Aug. 6, 1957 R. C. ULM 2,801,763

FLOATING ROOF ARRANGEMENT

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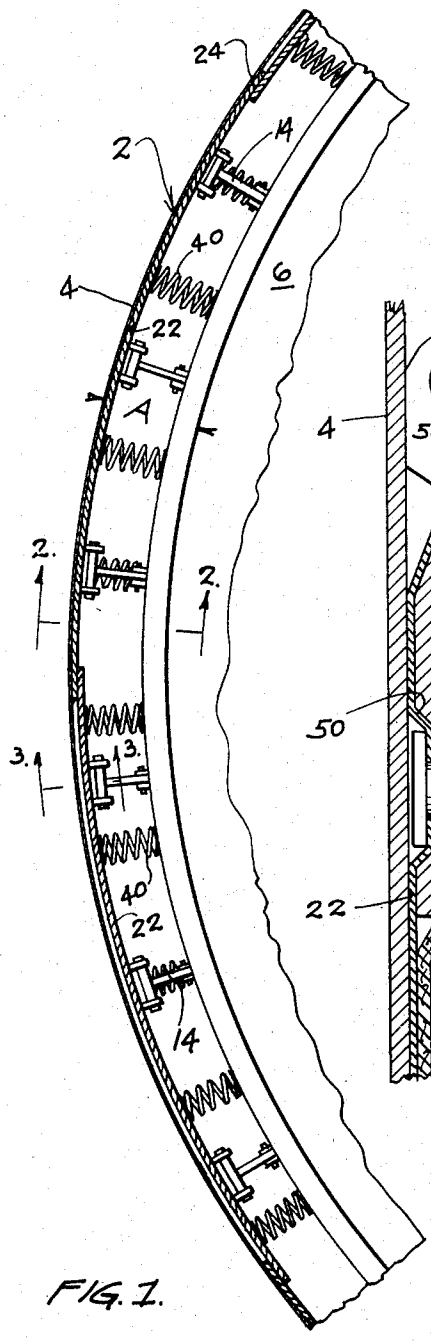


FIG. 1.

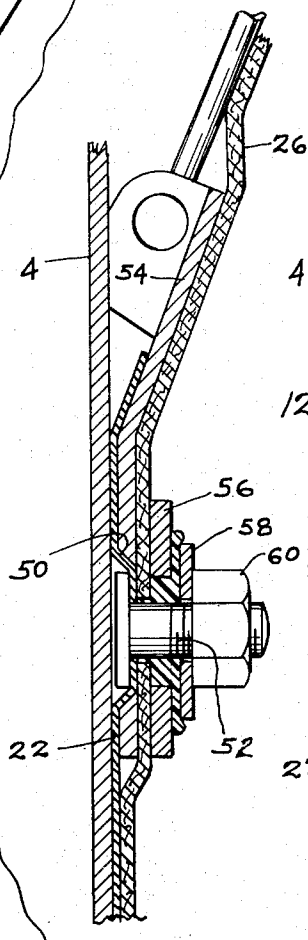


FIG. 3.

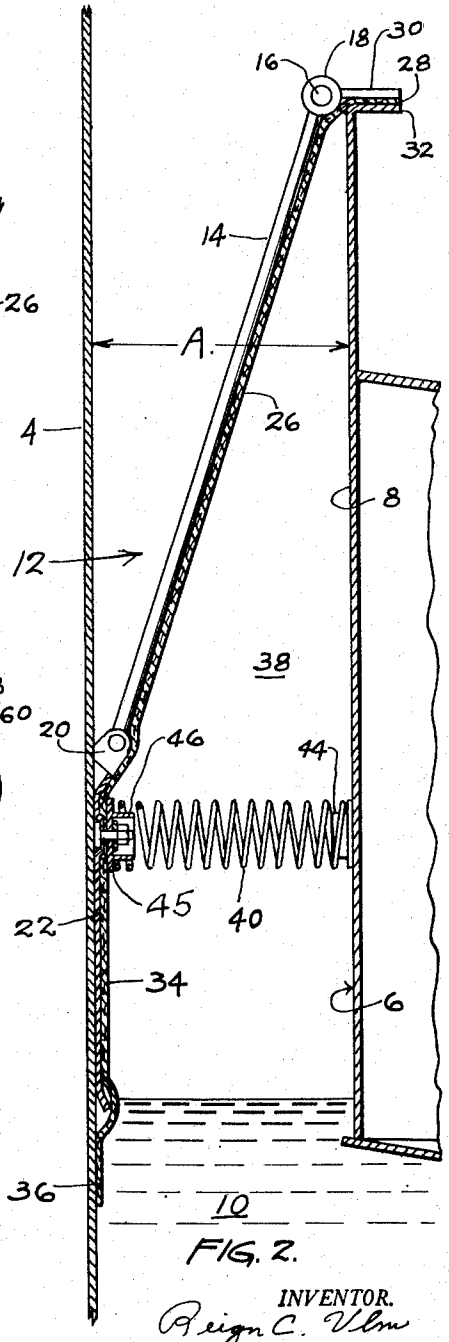


FIG. 2.

INVENTOR.
Reign C. Ulm
BY
Neil J Driscoll
ATTY.

United States Patent Office

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FLOATING ROOF ARRANGEMENT

Reign C. Ulm, Schererville, Ind., assignor to Graver Tank & Mfg. Co., Inc., East Chicago, Ind., a corporation of Delaware

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3 Claims. (Cl. 220—26)

The invention relates to liquid storage tanks and particularly to a floating roof sealing arrangement therefore.

As is well known in the art, tanks of this type embody an open top shell which may contain liquid product, said shell being substantially closed by a roof which floats on the product therein. Tanks of this nature are of relatively large diameter and it is extremely difficult to maintain perfect concentricity between the roof and the tank shell with the result that the roof must be constructed somewhat smaller than the shell to positively accommodate vertical movement of the roof in response to filling and evacuation of product from the tank. It then becomes necessary to seal the space between the edge of the roof and the adjacent tank wall and it is to this type of an arrangement that my invention is primarily directed.

It is a primary object of the invention to provide a floating roof-seal arrangement offering an improved practical vapor tight seal.

It is a further object of the invention to provide an arrangement of the type described that may be more economically produced than those used heretofore in the art, while still offering effective operation.

It is a further object of the invention to provide an arrangement of the type described that will accommodate maximum travel of the roof from the low point thereon to an upper limit where the tank approaches an overflow condition without the sealing arrangement becoming operatively disengaged from the tank, thereby increasing the effective capacity of the tank.

It is a further object of the invention to provide a seal arrangement that will offer long service life and reduce the undesirable effects of climatic action thereon.

It is yet another object of the invention to provide an effective arrangement to reduce the possibility of rim fire occurrance, and further to provide physical features which facilitate fire extinguishing in the event such fires occur.

These and other objects of the invention will become apparent in the course of the following description and examination of the concerned drawings, wherein:

Figure 1 is a top plan view of a portion of a storage tank embodying the invention, the sealing fabric being removed to more clearly show the arrangement of the parts,

Figure 2 is a sectional view taken along line 2—2 of Figure 1 showing the fabric in position, and

Figure 3 is a detailed sectional view taken along line 3—3 of Figure 1 showing the fabric in position.

Describing the invention in detail and directing attention first to Figure 1, it will be seen that the arrangement comprises a cylindrical tank **2**, said tank being formed of an upstanding shell **4** and having a floating roof **6** disposed therein. The roof **6** is so arranged in the tank that in the central position thereof a space A is provided between the outer rim **8** of the roof and the inner periphery of the shell **4**. The roof **6** may be of any conventional variety and is arranged to float in the tank upon the stored product **10**. It will be understood that the roof

will rise and fall within the tank in response to intake and evacuation of said stored product.

The space A is, of course, annularly disposed around the entire internal periphery of the tank shell, and because the tank is normally used to store volatile liquids it is desirable to seal the space A to prevent escape of an unreasonable amount of the vaporized liquid. Additionally, it is desirable to maintain the roof **6** in a central or concentrically located position within the tank both to make more effective the sealing function as well as to facilitate vertical movement of the roof. It is also well known in the art that roofs of this nature are frequently forced by wind and other action to move form one side or the other of the tank. It is, therefore, the purpose of the invention to provide a unique and economical arrangement that will both effectively seal the annular space between the roof and the tank and will act to maintain the roof centered within the tank. It will also be understood that the disclosed arrangement presents unique structural features which aid in reducing the possibility of rim fires and further provides an arrangement which accommodates quick and easy extinguishing of rim fires in the event any should occur.

Considering Figure 1, it will be noted that a peripheral ring may be formed of a plurality of shoes **22**, said shoes **22** having their ends in slight overlapping relationship as is indicated at **24**. It will be understood that in the preferred embodiment the ends of the shoes at **24** are not secured together, whereby slight relative vertical movement between adjacent shoes is accommodated. For example, as the roof **6** moves from the central position, the fixed lengths of the hangers will cause certain of the associated shoes to move vertically along the tank shell **4**, and it will be understood that the direction of vertical movement is opposite on opposite sides of the tank, namely, on the side where the roof **6** is closest to the shell the adjacent shoes tend to move downwardly and where the roof **6** is furthest from the shell, the shoes to move upwardly. The fact that the shoes are not individually secured together reduces and substantially eliminates the tendency of binding and twisting stresses to be set up in the entire seal shoe ring. It will also be understood that the novel fabric seal ararngement hereinafter described is such that the overlapping non-secured relation of the shoe itself does not diminish the effectiveness of the seal.

Considering Figure 1, it will be seen that the arrangement employs a plurality of springs **40** peripherally spaced at determined and constant center distances around the space A and is also provided with the hangers **14**, likewise spaced but preferably on greater constant center distances. The result is that there are more springs **40** peripherially disposed around the roof **6** than there are hangers **14**. In some instances a spring and hanger engage the shoe at adjacent points and in others they do not.

Each shoe **22** is preferably relatively shallow and occupies a vertical dimension considerably less than one-half the vertical dimension of the associated rim **8**. It will be understood that this construction allows the roof to be raised to a maximum vertical position within the tank, that is, approaching a point where the product will overflow the upper edge of the tank shell, without the shoe arrangement becoming unreasonably extended above the upper edge of the tank shell which would result in faulty operation. This feature accomplishes maximum tank fill. It will also be appreciated that each shoe does not extend substantially below the bottom of the roof **6** and will allow the roof to move downwardly almost to the bottom of the tank whereby a maximum amount of product can be evacuated from the tank. These features therefore have the effect of increasing the useful storage capacity of the tank.

A typical seal mechanism, indicated generally at **12**, comprises, in the preferred embodiment, a hanger **14**, said hanger **14** having its upper end pivotally connected, as at **16**, to a bar clip **18** which is firmly secured to the upper edge of the rim **8**. The hanger **14** angles downwardly and outwardly through the space A to a point whereat its lower end is pivotally connected to a clip member **20** which is secured to and extends slightly above the upper edge of the shoe **22**. As noted, the shoe **22** is comparatively shallow relative to its length, said shoe having its lower end horizontally positioned in approximate alignment with the lower edge of the rim **8** and slightly below the surface of the stored product.

It will be noted that a spring retainer boss may be securely fastened to the rim **8** and is telescoped within the adjacent end of the coiled spring **40** to position same. Another boss **46** is secured to a clip **45** which substitutes for the fabric clip **56** of Figure 3 in those instances where a hanger and spring coincide, and is telescoped within the adjacent end of the spring **40** to properly maintain the latter in operative position. Each spring **40**, of course, acts to maintain the associated shoe **22** in tight sealing abutment with the tank shell, and additionally, the plurality of springs coact to centrally position the roof **6** within the shell and return same thereto in the event of roof movement.

To effectively accomplish product sealing, a fabric element **26** may be arranged to continuously extend around the peripheral space A, said fabric **26** having its upper edge **28** tightly secured to the upper edge of the rim **8** by means of a plurality of bar clips **30** which may be continuously bolted to the flange **32** at the upper endge of the rim. Further, said fabric extends downwardly to continuously abut the inner surface of the seal ring, and additionally extends below the lower edge of the ring and into the product.

Attention is directed to Figure 3, which shows in detail a typical connection at the shoe between certain operating parts where the hanger **14** and spring **40** do not coincide. It will be seen that the shoe **22** has a bolt receiving boss **50** formed therein, said boss receiving the head of a bolt **52** which has a body extending inwardly therefrom. A hanger clip **54**, which may be pivotally secured to the hanger **14**, is provided with an aperture to surround the boss **50** and abut the inner surface of the shoe **22**. The fabric **26** is also provided with an aperture to receive the bolt **52** and is located immediately adjacent the hanger clip **54**. A fabric clip **56** is arranged to abut the inner surface of the fabric **26** and is tightly held thereagainst by means of the washer **58**, the sealing washer **57** and the nut **60** which threadably engages the end of the bolt **52**. In this manner, the fabric is held in tight sealing engagement with the inner face of the associated shoes **22**.

Further, it will be seen that the seal arrangement **12** defines a generally V-shaped trough with the associated tank shell **4**, and that said trough may serve as a receptacle for fire smothering foam or similar material in the event a rim fire occurs in the tank. It will be understood, however, that the trough considerably reduces the size of chamber **38**, thereby reducing the effective volume wherein rim fires could occur. It will be noted that the major portion of the fabric **26** projects downwardly in the space A between the roof and the tank shell whereat it is shielded by the rim **8** and shell **4** from the deteriorating effects of the sun. Further, the spring **40** is located in the chamber **38** and is effectively shielded from external climatic action thereon. Additionally, the fabric **26** is arranged to present a relatively smooth downwardly extending surface around the entire periphery of the tank whereby pockets which could collect foreign matter such as water and the like, which would tend to deteriorate and render ineffective the seal, are avoided. The fabric **26** being located entirely inwardly of the hangers **14** and the shoes **22** and having the lower end thereof in the product shields the chamber **38** from any contact with sparks which may result from the metal to metal contact between the shoe **22** and the tank shell **4**, thereby preventing any rim fire due to chance ignition by said sparks. Further, any foreign matter or the like that may collect on the inner periphery of the tank shell is precluded from collecting on the fabric **26** or the roof **6** as it will now pass downwardly between shoe **22** and into the product in the tank.

It will also be noted that the short shoe arrangement and the particular location of the spring **40** provides maximum sealing pressure at the most effective point, namely, immediately adjacent the surface of the product. Thus it will be seen that the arrangement provides an effective, efficient and economical seal for the type of tank here under consideration and additionally is operative to maintain the floating roof in a substantially central position within the tank.

The invention as disclosed is by way of illustration and not limitation and may be subject to various modifications without departing from the spirit thereof or the scope of the appended claims.

What is claimed is:

1. In a storage tank arrangement, the combination of a cylindrical product containing shell, a roof arranged to float on the product within the shell, said roof including an upstanding rim peripherally arranged thereon and in normal spaced relation with the shell, and means to seal the space between the rim and the shell comprising a ring member in substantial continuous engagement with the inner periphery of the shell, said ring member being composed of a plurality of shoes having the ends thereof in slight overlapping relationship to each other, said shoes being slightly vertically movable independently of each other, said shoes having the lower horizontal edges thereof in approximate horizontal alignment with the lower edge of the roof and having the upper horizontal edge thereof below the vertical mid-point of said rim, a plurality of straight hangers angling downwardly and outwardly between the rim and the shell, said hangers having the lower ends thereof pivotally connected to the top of the adjacent shoes and their upper ends pivotally connected to the top of the rim, a fabric member continuously connected at its upper edge to the top of the rim and angling downwardly in parallel relation to the hangers and disposed intermediate the hangers and the rim as seen in vertical sectional view, said fabric continuously abutting the shoes and continuously secured thereto, the lower edge of said fabric extending below the lower edge of the shoe and into the product, and coiled spring means compressively interposed between the rim and the respective shoes below the fabric to maintain the shoes in sealing relation with the shell and to urge the roof to a central position within the shell.

2. A storage tank arrangement according to claim 1, wherein the pivotal connection between each shoe and related hanger comprises a clip secured to the shoes and interposed between the fabric and said shoe and extending slightly above the upper edge of the shoe, and pin means interconnecting the lower end of the related hanger and the clip.

3. In a storage tank arrangement, the combination of a cylindrical product containing shell, a roof arranged to float on the product in the shell, said roof containing an upstanding rim peripherally arranged thereon and in spaced relation with the shell and means to seal the space between the rim and the shell comprising a ring member in substantially continuous engagement with the inner periphery of the shell, said ring member being composed of a plurality of shoes in end to end relationship to each other, said shoes having the lower edges thereof in approximate horizontal alignment with the lower edge of the roof and having the upper horizontal edge thereof below the vertical mid-point of said rim, a plurality of straight hangers angling downwardly and outwardly between the rim and the shell, said hangers having their lower ends pivoted to the adjacent shoes and their upper

edges pivotally connected to the top of the rim, a fabric member continuously connected at its upper edge to the top of the rim and angling downwardly in abutting relation to the hangers and intermediate the hangers and the rim as seen in vertical sectional view, said fabric being connected to and continuously abutting the inner surface of the related shoes and having the lower edge of the fabric extending below the lower edges of the shoes and into the product and a plurality of coiled springs compressively interposed between the shoes and the rim and located between the fabric and the rim.

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