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2,408,538

LIQUID STORAGE APPARATUS

Filed Dec. 24, 1943

2 Sheets-Sheet 1

FIG. 1.

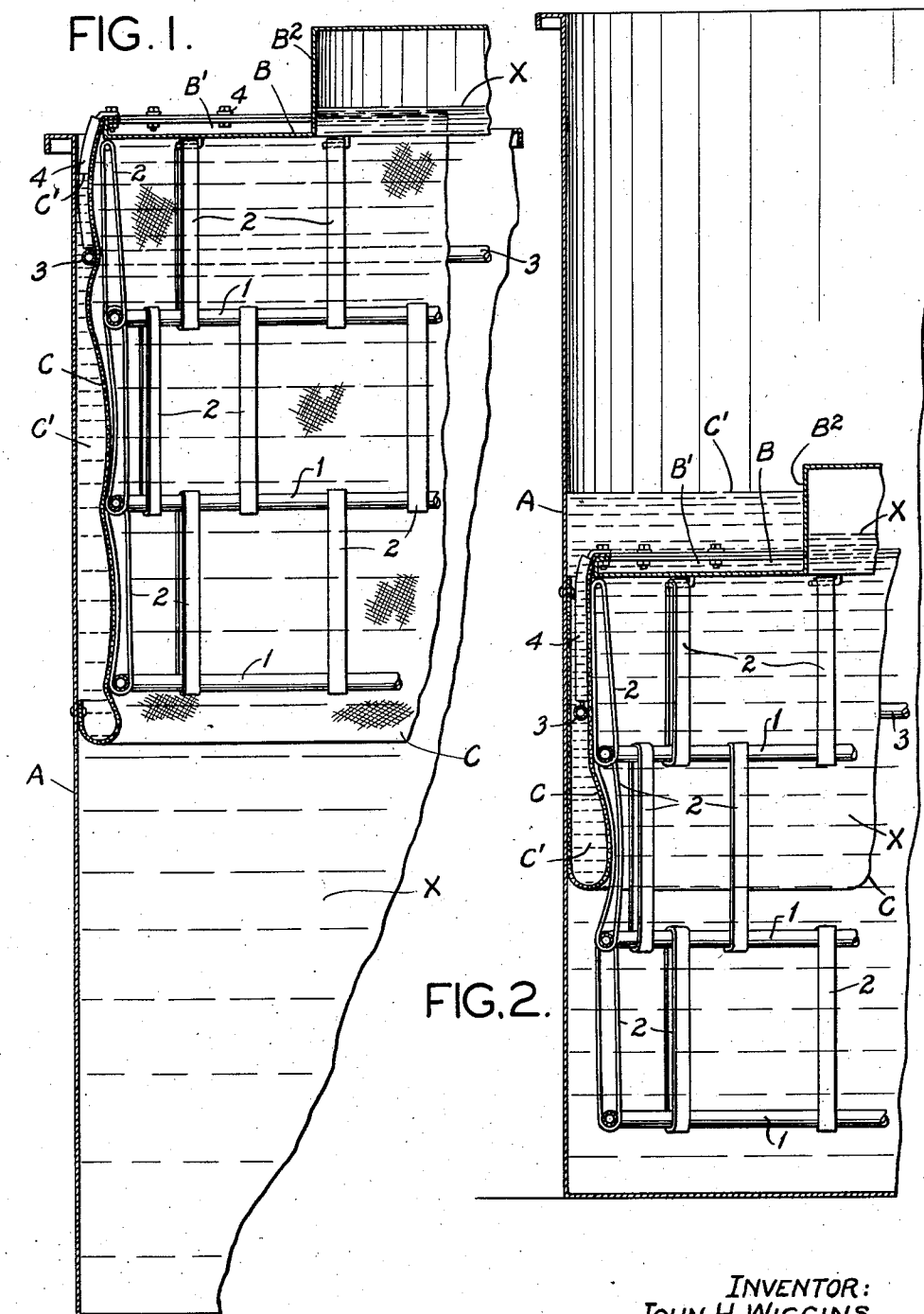
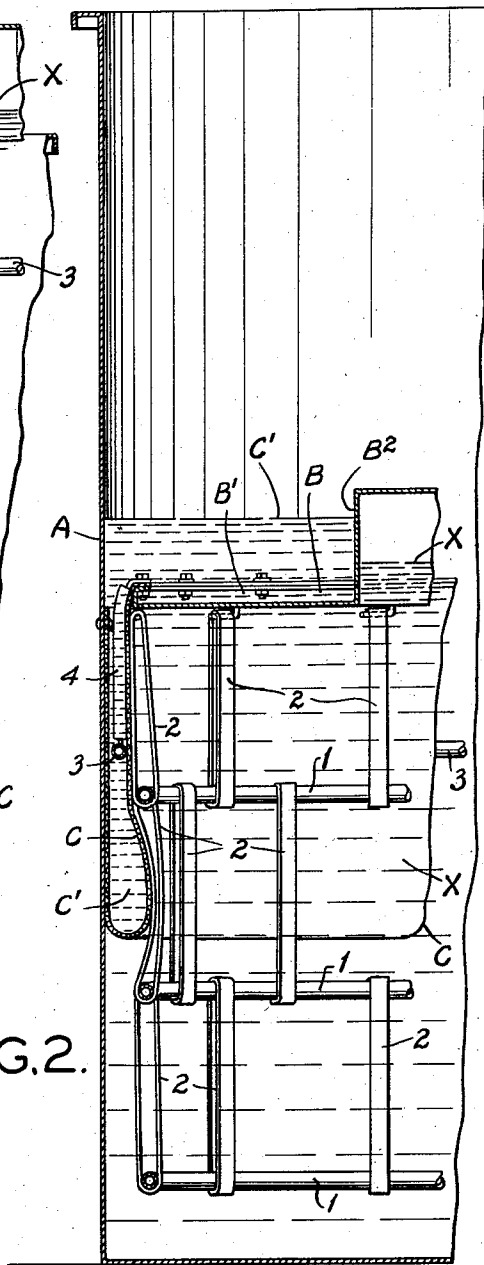


FIG. 2.



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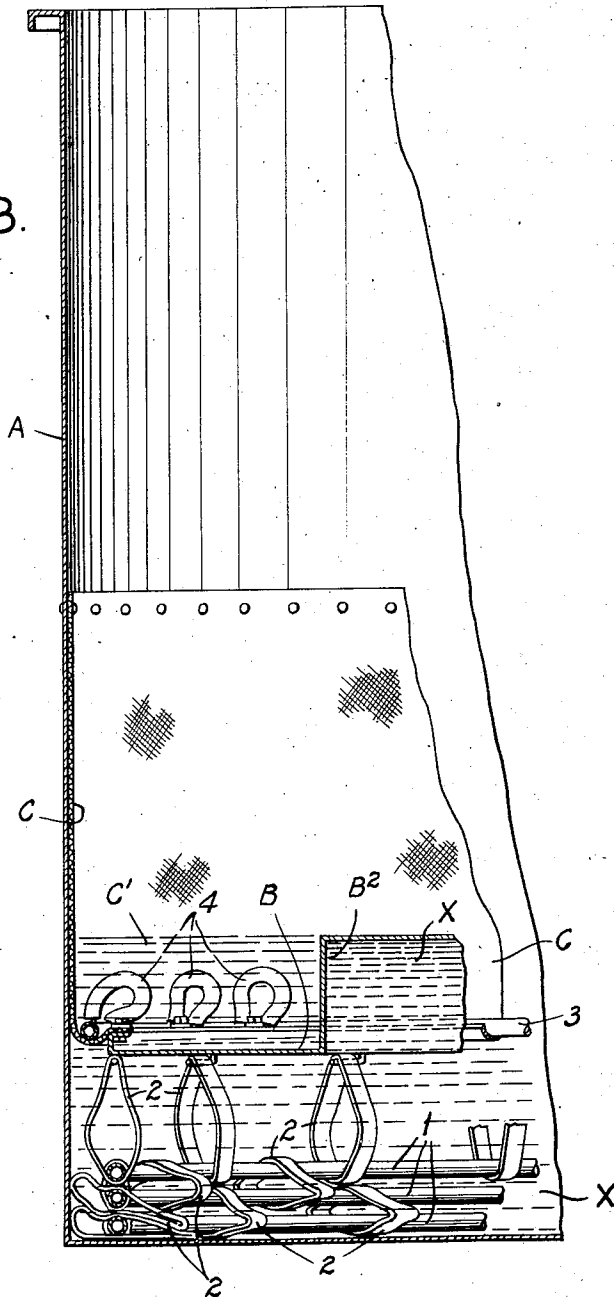
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FIG. 3.



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LIQUID STORAGE APPARATUS

John H. Wiggins, Chicago, Ill.

Application December 24, 1943, Serial No. 515,618

4 Claims. (Cl. 220-26)

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This invention relates to liquid storage apparatus of the general type that comprises a tank or container for holding the liquid, a vertically-movable member in said tank which constitutes a so-called "floating roof" that rests upon and is sustained by the liquid being stored, and a sealing means for the annular space around the peripheral edge of the roof, consisting of a flexible sealing element of treated fabric or other suitable material, attached to the edge of the roof and to the side wall of the container in such a manner that it will hang suspended from the underside of the roof during the rise and fall of the roof. A liquid storage apparatus of the general type or kind above mentioned is disclosed in my prior U. S. Patent No. 2,050,686, dated August 11, 1936.

One object of my present invention is to provide a liquid storage apparatus of the general kind mentioned, whose floating roof is provided at its peripheral edge with portions that constitute the bottom and one side wall of a trough which is adapted to receive a body of mobile liquid that is employed to hold the flexible sealing element in the form of a downwardly hanging loop, the co-acting parts of the apparatus being so arranged that during the upward travel of the roof, the mobile liquid in said trough will be discharged from same into the loop of the flexible sealing element or into the space between said element and the side wall of the container, and during the downward travel of the roof, said mobile liquid will be returned to said trough where it will be in readiness to perform its function during the succeeding upward travel of the roof.

Another object is to provide a storage apparatus of the general kind mentioned, that is equipped with a means or mechanism for preventing excessive bulging or bellying of the flexible sealing element, inwardly away from the side wall of the container, as a result of pressure exerted on said element by the mobile liquid confined in the loop of said element, or in the space between the sealing element and the side wall of the container.

And still another object of my invention is to provide a storage apparatus of the general kind mentioned, that is equipped with a novel means or mechanism for preventing the flexible sealing element from bulging or bellying outwardly excessively and rubbing against the side wall of the container, in instances where the liquid stored in the container exerts outward pressure on said sealing element in excess of the inward pressure which the mobile liquid exerts on said element.

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Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a fragmentary vertical transverse sectional view of a liquid storage apparatus embodying my present invention, showing the floating roof at the end of its upward stroke, in the position it occupies when the container is full of liquid.

Figure 2 is a similar view, showing the floating roof in an intermediate position between its high and low positions; and

Figure 3 is a similar view, showing the roof in its lowermost position.

In the drawings, A designates the side wall of a container or tank in which liquid X is being stored, and B designates a vertically-movable floating roof that rests upon and is sustained by the liquid X being stored. The annular space at the peripheral edge of the roof is closed by a flexible sealing element C, preferably constructed of treated fabric, attached to the peripheral edge of the roof and to the intermediate portion of the side wall of the container, and made of such shape and size that it is capable of folding or doubling during the rise and fall of the roof.

In order to insure that the sealing element C will assume the form of a downward-hanging loop, I provide the roof B at its peripheral edge with portions that constitute the bottom and one side wall of a trough, designated as an entirety by the reference character B', that is adapted to contain a body of mobile liquid C', which, during the upward travel of the roof, escapes from or spills out of said trough B' and exerts a force on the sealing element C that causes said sealing element to assume the shape or form of a downwardly hanging loop. Said trough B' can be constructed in various ways without departing from the spirit of my invention. In the form of my invention herein illustrated, the roof is provided with an upwardly-projecting rim B², set some distance inwardly from the edge of the roof, so that it constitutes one of the vertical side walls of a trough B', whose bottom is formed by the peripheral portion of the roof, the sealing element C being made of such length that when the roof is in its lowermost position, as shown in Figure 3, said sealing element constitutes the other vertical side wall of the trough B'. At such times the mobile liquid C' in the trough B' exerts a downward force on the part of the sealing element C immediately adjacent the peripheral edge of the roof, and causes it to assume a downwardly-looped form, as clearly shown in Figure 3. As the roof moves upwardly,

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more and more of the mobile liquid C' escapes from the trough B', into the loop of the sealing element C, or into the space between said element and the side wall of the container, with the result that by the time the roof reaches its highest position, as shown in Figure 1, all, or practically all, of the mobile liquid has been discharged from the trough B' and applied to the sealing element C in such a way as to insure that said sealing element will hang suspended from the edge of the roof. During the first portion of the downward travel of the roof, the portion of the side wall A of the container located above the point of attachment of the sealing element C with said side wall, functions as a side wall for the trough B', arranged in opposed relation to the other side wall B² of said trough. During such movement of the roof, the mobile liquid C' starts to return to the trough B' and as the downward movement of the roof continues, more and more of the mobile liquid returns to said trough, with the result that by the time the roof reaches its lowermost position, all of the mobile liquid C' is in the trough B' in readiness to again perform its function on the succeeding upward-stroke of the roof. By handling the mobile liquid C' in the manner above described, I produce an inexpensive apparatus, inasmuch as the bottom and one side wall of the trough B' are formed by portions of the roof and the other side wall of said reservoir is formed by a flexible sealing element C, or by the upper portion of the side wall A of the container.

If the mobile liquid C' is of greater specific gravity than the liquid X being stored in the apparatus, there is a tendency for the flexible sealing element C to bulge inwardly excessively, away from the side wall of the container, due to the weight of the sealing liquid C', or the inward force said liquid exerts on the sealing element C. Such excessive inward flexing or bellying of the sealing element C produces random wrinkles or folds in same, which are injurious to said element. In order to overcome this objection, I have provided the floating roof B with a means or mechanism that effectively takes up forces or strains exerted on the sealing element C in a direction tending to cause it to bulge or belly inwardly excessively during the rise and fall of the roof, and when the roof is in its uppermost position, said means or mechanism being of such construction and arrangement that it accomplishes this highly desirable result, without subjecting the sealing element to excessive friction or causing said element to wear rapidly, due to relative vertical movement between said means and the element C. Preferably, the means or mechanism just mentioned is of general construction or character described in my companion application Serial No. 515,613, filed of even date herewith, and consists of a collapsible barrier, fender, or fence suspended from the peripheral edge of the floating roof B at a point between the sealing element C and the center of the roof, and composed of a plurality of superimposed, annular-shaped compression members 1, joined to each other and suspended from the underside of the roof by groups of flexible supporting devices 2. The compression members 1 can be conveniently formed from metal pipe or tubing, bent to form ring-shaped members of a diameter only slightly less than the diameter of the roof B, and the flexible supporting devices 2 can be formed from strips of suitable flexible material, or from pieces of chain or cable, cov-

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ered with rubber or some other suitable material, that will prevent injury to the sealing element C when said element contacts with said supporting devices.

When the roof B approaches its lowermost position, shown in Figure 3, the above described barrier or fender collapses into an inactive condition, with the compression members 1 disposed in stacked relationship on the bottom of the container, the supporting devices 2 being sufficiently flexible to permit the members 1 to pile up, one on top of the other. During the upward travel of the roof, said barrier or fender progressively unfolds and assumes an active position, or operative position, wherein it is arranged in such relationship with the sealing element C, that pressure exerted by the mobile liquid C' on the sealing element C in a direction tending to flex said element inwardly, or towards the center of the container, is taken up or absorbed by the barrier, whereby excessive inward bulging, ballooning or bellying of the flexible sealing element is effectively prevented. Moreover, this highly desirable result is accomplished without subjecting the sealing element C to excessive friction, inasmuch as the sealing element C travels at the same speed as the fender, or barrier, and at no time has a rubbing action on the fender, caused by relative vertical movement between said element and fender.

In addition to providing the floating roof B with a barrier or fender that rises and falls with the roof, and automatically collapses into an inactive condition as the roof approaches its lowermost position, I prefer to provide the roof with a means for preventing the flexible sealing element C from being forced outwardly into rubbing contact or engagement with the side wall A of the container, in the event the pressure in the space between the sealing element C and the side wall of the container becomes less than the outward force or pressure which the stored liquid X exerts on the sealing element C. Such a reduced, diminished or minus pressure might be created on the external side of the sealing element C, or in the space between said element and the side wall of the container from various causes. For example, abnormal evaporation of the sealing liquid C' might cause the stored liquid X to exert an outward force on the sealing element C, tending to cause said element to rub on the side wall of the tank, thereby retarding the upward movement of the roof and subjecting the sealing element C to excessive wear. In the form of my invention herein illustrated the means last referred to that is used to control or limit outward flexing of the sealing element C, consists of one or more annular shaped tension members 3 suspended by chains or other suitable flexible devices 4 from the peripheral edge of the roof B, at a point on the outside of the fabric element C. If, during the upward travel of the roof, or when the roof is in its uppermost position, the sealing element C tends to belly outwardly excessively, the tension member or members 3 take up the outward force exerted on the element C, and prevent the same from rubbing against the side wall of the container.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a liquid storage apparatus, the combination of a container for holding the liquid being stored, a floating roof sustained by the stored liquid, an annular, flexible, liquid-imper-

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sealing element attached to the peripheral edge of the roof and to the side wall of the container substantially midway of its height so that in the extreme high and low positions of the roof said element will be distended or stretched in substantially parallel relation to the side wall of the container and in an intermediate position of the roof said element will form a downwardly hanging loop which is open at its upper end, a body of mobile liquid that is adapted to flow into and out of the loop of said sealing element and into and out of the space between said element and the side wall of the container during the rise and fall of the roof, and a trough that is adapted to hold said mobile liquid, the bottom and one side wall of said trough being formed by portions of the roof and the opposed side wall of said trough being formed by the flexible sealing element when the roof is at or near its extreme low position and by the side wall portion of the container when the roof is at or near its extreme high position.

2. In a liquid storage apparatus, the combination of a container for holding the liquid being stored, a floating roof sustained by the stored liquid, an annular, flexible, liquid-impervious sealing element attached to the peripheral edge of the roof and to the side wall of the container substantially midway of its height so that in the extreme high and low positions of the roof said element will be distended or stretched in substantially parallel relation to the side wall of the container and in an intermediate position of the roof said element will form a downwardly hang-

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ing loop which is open at its upper end, a body of mobile liquid that is adapted to flow into and out of the loop of said sealing element and into and out of the space between said element and the side wall of the container during the rise and fall of the roof, and a trough for holding said mobile liquid when the roof is in its lowermost position, said trough being formed by said sealing element, by the peripheral portion of the roof, and by an upwardly-projecting part on the roof located adjacent the peripheral edge of the roof.

3. A liquid storage apparatus of the kind described in claim 1, provided with a barrier for preventing excessive bulging of said flexible sealing element, said barrier being composed of a plurality of superimposed, horizontally-disposed, ring-shaped compression members joined to each other and suspended from the underside of the roof by flexible supporting devices.

4. A liquid storage apparatus of the kind described in claim 1, provided with a vertically-collapsible barrier suspended from the underside of the roof for preventing excessive inward bulging of said flexible sealing element, said barrier being composed of a plurality of superimposed, horizontally-disposed, ring-shaped compression members, and an independent barrier for restricting excessive outward flexing of said sealing element, mounted on the roof so as to occupy a position between said sealing element and the side wall of the container during a portion of the cycle of operations of the roof.

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