June 23, 1942. J. H. WIGGINS 2,287,211

FLOATING TANK ROOF

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FIG. 1.

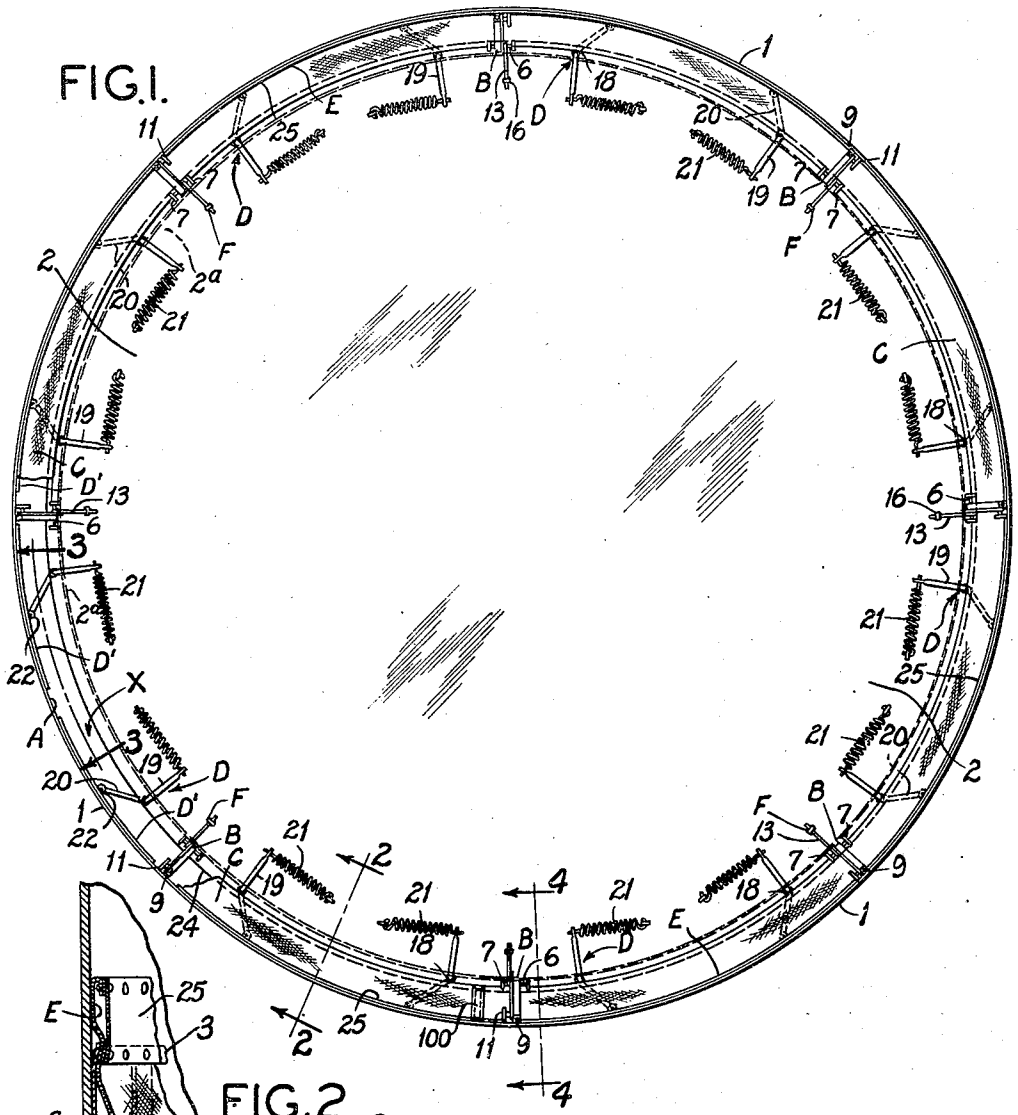

FIG. 2.

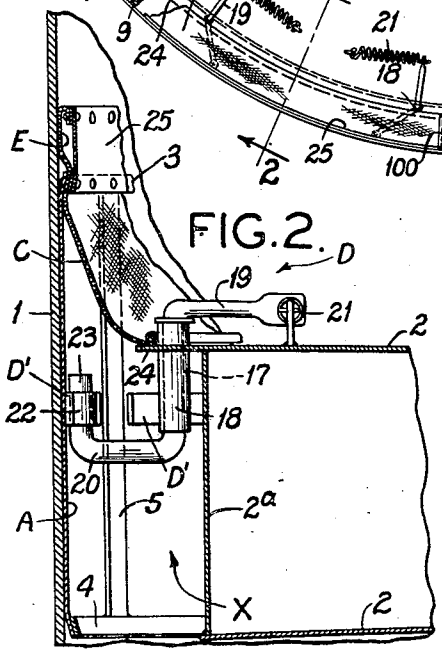

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FIG.3.

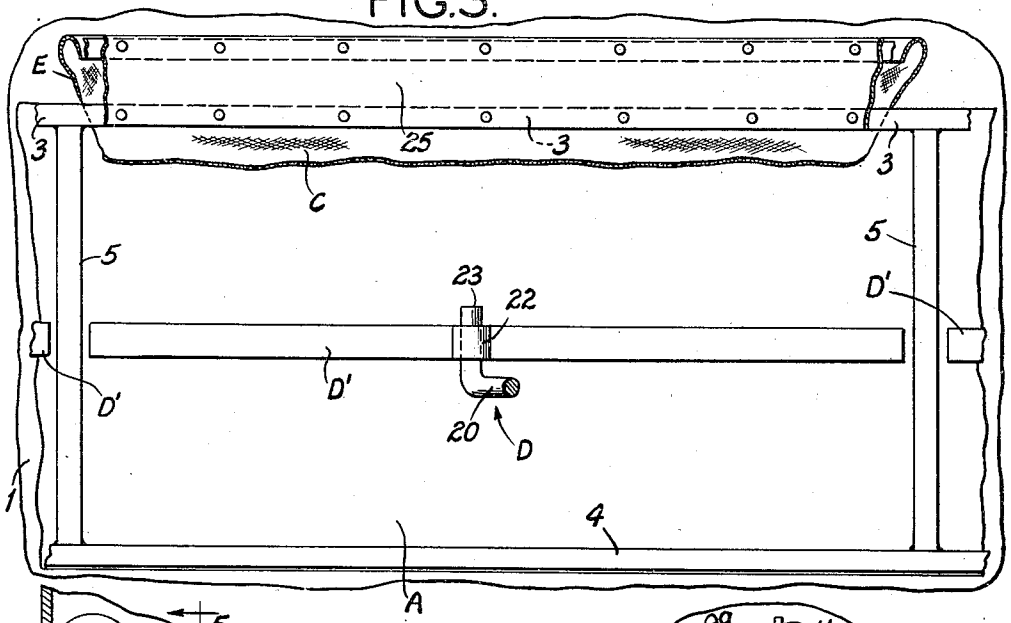


FIG.4.

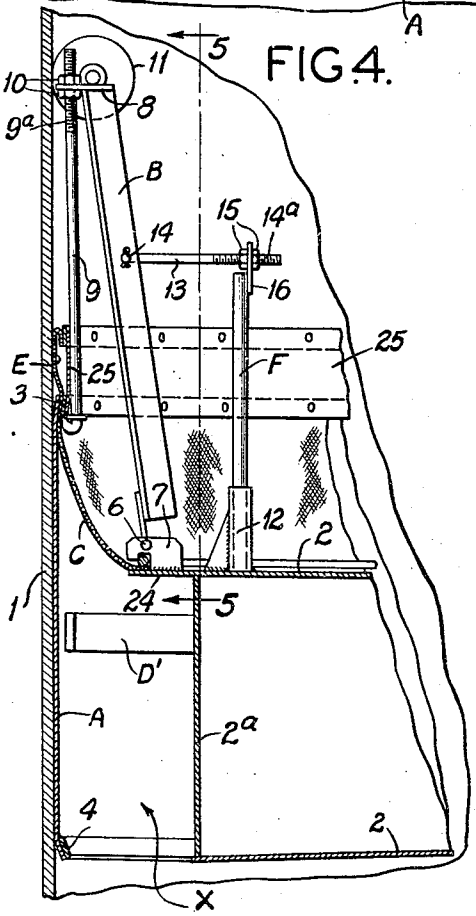
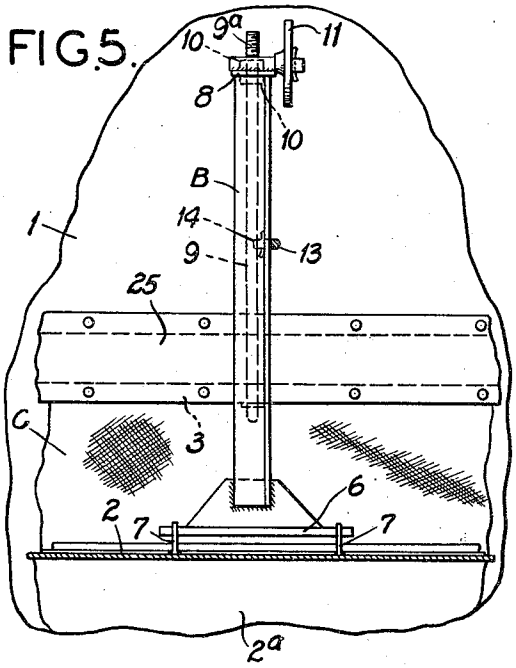


FIG.5.



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2,287,211

FLOATING TANK ROOF

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Application December 21, 1938, Serial No. 247,031

10 Claims. (Cl. 220—26)

This invention relates to floating tank roofs, and particularly, roofs of the type that comprise an annular seal sustained by swinging hangers or equivalent devices on the roof, and arranged in sliding engagement with the side wall of the tank, and a closure for the annular space between said seal and the rim on the floating roof, formed usually by gas-tight fabric attached to said seal and rim.

One object of my present invention is to provide a floating tank roof of the general type mentioned, that is easy to erect or build; that will reduce evaporation losses to a minimum; that comprises fewer parts than floating tank roof seals of conventional construction, and which will efficiently perform its function, even after long usage.

Another object of my invention is to provide a floating tank roof in which the means that is employed to hold the side wall seal in sliding contact with the side wall of the tank is of such design that, notwithstanding the fact that some of the parts of said means are arranged on the exterior of said roof, and some of the parts of said means are arranged in the vapor space of the tank, there are no parts or portions of said means which penetrate or pass through the fabric element that is used to form a closure for the space between the rim of the floating roof and the seal that acts on the side wall of the tank.

And still another object of my invention is to provide a floating tank roof sealing means in which the seal that acts on the side wall of the tank is provided at its top edge with a secondary seal or auxiliary seal of novel construction, that is tightly pressed against the tank side wall at all times. Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a top plan view of a floating tank roof constructed in accordance with my invention, partly broken away, so as to more clearly illustrate the construction of the spring-actuated presser devices that are used to exert outward pressure on the said side wall seal intermediate its top and bottom edges so as to press said seal against the side wall of the tank.

Figure 2 is a vertical sectional view, taken on the line 2—2 of Figure 1.

Figure 3 is an enlarged fragmentary view, for the purpose of more clearly illustrating the construction of the side wall seal, the secondary or auxiliary seal at the top edge of said seal, and the presser bars that act on the inner side of the side wall seal, the said view being taken at the point indicated by the arrows marked 3 in Figure 1.

Figure 4 is an enlarged vertical sectional view, taken on the line 4—4 of Figure 1, and illustrates the construction of the swinging hangers that are used to sustain the side wall seal; and

Figure 5 is a vertical sectional view, taken on the line 5—5 of Figure 4, looking in the direction indicated by the arrows.

The floating tank roof that constitutes my present invention may be of the pontoon type or of the pan type, and is provided with the following elements, i. e., a side wall seal designated as an entirety by the reference character A arranged vertically in substantially parallel relationship with the side wall 1 of the tank, a plurality of swinging hangers B mounted on the peripheral edge portion of the floating roof 2 for sustaining said seal, a closure for the annular gas space x between the side wall seal and the rim 2^a of the floating roof, and formed preferably by an annular-shaped piece of gas-tight fabric C attached in any suitable way to the peripheral portion of the floating roof, and to the seal A, and a plurality of spring-actuated presser devices D rockably mounted on the peripheral portion of the roof and combined with presser bars D' that bear upon the inner side of the seal A, at a point intermediate the top and bottom edges of said seal, and exert outward pressure on said seal in a direction to hold it against the side wall of the tank. I also prefer to equip the above described sealing structure with a secondary seal or auxiliary seal E arranged at the top edge of the side wall seal A, and constructed in such a way that it will always remain tightly pressed against the side wall of the tank.

The side wall seal A may be of any preferred construction, so long as it is of substantial height and has sufficient circumferential flexibility to enable it to conform, or approximately conform, to the shape of the curved or circular-shaped wall of the tank. It may be composed of a plurality of segmental-shaped shoe members whose ends are joined together by gas-tight, flexible connecting devices, as is more or less standard practice, or it may consist of a single shoe that extends practically continuously around the side wall of the tank. In the preferred form of my invention herein illustrated the side wall seal A is preferably constructed in the form of a split ring or shoe that extends unbrokenly around the side wall of the tank, and which is provided with a single gap that is closed or sealed by a verti-

cally-disposed sealing device 100, as shown in Figure 1, that may be of any preferred type or kind, so long as it provides for the expansion and contraction of the shoe. Said shoe comprises a vertically-disposed web and reinforcing members 3 and 4 at the top and bottom edges of said web that extend around the entire circumference of the shoe. In order that the shoe will be relatively light in weight, strong enough to successfully perform its function and still be capable of flexing circumferentially sufficiently to conform to the shape or curvature of the side wall of the tank, I prefer to construct the shoe in the form of a girder composed of the reinforcing elements 3 and 4, previously referred to, that act as stress members, and vertically-disposed bars or members 5 that take the shear, the co-acting parts 3, 4 and 5 forming, in effect, a light weight beam which carries a vertically-disposed web that acts on the side wall of the tank. The web of the shoe can be formed from any suitable relatively light weight limber sheet material. I have found that No. 16 extra heavy galvanized steel is suitable material from which to form the web of the shoe, but various other types and kinds of thin sheet material and fabrics might be used. If desired, rubbing strips or equivalent devices may be attached to the outer face of the web of the shoe, so as to protect the finish of the sheet material from which said web is constructed. In the event the side wall seal is made up of a plurality of segmental shoe members, instead of a single annular-shaped shoe, as herein illustrated, each of said segmental shoe members will preferably be composed of a vertically-disposed web provided with stress members, as above explained. A side wall seal of the construction above described can be easily fabricated in the field, or at the point where the tank is erected; it is inexpensive to construct; it is relatively light in weight, but nevertheless, is capable of holding its shape or form; and it has sufficient circumferential flexibility to insure its accurately conforming to the shape of the side wall of the tank.

The hangers B that carry the side wall seal A are arranged in spaced relationship around the peripheral portion of the floating roof 2, and are of such design that in addition to suspending said seal A in a vertical position, they exert pressure on the roof in a manner tending to maintain said roof in concentric relationship with the side wall of the tank. While the specific construction and arrangement of the hangers B may be varied to suit different conditions, they differ from the conventional hangers heretofore used for supporting the side wall seals of floating roofs for liquid storage tanks, in that said hangers are rockably mounted on the roof and are so disposed that the upper ends or free ends of said hangers lean against the inner face of the side wall of the tank, the side wall seal being suspended from said hangers. This method of arranging the hangers and side wall seal is desirable, in that it utilizes the tank side wall to furnish one component of the force required to sustain the hangers and the load thereon, and it allows the side wall seal to move freely in all directions in a substantially horizontal plane. In the particular form of my invention herein illustrated, each of the hangers is composed of an upright member, formed preferably by a piece of angle iron, whose lower end portion has attached to same a horizontally-disposed trunnion 6 that is supported in bearings 7 on the floating roof. At the upper end of the member B is a bracket 8 from which is suspended a swinging rod 9 provided at its lower end with a hook on which the seal A is supported, preferably by the reinforcing member or bar 3 at the top edge of said seal. In order that the side wall seal may be adjusted vertically relatively to the hanger, the rod 9 is provided with a screw-threaded portion 9a that receives a nut 10 arranged above the bracket 8 on a pair of nuts 10 arranged above and below the bracket 8. The swinging member B is provided at its upper end with a roller or equivalent anti-friction device 11 that engages the inner face of the side wall 1 of the tank, and a resilient means is associated with said swinging member B, so as to normally hold it in a certain approximate position, but permit said member to move inwardly and outwardly slightly with relation to the side wall of the tank. Preferably, the means just referred to is formed by a spring rod F arranged vertically in a socket 12 on the floating roof, and provided at its upper end with a connecting member 13 that joins said spring rod F to the hanger B. In the preferred form of my invention herein illustrated the connecting member 13 is formed by a horizontally-disposed rod pivotally connected at 14 to the hanger, and provided at its opposite end with a threaded portion 14a which carries two nuts 15 that are arranged at the opposite sides of a bracket piece 16 on the upper end of the spring rod F. The rod 9 from which the side wall seal A is suspended gives a vertical lift in all positions, and causes the lift on the seal to go right against the seal itself, thereby eliminating all overturning movement. The roller 11 at the upper end of the hanger makes the hanger practically frictionless, and on account of the relatively great length of the swinging member B, the horizontal thrust of said member on the tank wall is very small and this is decreased to nearly zero by the pull back effect of the spring rod F. Thus, all the forces on the hanger relative to the roof tend to center the roof in the tank. In the normal operation of the roof the spring rod F pulls the hanger back, if it moves out, and pushes the hanger out, if the hanger moves inwardly from the position shown. The horizontal thrust of side wall seal weight and friction is taken by the roller 11 at the upper end of the hanger, thus eliminating friction due to side wall seal weight.

In order to insure proper contact or engagement between the seal A and the side wall of the tank, I employ presser devices of novel construction, that exert outward pressure on said seal in such a way as to effectively produce a line contact along all points of which the outward presure exists. Some of the parts of said presser devices are arranged on the exterior of the floating roof, and some of the parts of said devices are arranged in the annular gas space x between the side wall of the tank and the rim 2a on the floating roof, but said presser devices are so constructed that they do not penetrate or pass through the flexible closure member C that is joined to the side wall seal A and to the peripheral portion of the floating roof. Preferably, the seal comprises a plurality of presser devices, each designated as an entirety by the reference character D, arranged in spaced relationship around the peripheral edge of the floating roof, as shown in Figure 1. Each of said presser devices comprises a vertically-disposed shaft portion 17 mounted in a bearing or stuffing box 18 carried by the floating roof, a horizontally-disposed arm

19 at the upper end of said shaft portion 17 arranged on the exterior of the roof, and a horizontally-disposed arm 20 at the lower end of said shaft portion 17 that is attached to a horizontally-disposed presser bar D', which bears against the inner side of the shoe, as shown clearly in Figures 2 and 3. Attached to the outer arm 19 of the presser device is a contractile spring 21, which exerts pressure on the arm 19 in a direction tending to cause the inner arm 20 of the device to force the presser bar D', and the seal A which it engages, towards the side wall of the tank, thereby causing said seal to be held in snug engagement with the tank side wall by a horizontally-disposed, spring-pressed member, to wit, the presser bar D' which engages the inner side of the seal at a point intermediate the top and bottom edges of the same. The connection between the presser bar D' and its supporting arm 20 is preferably formed by a bearing 22 on the inner side of the presser bar that receives a vertically-disposed pintle 23 on the arm 20, thus forming a pivotal connection between the presser bar and the device which actuates it. The presser bars D' have a circumferential friction on the seal A, if said seal moves in or out, thus causing the bars D' to slide along said seal. In order to balance this friction, I construct and arrange the presser devices D so that one-half of the total number of presser devices have arms 20 that project to the right, and the remainder of said presser devices have arms 20 that project to the left, as shown in Figure 1, the springs 21 being combined with the presser devices D in such a way that half of said presser devices will rock to the right and half of said presser devices will rock to the left, thereby effectively balancing the circumferential friction of the presser bars D', on the side wall seal A. The stuffing box or bearing 18 that receives the shaft portion 17 of the presser device is mounted in a flange or metal portion 24 of the floating roof that overhangs the vapor space x and which is arranged above the normal liquid line, thereby making it possible to mount the presser devices on the floating roof, without interfering with the gas-tight closure element C, and without interfering with the pontoon of the roof, in case the roof is of the pontoon type. In addition to permitting the presser devices D to be mounted on the floating roof without puncturing the fabric element C, the above described flange or laterally-projecting portion 24 of the roof effects a considerable saving in the quantity of fabric required to form the closure element C, due to the fact that it is possible to extend said flange laterally into comparatively close proximity to the side wall of the tank, and still have ample space beneath said flange for any mechanism it may be necessary or desirable to use to press the seal A against the side wall of the tank. Still another advantage of said flange or laterally-projecting shelf portion 24, is that it decreases the amount of steel required to build the float of the roof, inasmuch as the bottom plate and rim portions 2^a of the float are smaller than would be required if the rim of the roof were not equipped with a laterally projecting portion 24 overhanging the gas space at the peripheral edge of the roof. In a structure of the character above described, the side wall seal A is subjected to an outward push at substantially all points of its circumference, and the point at which the pressure is applied usually is located at about the center of the vertical dimension of the shoe. All of the forces exerted on the shoe tend to center the roof in the tank, and another desirable feature of such a structure is that the springs 21 that form part of the presser devices D are located on the outside of the roof where they are easily accessible and not subjected to the deleterious action of gases or vapors arising from the oil confined in the tank.

The secondary or auxiliary seal E, previously mentioned, that is arranged at the top edge of the side wall seal or shoe A, is preferably formed by a flexible element, preferably constructed from gas-tight fabric, and arranged so as to extend upwardly from the shoe A and bear against the side wall of the tank at a point above the top edge of said shoe. The lower end of said flexible auxiliary sealing element E is attached to the shoe A, and various means may be used to support the upper end portion of said sealing element and hold it in snug sliding engagement with the side wall of the tank. In the form of my invention herein shown the fabric that constitutes the auxiliary seal E is attached at its upper end to a spring member or resilient member 25 carried by the shoe E and projecting upwardly above the top edge of said shoe, the member 25 being of such design, construction and arrangement that the auxiliary seal E will extend upwardly from the top edge of the shoe A, thence upwardly in a substantially vertical direction in sliding engagement with the tank side wall, and thence inwardly to the supporting member 25, to which the top edge of said auxiliary seal is attached. One advantage of an auxiliary seal of the kind above described is that a change in the direction of movement of the floating roof does not subject said auxiliary seal to additional strain by causing it to flap into one position when the roof starts to move downwardly, and then flap into a different position when the roof starts to move upwardly. In my improved construction the supporting member 25 always holds the auxiliary seal E in substantially the same position, irrespective of the direction of movement of the floating roof, i. e., in a position disposed above the top edge of the side wall shoe A and in sliding engagement with the side wall of the tank, and a change in the direction of movement of the roof imposes no additional strain on the flexible material from which the auxiliary seal E is constructed and does not reduce the efficiency of the sealing action of said auxiliary seal on the tank side wall. And still another advantage of my improved construction is, that it is inexpensive to manufacture and it is easy to service, the side wall shoe A being formed from an annular-shaped circumferentially flexible structure having a straight top edge, and the auxiliary seal E being formed from a substantially cylindrical-shaped, flexible element whose lower end can be easily attached to the side wall shoe A and whose upper end can be easily attached to the means that supports said auxiliary seal in a substantially upright position and holds it in sliding contact with the tank side wall.

A floating tank roof of the construction above described has a materially lower evaporation loss then floating tank roofs of conventional construction; it is cheaper to build; the co-acting parts of same are easy to fabricate and install, and notwithstanding the fact that the side wall seal is always held in snug engagement with the side wall of the tank, there is very little friction between the tank side wall and the seal, and the

roof is maintained in accurate concentric relationship with the side wall of the tank.

In my present application I have not claimed all of the elements, or all of the combinations of elements, above described, in view of the fact that I have filed two divisional applications, to wit, Serial No. 372,865, filed January 2, 1941, whose claims are directed to an annular side wall seal, or a segment of an annular side wall seal, made up of a beam of skeleton-like construction, to which is attached a web formed from a piece of limber, light-weight sheet material, and Serial No. 372,866, filed January 2, 1941, whose claims are directed to a side wall seal of substantially cylindrical form, that is mounted on the floating roof in a novel manner that permits said seal to move freely in all directions in an approximately horizontal plane, and also permits said seal to be adjusted vertically, relatively to the floating roof, so as to maintain said seal in substantially parallel relationship with the side wall of the tank.

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

1. In a container for storing liquids, the combination of a side wall, a floating roof, a sealing means for the space between said roof and side wall, comprising a seal adapted to act on said side wall, a supporting means for said seal, a flexible member attached to said seal and to said roof to form a closure for the space at the peripheral edge of the roof, thus forming an annular vapor space between said closure and the liquid in the tank, presser devices within said annular vapor space that move relatively to said seal and force said seal outwardly against said side wall, and an actuating means for said presser devices arranged on the exterior of the roof.

2. In a container for storing liquids, the combination of a side wall, a floating roof, a sealing means for the space between said roof and side wall, comprising a seal adapted to act on said side wall, a supporting means for said seal carried by said roof, a flexible member attached to said seal and to said roof to form a closure for the space at the peripheral edge of the roof, thus forming an annular vapor space between said closure and the liquid in the tank, presser devices within said annular vapor space that move relatively to said seal and force said seal outwardly against said side wall, and actuating springs for said presser devices arranged on the exterior of the roof, said presser devices comprising portions that turn in bearings on the roof that are located outside of the zone at which said flexible closure member is attached to the roof.

3. In a container for storing liquids, the combination of a side wall, a floating roof provided at its peripheral edge with a rim that is separated by an annular space from said side wall, a seal comprising a relatively deep, vertically disposed portion arranged in sliding engagement with said side wall and projecting downwardly into said annular space, a supporting means on the roof from which said seal is suspended, a flexible member attached to said seal and to said roof to form a closure for said annular space, thus forming a vapor space between said closure and the liquid in the tank, and spring-actuated presser devices on the top side of the roof provided with parts, located in said vapor space, that move relatively to the vertically-disposed portion of said seal and exert outward pressure on said vertically-disposed portion intermediate the top and bottom edges of same.

4. In a container for storing liquids, the combination of a side wall, a floating roof provided at its peripheral edge with a rim that is separated by an annular space from said side wall, a seal adapted to act on said side wall and arranged partly in said annular space, swinging hangers on the exterior of the roof that support said seal, a flexible member attached to said seal and to said roof to form a closure for the said annular space, thus forming a vapor space between said closure and the liquid in the tank, presser devices in said annular space that move relatively to said seal and force said seal outwardly towards the side wall, and actuating devices on the exterior of the roof combined with said hangers and presser devices in such a way that the side wall seal is at all times subjected to the action of a yielding force that tends to hold the roof in concentric relationship with the side wall.

5. In a container for storing liquids, the combination of a side wall, a floating roof provided at its peripheral edge with a rim that is separated by an annular space from said side wall, a seal adapted to act on the side wall and arranged partly within said annular space, a metal portion on the roof that overhangs said annular space, a supporting means on the roof that carries said seal, a flexible closure member attached to said seal and to the metallic portion of the roof that overhangs said annular space, thus forming a vapor space between said closure member and the liquid in the tank, bearings in the said overhanging portion of said roof, and presser devices oscillatingly mounted in said bearings and comprising spring-actuated parts arranged on the exterior of the roof and portions within said vapor space that exert outward pressure against said side wall seal.

6. In a container for storing liquids, the combination of a tank side wall, a floating roof, a seal adapted to act on said side wall, swinging hangers on the top side of the roof arranged with their free ends or terminal ends bearing against said side wall, means for suspending said seal from said hangers, resilient devices on the top side of the roof combined with said hangers in such a way as to press said hangers against said side wall, a flexible member attached to said seal and roof to form a closure for the annular space at the peripheral edge of the roof, thus forming a vapor space between said closure and the liquid in the tank, and spring-actuated presser devices on the top side of the roof provided with portions that project downwardly into said vapor space and exert outward pressure on the web of the side wall seal intermediate its top and bottom edges.

7. In a container for storing liquids, the combination of a tank side wall, a floating roof, a seal adapted to act on said said side wall, swinging hangers on the top side of the roof arranged with their free ends or terminal ends bearing against said side wall, means for suspending said seal from said hangers, reilient devices on the top side of the roof combined with said hangers in such a way as to press said hangers against said side wall, a flexible member attached to the seal and to the roof to form a closure for the annular space at the peripheral edge of the roof, thus forming a vapor space between said closure and the liquid in the tank, a spring-pressed auxiliary seal at the upper end of the side wall seal

that acts on the side wall, and spring-actuated presser devices mounted in a metallic portion of the roof that overhangs the annular space at the edge of the roof and arranged so as to exert outward pressure on said side wall seal intermediate its top and bottom edges.

8. In a container for storing liquids, the combination of a side wall, a floating roof, an annular-shaped shoe carried by said roof and arranged in opposed relation to said side wall, and rockable presser devices attached to the peripheral portion of the roof in spaced relationship around the circumference of same and rotatable on vertical axes in such a manner that they yieldingly force the shoe outwardly towards said side wall, substantially one-half of said presser devices being arranged so as to swing clockwise and the remainder of said presser devices being arranged so as to swing counter clockwise.

9. In a container for storing liquids, the combination of a side wall, a floating roof, an annular-shaped shoe carried by said roof and arranged in opposed relation to said side wall, an auxilary seal comprising an annular strip of flexible material attached at its lower end to the upper edge portion of said shoe, said strip extending upwardly from the shoe, and a supporting means on the shoe extending upwardly from same and attached to the upper end portion of said strip and sustaining the same in a position extending upwardly from the shoe and engaging the tank side wall at a point above the top edge of said shoe.

10. A structure of the kind described in claim 9, in which the flexible strip constituting the auxiliary seal, extends outwardly until it contacts the tank side wall, then upwardly in contact with said wall, and thence extends inwardly towards the supporting means to which the upper end portion of said flexible strip is attached.

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