Feb. 6, 1962 L. E. ANDERSON, SR 3,019,935

FLOATING SEAL FOR TANKS

Filed Sept. 1, 1959 2 Sheets-Sheet 1

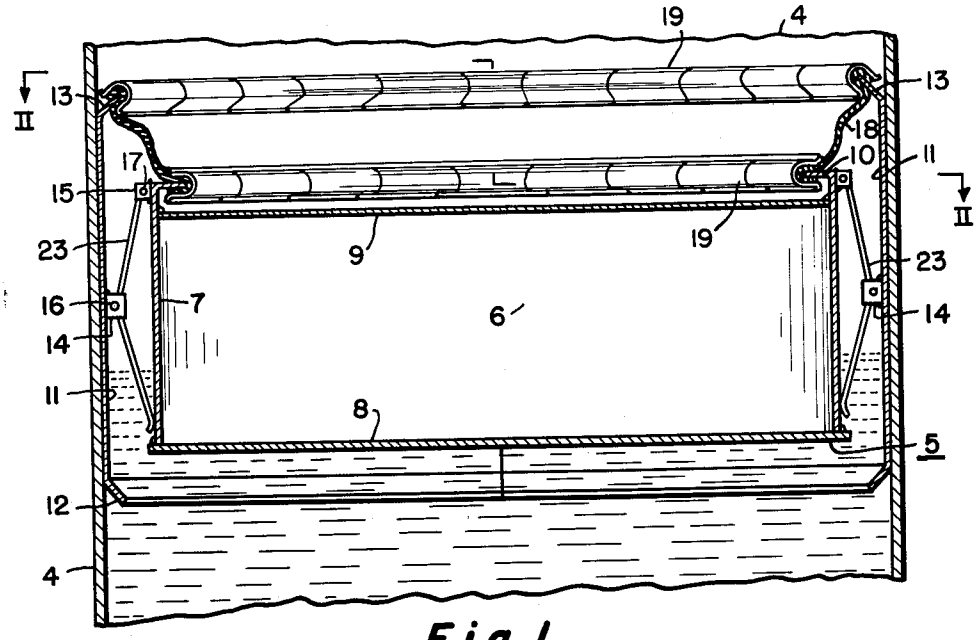


Fig. 1

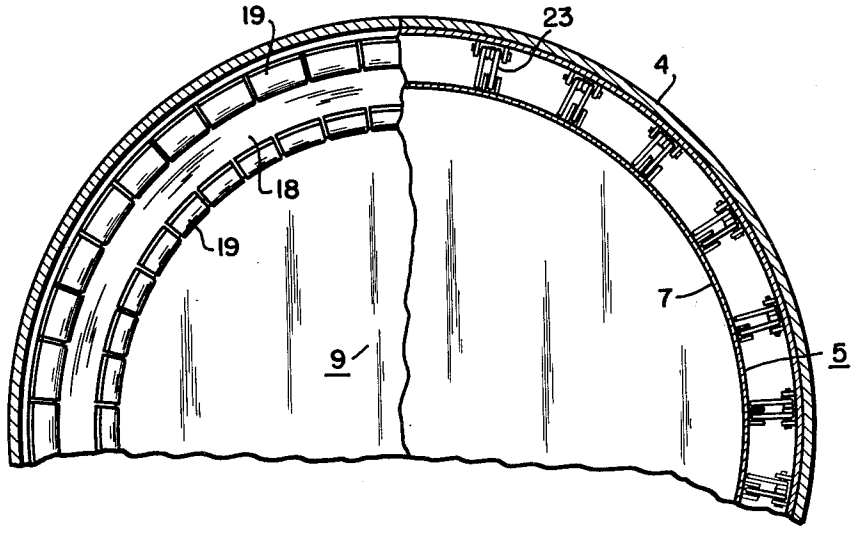


Fig. 2

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FLOATING SEAL FOR TANKS

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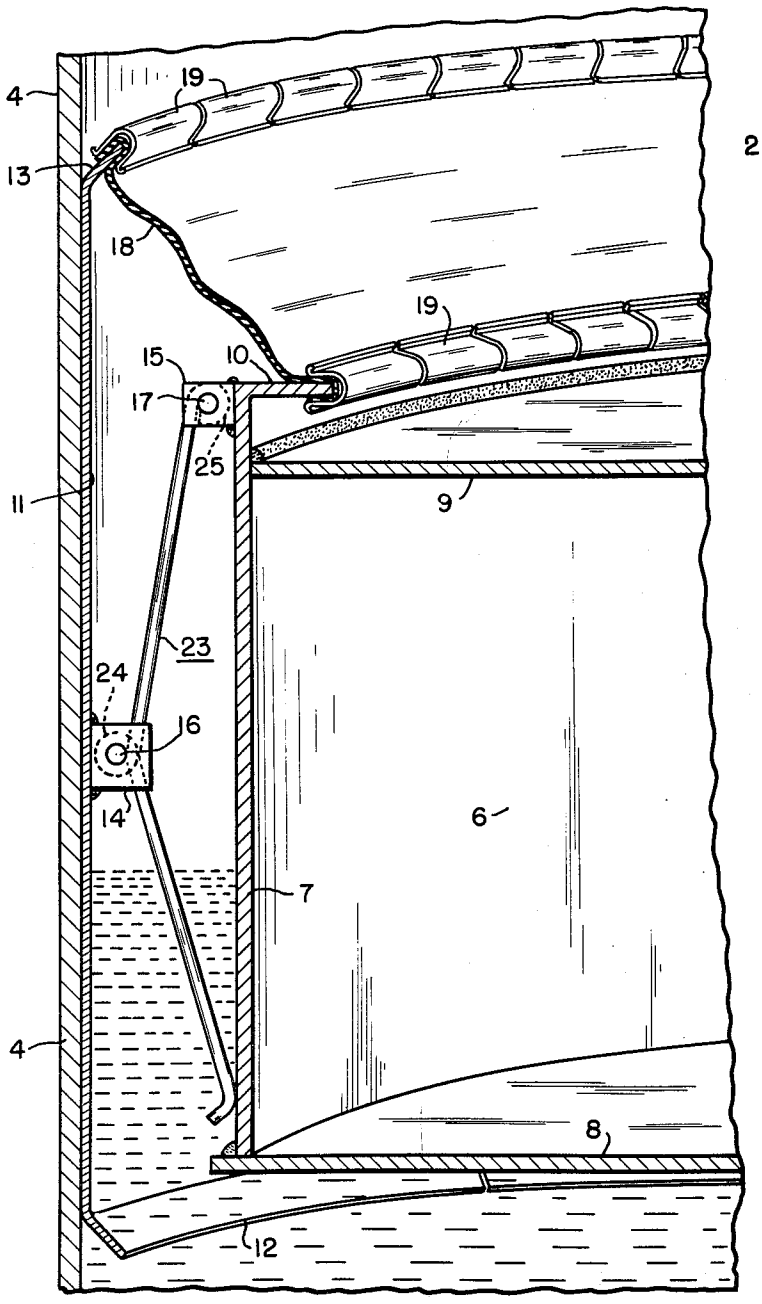


Fig. 3

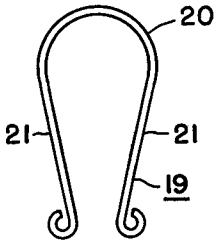


Fig. 5

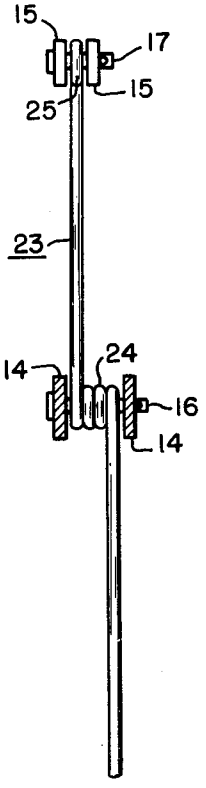


Fig. 4

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3,019,935

FLOATING SEAL FOR TANKS

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Filed Sept. 1, 1959, Ser. No. 837,407
6 Claims. (Cl. 220—26)

This invention relates generally to storage tanks for liquids and more particularly to a floating seal for such tanks which moves with variations in the position of the surface of the liquid in the tank and minimizes or prevents evaporation and contamination of that liquid.

An object of the invention is to produce an improved and highly effective sealing mechanism for storage tanks which includes as a part thereof a floating roof and means movable with the roof for sealing the surface of the liquid located between the roof and the vertical wall of the tank.

A further object is to produce an improved stay member included as a part of a sealing mechanism which performs the double function of supporting from the floating roof other structural parts of the sealing mechanism and also the function of centering the floating roof in the storage tank.

A still further object is to produce new and improved means for securing the flexible part or parts of the sealing mechanism to the floating roof and to rigid parts of the sealing mechanism, which means are highly effective in use and which are readily and easily installed.

These and other objects which will be made more apparent throughout the further description of the illustrated embodiment of my invention, are attained by means of apparatus herein described and illustrated in the accompanying drawings in which FIGURE 1 is a fragmental transverse sectional view of a storage tank equipped with a floating roof and with sealing equipment embodying my invention.

FIGURE 2 is a fragmental sectional view taken along the broken line II—II of FIGURE 1.

FIGURE 3 is a fragmental sectional view on an enlarged scale of a tank equipped with an embodiment of my invention, the view being along a vertical plane through a radius of the tank.

FIGURE 4 is a side view of a stay member constituting a detail of my invention. The view is of the same scale as that of FIGURE 3.

FIGURE 5 is a side elevation of a spring clip which forms a structural detail of the present invention.

The seal illustrated as an embodiment of my invention includes as the principal elements thereof a floating roof which moves up and down with variations in the position of the upper surface of the liquid within the tank, a plurality of shoes or formed plates which are held in yielding engagement with the inner surface of the vertical wall of the tank, and an impervious but flexible structure which encircles and is located above the space between the floating roof and the wall engaging shoes and is secured to both the roof and the shoes and moves with those elements as the surface of the liquid within the tank changes during either the delivery of liquid to, or the removal of liquid from the tank.

The vertical wall 4 of the storage tank is indicated in FIGURE 2 is a cylindrical wall. A floating roof 5 is located within the tank enclosed by the wall 4 and, as illustrated, includes a buoyancy chamber 6 which is cylindrical and of less diameter than that of the cylindrical wall 4. The chamber 6 is enclosed by a cylindrical wall 7, a circular lower wall 8, and a circular wall 9 located immediately above but spaced from the wall 8. The cylindrical wall 7 is illustrated as provided with an

L-shaped extension projecting above the wall 9 and terminating in a re-entrant annular flange 10 which, in the embodiment illustrated, extends substantially parallel to the wall 9.

The space between the wall 4 of the tank and the outer wall 7 of the floating roof is sealed by a sealing mechanism which includes the floating roof and a plurality of arc-shaped shoes or plates 11 each having a radius of curvature similar to that of the inner face of the wall 4, with the result that the convex surface of each plate 11 is adapted to fit substantially snugly against the inner face of the wall 4, when the plates are located as illustrated in FIGURES 1–3 of the drawings. The lower end of each plate 11 is shown as provided with an inwardly and downwardly turned angular flange 12 so formed that the lower face thereof extends at an acute angle to the inner face of the wall 4 of the tank. Likewise, each plate 11 is provided along its upper end with an inturned angular flange 13 which extends upwardly and is located at an obtuse angle to the concave face of the plate.

Each plate 11 is provided with a support bracket 14, shown as located between the ends and also the lateral edges of the plate. The angular extension 10 of the cylindrical wall 7 forming a part of the floating roof 5 is provided with a plurality of spaced brackets 15 secured to the outer face of the wall 7, at points adjacent to each other and opposite to the inturned flange 10. Each of the brackets 14 and 15 is approximately U-shaped with the base of the bracket secured to the supporting plate 11 or wall 7 of the chamber 6. That is to say, the base of each bracket 14 is secured to the concave face of a separate one of the plates 11 and the base of each bracket 15 is secured to the convex face of the extension of the cylindrical wall 7 of the buoyancy chamber 6 adjacent the flange 10. Each bracket 14 supports a pin 16 which extends horizontally across the bracket, with each end of the pin supported in a separate opening formed in each extending leg of the bracket. Each bracket 15 is so spaced along the cylindrical wall 7 of the chamber 6 that it is capable of cooperating with a separate one of the brackets 14 and is provided with openings formed in the separate legs thereof for supporting a separate one of the pins 17 which extends parallel to a cooperating pin 16 carried by one of the plates 11. Each pin 16 and 17 is secured to its mounting bracket by any suitable means such, for example, as nuts secured to the ends thereof, or each pin may be formed with an integral head at one end and with the other end arranged to receive a securing nut or a washer held in place on the pin by a cotter pin.

From the drawings and the foregoing description it will be apparent that the flanges 13 located at the upper ends of the plates 11, extend around the inner face of the wall 4 in a circular relationship and define an inwardly projecting circular ledge around the inner face of the wall 4. When the floating roof is in normal position within the tank this ledge extends substantially parallel to the flange 10 of the wall 7. In order to seal the space between the floating roof and the inner faces of the plates 11 a flexible fabric band 18 is employed which extends between the inner edge of the flange 10 and the inner edges of the inturned flanges 13 of the plates 11. The band 18 is treated with suitable material to render it impervious to the passage of air or other gases while at the same time retaining its flexibility.

The outer, viz., the upper peripheral edge portion of the band 18 is as shown looped around and secured to the inwardly projecting ledge formed by the flanges 13, with the edge of the band located on the upper side of each of the flanges and extending along the circular

ledge formed by the flanges. Likewise, the lower or inner edge portion of the band is shown as looped around and secured to the free edge of the flange 10 with the inner edge of the band lying against the lower face of the flange 10 and extends substantially parallel to the free edge of the flange. The steel clips 19 illustrated as the means for securing the band to the flanges 13 of the plates 11 and the flange 10 of the wall 7, constitute a part of the present invention. Each such clip 19, as shown in FIGURE 5, includes an arc-shaped base portion 20 and two legs 21 which extend from the base portion in converging relationship. The free end of each leg is curved outwardly and upwardly as the clip is shown in FIGURE 5. These clips are preferably formed of stainless steel and in different sizes. The terminal ends of the legs 21 may be located at different positions with relation to each other, i.e., closer together or further apart than the clip illustrated in FIGURE 5, since the intention is to employ the clips as clamping members for holding the loops of flexible band 18 permanently in place along the edges of rigid structures which the loops enclose.

It will be apparent that the band 18 is preferably of substantially greater width than the distance between the circular ledge formed by the flanges 13 and the edge of the flange 10 of the wall 7 of chamber 6 of the floating roof 5, when the roof is in normal position with relation to the side wall 4 of the tank. Such an arrangement permits some freedom of motion of the floating roof relatively to the flanges 13 of the plates 11.

An important feature of the present invention is that the use of the clips 19 permit the floating roof structure, including the plates 11, to be located within the tank after the wall 4 of the tank is erected. This is because the clips 19 are accessible for securing the flexible band 18 to the flange 10 of the wall 7 of the buoyant chamber 6 and also to the flange 13 of each plate 11. It is, therefore, apparent that the band 18 whether formed as an annular band or of arc-shaped pieces, may be secured to the flanges 13 of the plates 11 either before or after the plates 11 and the buoyant chamber 6 of the roof structure are located within the vertical wall 4 of the tank and either before or after that wall is completely erected.

Another feature of the invention is the formation of each of the supporting stays 23 and the means for mounting those stays on the brackets 15 and 14. Each stay is formed of round rod-shape spring steel and includes a coiled spring 24 located intermediate its ends. The upper end of each stay is bent to form a circular loop 25 (FIGS. 3 and 4) capable of receiving one of the pins 17 supported in, and secured to one of the brackets 15. The coil 24 of each stay is in fact a coil spring and is so formed that it is capable of receiving and somewhat loosely surrounding one of the pins 16 carried by and secured to each of the brackets 14. The end of each stay remote from the loop 25 is formed so that a rounded shoulder or an extended surface thereof engages the surface of the wall 7 and is capable of a sliding movement relatively thereto to permit slight variations in the relative position of the floating roof and the plates 11.

It will be apparent that the stays 23 perform the double function of supporting the shoes or plates 11 from the wall 7 of the floating roof and of acting as struts in holding the plates 11 against the inner face of the tank wall 4. The coil springs 24 are formed with the proper number of turns to develop sufficient pressure to insure good contact between the plates 11 and the engaged surface of the wall 4 but without causing excessive wear on the plates. In addition, the coil springs 24 will not only yieldingly hold the plates 11 against the wall 4 but will also yieldingly hold the floating roof substantially centrally with relation to that wall. As the springs of some of the stays are placed under tension as the space between the roof and a portion of the tank wall 4 is

decreased, the stays will develop increasing force in the effort to move the roof to a normal position centrally of the wall 4.

The portion of each stay 23 located between the loop 25 and the coil spring 24 is so positioned and attached to brackets 15 and 14 that it constitutes an effective support for one of the plates 11. As to this, it will be apparent that each bracket 15 is so spaced around the cylindrical wall 7 of the buoyance chamber 6 that it effectively cooperates with a bracket located on the concave or inner face of one of the plates 11. It will also be apparent that each plate 11 may be provided with at least two spread brackets 14, each of which is so located on its supporting plate as to cooperate with a separate one of the brackets 15 secured to the floating roof.

It is apparent that the seal as here disclosed prevents contamination of the liquid contained within the tank and also minimizes or prevents evaporation of that liquid and moves with the surface of the liquid within the storage tank and consists essentially of the floating roof 5, the plates or shoes 11, and the flexible band 18 secured to, and in place between the ledge formed by the flanges 13 and the flange 10 of the circular plates 7 of the roof structure. It will also be apparent that each shoe 11 not only moves with the floating roof 5 as the roof moves up and down within the tank due to changes in liquid level, but also because each stay 23 is in fact a spring, each shoe will move up and/or down along the inner face of the tank wall 4 as its supporting stay is flexed by the movement of the roof 5 closer to or farther from that shoe. It will also be understood that the flexible band 18 need not be made in one piece of material, i.e., it may be made up of a plurality of arc-shaped pieces with their adjacent ends overlapping and secured together by suitable means including the clips 19 employed for holding them in place on flanges 13 of the plates 11 and the flange 10 of the floating roof. It will also be apparent that various changes, modifications, additions, and omissions may be made in the apparatus illustrated without departing from the spirit and scope of the present invention as defined by the appended claims.

What I claim is:

1. In combination with a storage tank having an upright cylindrical wall surrounding the storage space of said tank, a seal for said storage space including a roof surrounded by and spaced from said cylindrical wall and including a buoyancy chamber; a cylindrical wall surrounding said buoyancy chamber and terminating at its upper end in an inturned annular flange; a plurality of elongated arc-shaped shoes located side by side and each in contact with the upright wall of said tank; a separate rod-shaped spring located between each such shoe and said buoyancy chamber with an intermediate portion of each such spring pivotally secured to a separate one of said shoes at a point intermediate the edges thereof and with one end of such spring pivotally secured to said cylindrical wall of said buoyancy chamber adjacent said inturned flange and with the other end of such spring located in sliding engagement with said cylindrical wall of said buoyancy chamber and a flexible impervious annular band secured to the upper end of each of said shoes and to the free edge of said inturned flange on the cylindrical enclosing wall of said buoyancy chamber.

2. In combination with a liquid storage tank having an upright cylindrical enclosing wall, a floating roof located within said tank and adapted to float on liquid contained therein; an arc-shaped shoe located within said tank and between said cylindrical wall and said roof and in engagement with the inner face of said wall; and an elongated rod-shaped spring pivotally secured to said shoe at an intermediate point of both said shoe and said spring and having one end thereof pivotally secured to

said roof and the other end thereof located in sliding engagement with a wall of said roof.

3. In combination with a liquid storage tank having an upright cylindrical wall, a floating roof structure located within and spaced from said wall; a plurality of arc-shaped plates located side by side within said wall and each in surface contact with an inner face of said wall; a separate elongated, rod-shaped spring member located between said roof and each of said plates with an intermediate portion of each such member pivotally secured to a separate one of said plates at a point intermediate the lateral edges thereof and with one end of each such member pivotally secured to said roof structure with the opposite end thereof located in sliding engagement with a vertically extending surface of said structure; and a flexible band-shaped member extending between said structure and each of said plates and rigidly secured to the upper edge of each of said plates and to an annular flange of said roof structure.

4. In combination with a storage tank for liquids, an open top cylindrical enclosing wall of said tank; a floating roof structure located within said tank and spaced from said wall and including in its make-up a buoyancy chamber; a plurality of arc-shaped shoes located between said roof structure and said cylindrical wall with each such shoe extending longitudinally of said wall; and a plurality of elongated springs each pivotally secured to a separate one of said shoes and pivotally secured at one end thereof to said roof structure, with the other end thereof located in sliding engagement with a vertically extending cylindrical wall of said chamber; and a flexible band located between said shoes and said roof and secured to the upper edge of each such shoe and to the upper portion of said roof structure.

5. In combination with a storage tank having a vertically extending, open top, cylindrical wall, a floating roof spaced from and surrounded by said wall; a plurality of arc-shaped shoes located side by side within said tank and between said wall and said roof, each such shoe extending longitudinally of said wall in surface contact with the inner surface thereof; and a separate elongated spring pivotally secured to each such shoe at an intermediate point of such shoe and of such spring and having one end thereof pivotally secured to said roof and the other end thereof located in sliding engagement with a surface of said roof.

6. In combination with a storage tank having a vertically extending, open top, cylindrical enclosing wall, a floating roof located within said tank and spaced from said wall and having a cylindrical surface of a portion thereof located opposite to and substantially centrally of the inner surface of said enclosing wall; an arc-shaped shoe located within and extending longitudinally of said wall with the concave surface thereof in surface engagement with the inner surface of said wall and an elongated spring located between said wall and said shoe with an intermediate portion thereof pivotally secured to one of said surfaces and with one end thereof pivotally secured to the other of said surfaces and with the other end of such spring in sliding engagement with the surface to which the first mentioned end is pivotally secured.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,019,935 February 6, 1962

Lloyd E. Anderson, Sr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 64, after "FIGURE 2", for "is" read -- as --; column 4, line 13, for "spread" read -- spaced --.

Signed and sealed this 29th day of May 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents