEAL FOR FLOATING TANK ROOF

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ABSTRACT OF THE DISCLOSURE

A secondary seal connecting a floating roof of a storage vessel to the wall of the storage vessel. The seal is arcuately configured and has a stiffening member positioned thereon. A sleeve is provided on the upper surface of the seal adjacent the sealing lip, the sleeve being less resilient and of a lower coefficient of friction than the sealing lip.

This invention relates to storage tanks, such as for oil and oil products and the like, of the type having a floating roof or covering that floats on the liquid stored in the tank so that it rises and falls with the liquid level, and more particularly it relates to improved means for providing a seal between the periphery of the roof and the inside wall of the tank in which the roof is used.

In tanks of this type a problem is encountered in providing and maintaining an effective seal between the edge of the floating roof and the wall of the tank. Necessarily, the roof is spaced inwardly of the wall of the tank so as to leave an annular space therebetween. It has previously been the practice to provide guide shoes which are attached to the roof and which are resiliently biased against the wall of the tank, and which include a flexible primary seal member extending from the guide shoe to the tank to provide means for preventing foreign material from falling through the annular space into the oil or oil products stored below the roof. For example, one such structure is as shown in U.S. Patent No. 2,478,422. To further insure against leakage, a secondary seal of resilient material such as rubber extending between the guide shoe and the wall of the tank is sometimes used. Examples of such secondary seals as previously used are shown, for example, in the following United States Patents: 2,459,178, Moyer; 2,873,042, Fino; 2,973,113, Fino; 3,106,309, Nelson et al.; 3,106,310, Scherer; 3,167,206, Nelson.

Difficulties have arisen in the use of such tank seals which are the result of rough spots on the inside wall of the tanks. Such rough spots may be caused by rust or other corrosion, or may be due to the horizontal welds between the plates from which the tanks are fabricated. The difficulty is that when the sealing edge of the tank seal encounters such a rough spot during upward movement of the roof in the tank, the sealing edge tends to catch on the rough spot and turn under so as to destroy the seal between the roof and the tank wall, and injure the secondary seal. In addition, where stiffeners are used, as shown in the aforesaid Patent No. 3,167,206, such turning under of the sealing lip of the seal member causes the stiffeners to slip out of the grooves in which the stiffeners are fitted.

According to the present invention, means are provided to prevent the sealing lip of the seal member from catching on the tank wall when it encounters a rough spot to the extent that the seal member is bent downwardly. In a preferred embodiment of the invention this is accomplished by providing a substantially harder surface just above and radially inwardly from the sealing surface of the seal member. Such a harder surface has a lower coefficient of friction with the tank wall and therefore slides more easily on it. This harder surface is positioned so that when the seal member starts to bend downwardly due to engagement with a rough spot on the wall of the tank,

the harder surface will contact the rough spot and will slide upwardly on it. Thus the relatively softer sealing lip is not permanently caught on the rough spot on the tank wall. Furthermore, when a stiffening element is used, the seal member is not allowed to bend downwardly enough to cause the stiffening element to slip out of the seal member. In addition, in another embodiment of the invention means are provided for locking one edge of the stiffening element so as to reduce the possibility that it will slip out of engagement with the seal member.

For a better understanding of the invention and of the functions and objectives obtained by it, reference is now made to the following description and to the accompanying drawing, wherein:

FIGURE 1 is a perspective view of a cross-section of a floating roof tank showing one embodiment of the seal of this invention;

FIGURE 2 is a cross-sectional view of one embodiment of the principal element of the seal member of this invention; and

FIGURE 3 is a partial cross-sectional view of the embodiment of the seal member of this invention shown in FIGURES 1 and 2, here shown in operative position,

Referring to the drawing, part of a cylindrical, open-end storage tank, indicated generally at **10**, is shown, including the upstanding side wall **11** and the floating pontoon type cover, or roof **12**. The floating roof **12** comprises the top deck **13**, the bottom deck **14** interconnected by the rim plate **15**, and bulkheads, one of which is shown at **30**.

In the embodiment showing in the drawing, a primary seal for the tank is indicated generally at **16**, and comprises a number of shoes such as indicated at **32**, each of which is supported by and interconnected with the floating roof by means of the hangar structure indicated generally at **17**. By an appropriate balance of the hangar **34**, the shoes of the primary seal are held in contact with the inner surface of the tank side wall as the floating roof rises and falls in accordance with changes in the amount of the liquid stored in the tank.

To close the annular space between the floating roof and the shoes of the primary seal, a continuous flexible seal **18**, made of fabric for example, is fastened to the roof and to the primary seal at **36** and **38**, respectively, by means of backing strips and bolts. Conventional grounding straps between the floating roof and the primary seal are indicated at **19**. Seals and interconnections between each of the shoes are in a manner well known in the art and are not described here.

With respect to the edge structure of each of the shoes of the primary seal, there is disclosed at **40** an inwardly turned edge or flange portion angled approximately at 45° and usually around one-half inch in extent. On this inwardly turned flange portion, or break, a secondary seal **20** is positioned, the seal having a slot or recess **42** (see FIGS. 2 and 3) for fitting over the break in the shoe for support thereby.

Referring in detail to FIGURE 2, there is shown a cross-section of a preferred embodiment of the resilient secondary seal of this invention. Preferably the seal is made of a flexible, resilient plastic material, for example synthetic rubber, resistant to hydrocarbon attack and tendency to set. In the embodiment shown, the seal member comprises a relatively thickened lower annular portion **44** which is adapted to fixedly engage the edge or finge **40** which slips intot the recess **42**.

The seal member may be attached to the break by any convenient means. In the drawing the seal member is shown as being secured to the break by means of a rubber insert member **74** which fits within a groove **76** to force the walls of the recess **42** into secure engagement

with the break. If desired, a cement may be used to further insure securing the seal member.

It will be apparent that the seal member of this invenextends all the way around the circumference of the tank roof so that each of the areas of the tank seal constitute annular areas. Extending upwardly and outwardly from the lower annular portion is a relatively thinned flexible intermediate annular portion **46** which terminates in a relatively thickened upper annular portion **48** on the upper edge of the seal member. This upper annular portion is provided with a sealing surface or sealing lip **50** which is adapted to sealingly engage the inner wall of the tank. The sealing lip **50** is shown as having a relatively sharp contact edge, but other configurations can be used for this portion to compensate for wear and to insure sufficient pressure against the inner tank wall surface to provide a good seal.

On the radially inner surface **52** of the intermediate portion **46** there are provided tongue-like members **54** and **56** projecting toward each other to define grooves **58** and **60** which face each other. These grooves are provided to receive the edges of an annular resilient stiffening member **62**, which extends between the lower relatively thickened annular portion of the seal member and the upper annular portion of the seal member. The width of the stiffener is preferably slightly greater than the distance between the bottoms of the facing grooves **58** and **60**. As shown in the drawing, in a preferred embodiment the stiffener is made with a corrugation **64** in the middle. This form, combined with the fact that the stiffener is preferably made of a relatively rigid material such as light sheet metal or a hard rubber or plastic material, results in a spring-like construction which exerts a force against the bottoms of the facing grooves **58** and **60** so as to provide pressure to insure a more positive contact with the inner wall surface of the tank. In the preferred embodiment of the invention, the stiffening member **62** is made of as few pieces as is practicable so as to form a substantially continuous stiffening element extending all the way around the circumference of the tank roof.

The upper annular portion **48** of the seal member is preferably formed with a bevel surface **66** which extends upwardly and radially inwardly from the sealing lip **50**. In the embodiment shown in the drawing, a major portion of this bevel surface **66**, together with the tongue **54** and that part of the portion **48** therebetween, are enclosed within a sleeve-like member **68** which extends all the way around the circumference of the seal member. The member **68** is made of a relatively stiff, hard material, which may be similar to the material from which the stiffening member **62** is made, and which is substantially harder than the flexible, resilient material from which the main body member **46** of the seal member is made. Although a separate hard surface is provided on the sealing edge of the seal member in the embodiment shown in the drawing, this hard surface may also be provided by extruding a harder rubber material integrally with the main body portion of the seal member.

In the embodiment of the invention shown, the upper edge of the stiffening member **62** is provided with a lip **70** which engages itself behind the edge **72** of the member **68** which sticks into the groove **58**. Thus the edge **72** interlocks with the lip **70** to resist disengagement of the lip **70** from the groove **58** in the seal member.

It will be appreciated that the main body portion **46** of the seal member of this invention is made of a resilient, flexible material as previously described, and that it will have a hardness in the general range of about 60 to about 85 on the Durometer A scale. Variations in the hardness may be used in accordance with the requirements of various specific applications. However, the hard portion of the bevel surface extending upwardly and radially inwardly from the sealing lip must be substantially harder in order to reduce the coefficient of friction between this portion and the wall to some value substantially less than the coefficient of friction between the sealing lip and the wall surface. Thus the softer material of the sealing lip will slide up the wall relatively easily as the tank roof floats upwardly on the liquid within the tank until this sealing lip contacts a rough spot such as may be caused by a horizontal weld **74** joining two plates **76** and **78** of the tank wall **11**. Upon encountering such a roughened area, the sealing lip will tend to stick and not ride upwardly, so that as the tank cover or roof continues to rise the upper and outer edge of the tank seal will be bent downwardly, pivoting about the sealing lip **50**. This will cause the sleeve-like hard member **68** to come into contact with the weld **74** so as to pull the sealing lip out of engagement with the weld. Because of the greater hardness of the member **68** this member has a lower coefficient of friction with the weld and therefore easily slips upwardly so that the sealing lip is moved past the weld and allowed to continue its sliding movement upwardly along the inside surface of the wall. During the period during which the upper part of the seal member is being bent downwardly the upper edge of the stiffening member is not pulled out of the groove **58** because of the fact that the lip **70** is interlocked therein.

In addition to providing stiffening of the seal member so as to insure contact of the seal member with the wall of the tank, the stiffening member of this invention functions to hold the seal in a more nearly vertical position at times when the tank roof has been raised so high that the seal sticks out above the tank wall. The fact that the stiffening member is substantially continuous around the circumference of the tank roof insures that the seal member not be allowed to flop outwardly so that it possibly could become caught between the roof and the wall in a position other than the preferred position shown in the drawing.

Although preferred embodiments of the invention have been shown and described herein, other modifications and variations will be apparent to those skilled in the art and therefore the scope of the present invention is limited only as set forth by the appended claims.

I claim:

1. A secondary seal for use with a floating roof having one or more guide shoes associated therewith in an open-end tank comprising

a flexible annular seal member adapted to fixedly engage the edge of said shoes and to slidingly engage the inside wall of said tank, said seal member comprising

an enlarged lower annular portion adapted to fixedly engage the edge of said shoes,

a flexible intermediate annular portion reduced in thickness extending upwardly from said lower portion,

an enlarged annular portion on the upper edge of the intermediate portion,

a resilient sealing surface on the outer face of the upper annular portion adapted to sealingly and slidingly engage a tank wall, and

a bevel surface on said outer annular portion extending upwardly and radially inwardly from said sealing surface,

said bevel surface having greater hardness than said sealing surface.

2. A secondary seal as defined by claim **1** wherein

said portion of greater hardness is formed by a separate member fitted around the upper edge of said upper annular portion and covering a part of said bevel surface.

3. A secondary seal as defined by claim **2** and including

stiffening means extending between said lower portion and said upper portion adapted to resist bending of the intermediate portion.

4. A secondary seal as defined by claim 3 and including

means on said separate member and said stiffening means locking them together to secure said stiffening means to said seal.

5. A secondary seal as defined by claim 3 wherein said lower annular portion and said upper annular portion contain oppositely facing grooves which removably receive said stiffening member.

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